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.

\_\_\_\_\_\_ Indicates opportunities for integrated English language development (reading, writing, listening & speaking).

## Lesson 1: Amplitude & Energy

Engage

## **In-person activity option:**

#### **Introduce Phenomenon**

**Human Wave demonstration** 

Ask a group of students (6 - 7) to come to the front of the classroom and stand in a horizontal line shoulder to shoulder facing the class. Stand next to the first person in the line and explain that you and the students are going to "do the wave" (like at a sporting event). Demonstrate the wave and say, "Waves transfer energy, not matter."

Then, demonstrate again. Explain that you are going to show something that does not happen with waves. You start the wave and as the wave moves, run to the end of the line (So, you are the start of the wave and also the finish). Ask the class how a wave at a sporting event works. Do the people participating run all around the stadium? Or does the wave "transfer" from person-to-person. Connect to the idea that waves in the world operate similarly in that they do not transfer matter either. They simply transfer energy.

## <u>In-person or online activity option:</u>



<u>Integrated ELD - Science Conversation Placemat</u> - Feel free to use prompts and response frames to promote language development during Science Talk.

Show the **Amazing Human Wave** video

Explain to the students that "Waves transfer energy, not matter."

Show the video again. Ask the class how a wave at a sporting event works. Do the people participating run all around the stadium? Or does the wave "transfer" from person-to-person. What do they notice from the video?

Connect to the idea that waves in the world operate similarly in that they do not transfer matter either. They simply transfer energy.

Next, ask students to picture an ocean wave. It begins far out in the ocean and those that move toward the shore break as they strike the shoreline. Have the students close their eyes and picture the most peaceful ocean beach. Play the <a href="Beach">Beach</a> <a href="Ambiance video">Ambiance video</a> as they visualize their beach.

Have them follow the wave from out in the ocean to the shore. Then say, "Continue to keep your eyes closed...how many of you are picturing the water in the middle of the ocean that started the wave moving with the wave and landing on the shore of the beach?"

Many students should raise their hands. A great number of students have the misconception that the water from the middle of the ocean travels all the way to shore. Explain that this is not the case. Again state, "A wave transfers energy, NOT matter." While energy is transferred from the middle of the ocean to the shore, the matter is not. Explain that instead, that water wave is transferring through the matter and that the matter that a wave travels through is called a medium. In an ocean wave, energy transfers through the medium of water.

To help conceptualize the ocean waves you can show students the following pictures and GIF's

#### Waves

#### Waves GIF

## **In-person or online activity:**

Have students make a poster/model of how they believe waves work. Please encourage academic vocabulary, encourage more than just one way, encourage pictures, encourage diagrams. Students will go back and revise this poster/model in the Elaborate phase adding new information to demonstrate their understanding of waves.

<u>Teacher Demo option</u> - This can be executed in-person, through a Zoom meeting or pre-recorded for students to watch online.

Attach a ping pong ball to string/yarn/rope and hold it by the

rope/string/yarn. You are to get your tuning fork, hit it against the corner of a table, and then slowly touch the ping pong ball.

Alternatively, you teacher can share the **Tuning Fork Lab video** 

Ask the students: "What do you notice? What do you wonder?" Student responses can be recorded on a Notice/Wonder chart or Tree Map, either by the teacher or as an activity by making a copy of the chart for each student.

Explore

### **In-person or online activity:**

Student Explorations - These stations can be completed in-person or virtually.

Intro to Waves station activity: Recalling the Amazing Human Wave video from Engage, have students work in pairs to fill in the following: Introduction to Waves Notes. If needed, guide the virtual students through the activity during a Zoom meeting.

Here is a completed worksheet for reference.

### Into to Waves Notes\_key

<u>Demonstration 1: Rope Wave Demonstration</u> Have students use a jump rope, or whatever similar item they have around the house, to create various waves of their choice. Ask them to start to look for characteristics and properties of the waves they create. In addition, ask them to note the <u>medium</u>, the <u>direction</u> of the disturbance as well as the <u>direction</u> the wave is traveling.

When students are finished with their rope demo, have them complete the *Rope Wave Demonstration* section on the <u>Introduction to Waves Notes</u> page labeling the focus named in the question. Discuss each of the foci as a class.

## **Demonstration 2: Water Wave Demonstration**

## **In-person option:**

Next, students demonstrate water waves with the same purpose as the Rope Wave. Using tuning forks, have the students hit the fork on the edge of the table and then lower the vibrating fork into the water. In addition to noting the medium, the direction of the disturbance as well as the direction the wave is traveling, have the students note if there is any difference or relationships in energy transfer with the different tuning forks.

Water will spray! Students love this, but it will get their papers wet. Have them perform this at a lab counter away from their personal work space. When students are finished demonstrating (5 minutes) have them complete the *Water Wave Demonstration* section on the <u>Introduction to Waves</u>

Notes page labeling the foci named in the question. Discuss each of the foci as a class.

## In-person or online option:

Have the students watch the following video. The video shows the lowering of a vibrating tuning fork into water at full speed and in slow motion. The students can watch the video as many times as they need to to complete the drawing and questions. A teacher-created video or a <u>live</u> demonstration would work great here also.

#### **Tuning Fork video**

Have the students note the medium, the direction of the disturbance as well as the direction the wave is traveling.

When students are finished watching the video, have them complete the *Water Wave Demonstration* section on the <u>Introduction to Waves Notes</u> page labeling the foci named in the question. Discuss each of the foci as a class.

Next, discuss the Earthquake Model included in the <u>Introduction to Waves Notes</u> page. Have students identify the medium, direction of disturbance, and direction of the wave for seismic waves.

## **Demonstration 3: Transverse vs. Longitudinal Waves**

Explain that various waves behave differently from one another. For example, transverse waves (like light and electromagnetic radiation) are waves that move perpendicular to their disturbance while longitudinal waves (like sound waves) move in the same direction as their disturbance. Have the students fill this in on their notes sheet.

Share the Slinky Demo Video with students.

If students were completing this activity in class they would discover that transverse waves can be created by moving their hands side to side or back and forth. Longitudinal waves are created when the students push the slinky forward on the ground towards a classmate at the other end of the slinky causing compressions in the slinky.

Have students draw their model on their <u>Introduction to Waves</u> <u>Notes</u> page.

## Additional activity option:

## **How Far Does A Whisper Travel?**

Have students create a paper cup phone.

Link to activity

Explain

### <u>In-person or online activities:</u>

Achieve 3000 - Have students complete the 5-step lesson. As the teacher, you can facilitate the learning, if students need more support. Be sure to have students read both pages of the article.

\*must be logged into Achieve3000 to view

"A Tsunami, where?"\*

## **Direct instruction:**

Draw a transverse and longitudinal wave on the board or using the document camera. Label and explain each of the following characteristics of waves: *crest*, *trough*, *amplitude*, *frequency*, *wavelength*, and *pitch*.

Then, ask students to see if they can determine if there is a relationship between frequency and wavelength. Check in with each group to see if they have developed the correct relationship model. Students should find that an increase in

frequency results in a decrease in wavelength.

Then, lead the groups through a series of models. These may take anywhere from 1 minute to 3 minutes each, depending on where the students are in their mastery. Typically, as the students gain understanding, each model can be completed fairly quickly.

Ask the students to model the following:

\*\*\* Demo of Linked Videos are shown\*\*\*

- 1. Longitudinal wave with a high amplitude.
- 2. Longitudinal wave with a low amplitude.

After the first two models, ask the students to verbalize what they have to do to create longitudinal waves.

- 3. <u>Transverse wave</u> with a high amplitude.
- 4. Transverse wave with a low amplitude.

After these models, stop the class and ask students to verbalize what they have to do to the slinky to make a transverse wave.

- 5. Longitudinal wave with a high pitch.
- 6. Transverse wave with a low pitch.

Following these models, ask the students to verbalize what they had to do in order to create a high pitch with a slinky.

- 7. Transverse wave with a short wavelength.
- 8. Longitudinal wave with a high frequency.

Following these models, ask the students to verbalize what they had to do in order to create a short wavelength. Then, increase the complexity:

- 1. Longitudinal, high pitch, high amplitude
- 2. Transverse, low frequency, high amplitude
- 3. Transverse, high frequency, low amplitude
- 4. Longitudinal, long wavelength, low amplitude
- Additional In-person or online activities:

<u>Choice Board:</u> Teacher can create a Choice Board for students with various asynchronous options, if desired, or use the one below.

**Example Choice Board** - Waves - Amplitude & Energy

BrainPOP - Students can watch the movie and complete the review or graded quiz as a check for understanding. There are additional activities and related readings that can be assigned as well.

#### Waves

Zingy Learning - Students can complete the interactive lessons and quizzes as a check for understanding. There are additional questions that can be used in a Google Form or Doc as an outline for note taking during the lessons.

MS Subject-Specific, Unit 53, Lessons 1 & 2 on Waves and Energy

Mystery Science - Teacher can facilitate the learning through the mystery/lesson. There are activities that can be assigned through Google Classroom and modifications for virtual learning as well.

4th grade content review: Waves of Sound



### **In-person or online activities:**

Phet Wave on a String Simulation - Students can go to the Phet website and experiment with the different variables such as frequency, amplitude and tension, prior to revising their poster/model from the Engage phase.

Poster/Model revision - Students will refer back to their initial model from the Engage phase. Students should revise/recreate their posters to accurately depict transverse and longitudinal waves and include all relevant academic vocabulary. They should also include real life examples of waves and where they would encounter them.

#### Evaluate

# **Evaluate activity options:**

- <u>FlipGrid</u> Have students present their posters, via FlipGrid. Students can watch the presentations and leave feedback for their peers.
- Students can also present in their Zoom breakout groups as an **online** option.
- Have students draw in their Science Notebook or poster, three sets of different energy waves.
- Have students explain via illustration and a couple sentences how the energy of the wave affects the amplitude of the wave.
- Then have them give three real life examples that back up their illustrations.

Example: the more energy a wave has, the greater its amplitude.