



# **Stackable Instructionally- embedded Portable Science (SIPS) Assessments Project**

## **Grade 8 Science**

### **Unit 4 Instructionally-embedded Assessment Task Specification Tool:**

#### **“Representing Wave Properties Mathematically”**

#### **Providing Solutions to Problems Using Simple Wave Properties**

**August 2023**

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Grade 8	Unit 4	Instructional Segment 1	Task Title: Representing Wave Properties Mathematically
<b>Unit 1 Title: Providing Solutions to Problems Using Simple Wave Properties</b>			
<b>Anchor Phenomenon</b>		<b>Problematization/Investigative Strategy for the Unit</b>	
<p>In this unit, the anchor phenomenon is about light and sound in different environments. The teacher presents students with an engineering design challenge: <i>Design a piece of equipment that a child your age could use to help cope with sensitivities to light, sound, or particular colors.</i></p> <p>The teacher can customize the anchor phenomenon, rather than using the design challenge example. Additional suggestions for the anchoring phenomenon include designing a piece of safety equipment that could be used by NASA in space or on the surface of the moon or Mars to protect individuals from sudden bright lights and loud sounds and allows them to quickly turn them on or off, or some other design challenge that challenges youth to use information about waves, light, and sound together.</p> <p>The teacher may also want to consider local industry and the community for the anchoring phenomenon. For the lesson, <i>Into the Shark Tank</i>, students are asked to present their idea as if making a pitch to investors. Potential investors could include local industry experts who could also provide guidance and feedback to students. The teacher may want to contact representatives from a local engineering group or regional industry to bring in local experts who may have additional ideas for a potential problem area.</p>		<p>If we want to understand properties of mechanical and light waves well enough to be able to design and develop effective solutions, we need to understand and compare waves' properties, including how those properties manifest in different environments. We need to understand what leads to these differences and the effect of a medium on wave behavior. What is it about the environment that causes changes to how we see and hear waves? How does the presence or absence of a medium affect wave behavior? We also need to compare frequency, amplitude, and wavelengths of different wave types. How does structure of various waves define their properties? Students engage in a variety of investigations, use mathematics, and build models as they answer these questions and develop their understanding of waves and wave behavior. Knowledge and abilities developed through Instructional Segments 1-3 are aimed at preparing students to apply them to solve problems/challenges in Segment 4.</p>	
<b>Segment 1 Overview</b>			
<p>By engaging in the practices of asking questions and defining problems, developing and using models, planning and carrying out investigations, constructing explanations and designing solutions, and using mathematical and computational thinking, students learn about the types and properties of simple waves. Students begin the unit by exploring an anchoring phenomenon that is based on how light and sound waves are experienced in different environments. Students' learning experiences will allow them to explore new driving questions in later segments. Possible driving questions include, "How do we use waves in everyday life?", "Have your eyes burned throughout the day?", "How do wave properties affect what we see?", etc. Students are also introduced to a design challenge based on the anchoring phenomenon and are asked to outline criteria and constraints as well as expected conditions and limitations as they refine the problem statements using their findings from exploring other local phenomena within the segment.</p>			

Assessments for this segment focus on Big Ideas 1 and 4. Students are informally assessed on their ability to ask questions, use mathematical and computational thinking, carry out investigations, and model waves as they apply their initial understanding to a design challenge. Students are formally assessed on their ability to carry out investigations about waves, use and develop models of waves, and use mathematical representations to describe that waves are repeating patterned disturbances that transfer energy and not matter.

Lesson Title(s)	Lesson Description(s)
Wave Properties Investigation	<p>In <i>What is a Wave?</i>, students collected observational data about waves using Slinkies. If the teacher followed the example activity, students qualitatively explored the relationships between wave properties. For this activity, students design and conduct an experiment to find the relationship between the speed, frequency, and wavelength of the wave by collecting numerical data. Students could either do this with a wave tank, a wave generator, by hand, or using a simulation such as <a href="#">Wave On A String</a>.</p> <p>After collecting their data, students analyze the data to find the linear relationship between frequency and wavelength, <math>f = v\lambda</math>, where <math>f</math> is frequency, <math>\lambda</math> is the wavelength, and <math>v</math> is both the slope of the line and the speed of the waves.</p> <p><u>What Students Figure Out</u></p> <ol style="list-style-type: none"> <li>Following their experiment and analysis, students write a conclusion based on their data. Then, students verify their results with the field. Students read or research the wave properties of frequency, speed, and wavelength using core curricular resources or other scientific texts such as <a href="#">CK-12: Wave Speed</a>.</li> <li>Students return to their conclusions and data analyses and compare their results to the field and make revisions. In their final conclusion, students support their findings using both data and their research from the field.</li> </ol>

Formal Assessment Title	Assessment Description
Representing Wave Properties Mathematically	In this assessment, students develop and use a mathematical representation to explain how different amplitudes or frequencies of mechanical waves have different amounts of energy when in the same medium.

NGSS PE(s) Code(s) & Description(s)
<b>MS-PS4-1.</b> 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. <b>[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.]</b>

AG(s) Code(s) & Description(s)
<b>A4.</b> Develop and/or use a model to describe and identify the wavelength, frequency, and amplitude of a wave.

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**A5.** Use mathematical and computational thinking to show that the wavelength and frequency of a wave are related to one another by the speed of travel of the wave.

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**A6.** Apply their understanding to real-world phenomena about the ability of waves to transfer energy without overall displacement.

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### **Evidence Statement(s)**

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- Accurately describe how a simple wave has a repeating pattern of specific wavelength, frequency, and amplitude.
  - Accurately apply the simple mathematical wave model to a physical system or phenomenon to identify how a wave is a repeating pattern of motion that transfers energy from place to place.
  - Accurately describe how a simple mathematical wave model corresponds to the properties of a physical phenomenon.
  - Accurately apply the simple mathematical wave model to a physical system or phenomenon to identify how the wave model characteristics correspond with physical observations.
  - Generate mathematical representations of the relationship between properties of waves to show that the wavelength and frequency of a wave are related to one another by the speed of travel of the wave.
  - Accurately identify the evidence that supports a claim about how waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.
  - Describe how mathematical representations support conclusions about differences in one property of a wave that will result in differences in the amount of energy present or transmitted.
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### **Phenomenon or Phenomenon-rooted Design Problem**

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- The phenomenon in this task is related to how scientists have identified 52 Blue, ‘The Loneliest Whale,’ using properties of waves and mathematical models of sound waves to identify aquatic mammals (i.e., a blue whale).
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### **General Scenario Description**

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- Students are presented with a scenario related to the whale known as 52 Blue, a large, male whale that is possibly a hybrid of two other species of whale. The task provides data about a repeating physical phenomenon that can be represented as a wave in which students identify the mathematical relationship between amplitude and energy as well as the relationships between frequency, wavelength, wave speed, and energy transmitted in a given time. Students use a model and mathematical computations to identify how the energy of the wave changes based on a change in another property. Finally, students integrate the wave characteristic used to identify this whale, which has a call frequency of 52 Hertz, to explain how no other whales making this whale call have been detected and why Blue 52 is called, “The Loneliest Whale.”
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### **Chain of Sensemaking**

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- Students determine that sound is a series of vibrations of matter which transfer energy, not matter.
  - Students interpret models of sound waves to describe the qualitative and quantitative relationships among wave properties (wavelength, frequency, wave speed, and amplitude).
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- Students use a model of a transverse wave to apply mathematical and computational thinking to show that the wavelength and frequency of a wave are related to one another by the speed of travel of the wave.
- Students apply understanding of sound waves to real-world phenomena (i.e., the frequencies heard by various organisms and the scenario of 52 Blue, ‘The Loneliest Whale’).

### Work Products

- Fill-in-the-Blank
- Short response
- Mathematical calculations

### Application of Universal Design for Learning-based Guidelines to Promote Accessibility (<https://udlguidelines.cast.org/> )

Multiple Means of Engagement	Multiple Means of Representation	Multiple Means of Action & Expression
<input checked="" type="checkbox"/> Context or content <input checked="" type="checkbox"/> Age appropriate <input checked="" type="checkbox"/> Appropriate for different groups <input type="checkbox"/> Makes sense of complex ideas in creative ways <input checked="" type="checkbox"/> Vary the degree of challenge or complexity within prompts	<input checked="" type="checkbox"/> Provide visual diagrams and charts <input checked="" type="checkbox"/> Make explicit links between information provided in texts and any accompanying representation of that information in illustrations, equations, charts, or diagrams <input type="checkbox"/> Activate relevant prior knowledge <input type="checkbox"/> Bridge concepts with relevant and simple analogies and limited use of metaphors <input checked="" type="checkbox"/> Highlight or emphasize key elements in text, graphics, diagrams, formulas <input type="checkbox"/> Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships <input type="checkbox"/> Give explicit prompts for each step in a sequential process	<input checked="" type="checkbox"/> Solve problems using a variety of strategies <input type="checkbox"/> Sentence starters <input checked="" type="checkbox"/> Embed prompts to “show and explain your work”

### Targeted PE(s) Code(s) and Alternate Conception(s)

- **NGSS PE: 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.]**
  - **Common Alternate Conceptions**
    - Period, frequency, and wavelength are interchangeable.

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- Amplitude affects wavelength and/or frequency.
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### Vocabulary

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| <ul style="list-style-type: none"><li>• Waves</li><li>• Amplitude</li><li>• Frequency</li><li>• Wavelength</li><li>• Energy</li><li>• Matter</li></ul> | <ul style="list-style-type: none"><li>• Pitch</li><li>• Trough</li><li>• Crest</li><li>• Speed</li><li>• Transverse wave</li><li>• Longitudinal wave</li></ul> |
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