MS-PS4-1 Waves and Their Applications in Technologies for Information Transfer

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.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education*:

**Science and Engineering Practices**

**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.

**Disciplinary Core Ideas**

**PS4.A: Wave Properties**
- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.

**Crosscutting Concepts**

**Patterns**
- Graphs and charts can be used to identify patterns in data.

**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.

**Observable features of the student performance by the end of the course:**

<table>
<thead>
<tr>
<th>1 Representation</th>
<th>2 Mathematical modeling</th>
<th>3 Analysis</th>
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<tbody>
<tr>
<td>a Students identify the characteristics of a simple mathematical wave model of a phenomenon, including:</td>
<td>a Students apply the simple mathematical wave model to a physical system or phenomenon to identify how the wave model characteristics correspond with physical observations (e.g., frequency corresponds to sound pitch, amplitude corresponds to sound volume).</td>
<td>a Given data about a repeating physical phenomenon that can be represented as a wave, and amounts of energy present or transmitted, students use their simple mathematical wave models to identify patterns, including:</td>
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<tr>
<td>i. Waves represent repeating quantities.</td>
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<td>i. That the energy of the wave is proportional to the square of the amplitude (e.g., if the height of a water wave is doubled, each wave will have four times the energy).</td>
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<td>ii. Frequency, as the number of times the pattern repeats in a given amount of time (e.g., beats per second).</td>
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<td>ii. That the amount of energy transferred by waves in a given time is proportional to frequency (e.g., if twice as many water waves hit the shore each minute, then twice as much energy will be transferred to the shore).</td>
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<td>iii. Amplitude, as the maximum extent of the repeating quantity from equilibrium (e.g., height or depth of a water wave from average sea level).</td>
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