**MS-PS4 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.]

**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.]

**MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.** [Clarification Statement: Emphasis is on using fiber optic cables to transmit light pulses, radio wave pulses in wifi devices, and conversion device.] [Assessment Boundary: Assessment does not include binary counting.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

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### 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 (such as wave pulses) are a more reliable way to transmit data than analog signals. (MS-PS4-3)

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### Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1)

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### 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 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)

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### Articulation across grade-bands:

**4.PS3.A (MS-PS4-1); 4.PS3.B (MS-PS4-1); 4.PS4.A (MS-PS4-1); 4.PS4.B (MS-PS4-2); 4.PS4.C (MS-PS4-3); HS.PS3.A (MS-PS4-1); HS.PS4.A (MS-PS4-2); HS.PS4.C (MS-PS4-3); HS.ESS1.A (MS-PS4-2); HS.ESS2.A (MS-PS4-2); HS.ESS2.C (MS-PS4-3)**

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### Common Core State Standards Connections:

**ELA/Literacy –**
- RST.6-8.1 Site specific textual evidence to support an analysis of a key central idea in technical texts. (MS-PS4-3)
- RST.6-8.2 Determine the central idea or purpose of a part of a text; summarize the text distinctly from prior knowledge or opinions. (MS-PS4-3)
- RST.6-8.9 Compare and contrast the point of view expressed in a text with the point of view expressed in another text on the same topic. (MS-PS4-3)
- WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-3)
- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-4)

**Mathematics –**
- MP.2 Reason abstractly and quantitatively. (MS-PS4-1)
- MP.4 Model with mathematics. (MS-PS4-1)
- 6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)
- 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS4-1)
- 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS4-1)
- 8.F.A.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS4-1)

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Some performance expectations have an asterisk:

- Performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

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