Students who demonstrate understanding can:

**HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

**HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.** [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]

**HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]

**HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is invited to qualitative descriptions.]

**HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.** [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity, medical imaging, and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

The performance expectations above were developed using the following elements from the NRC document, *A Framework for K-12 Science Education.*
**HS-PS4  Waves and Their Applications in Technologies for Information Transfer**

Connections to other DCIs in this grade-band: \( \text{HS.PS1.C (HS-PS4-4)} \), \( \text{HS.LS1.C (HS-PS4-4)} \), \( \text{HS.PS3.A (HS-PS4-4), (HS-PS4-5)} \), \( \text{HS.PS3.D (HS-PS4-3), (HS-PS4-4)} \), \( \text{HS.ESS1.A (HS-PS4-3)} \), \( \text{HS.ESS2.A (HS-PS4-1)} \), \( \text{HS.ESS2.D (HS-PS4-3)} \)

Articulation to DCIs across grade-bands: \( \text{MS.PS3.D (HS-PS4-4)} \), \( \text{MS.PS4.A (HS-PS4-1), (HS-PS4-2), (HS-PS4-5)} \), \( \text{MS.PS4.B (HS-PS4-1), (HS-PS4-2), (HS-PS4-3), (HS-PS4-4), (HS-PS4-5)} \), \( \text{MS.PS4.C (HS-PS4-2), (HS-PS4-5)} \), \( \text{MS.LS1.C (HS-PS4-4)} \), \( \text{MS.ESS2.D (HS-PS4-4)} \)

**ELA/Literacy**

- RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4)
- RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4)
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-1), (HS-PS4-4)
- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4)
- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-PS4-5)
- WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4)

**Mathematics**

- MP.2 Reason abstractly and quantitatively. (HS-PS4-1), (HS-PS4-3)
- MP.4 Model with mathematics. (HS-PS4-1)
- HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1), (HS-PS4-3)
- HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1), (HS-PS4-3)
- HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1), (HS-PS4-3)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*