

HS-PS4-1 Waves and their Application in Technologies for Information Transfer

California Science Test—Item Content Specifications

# HS-PS4-1 Waves and their Application in Technologies for Information Transfer

Students who demonstrate understanding can:

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.*]

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Using Mathematics and Computational Thinking  Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms; and computational tools for statistical analysis to analyze, represent and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.  Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. | PS4.A: Wave Properties   1. The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. | Cause and Effect  Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. |

## Assessment Targets

Assessment targets describe the focal knowledge, skills, and abilities for a given three-dimensional Performance Expectation. Please refer to the Introduction for a complete description of assessment targets.

### Science and Engineering Subpractice(s)

Please refer to appendix A for a complete list of Science and Engineering Practices (SEP) subpractices. Note that the list in this section is not exhaustive.

5.1 Ability to develop mathematical and/or computational models (e.g., graphical representation in a simulation)

### Science and Engineering Subpractice Assessment Targets

Please refer to appendix A for a complete list of SEP subpractice assessment targets. Note that the list in this section is not exhaustive.

5.1.1 Ability to generate mathematical representations to describe characteristics and patterns of a scientific phenomenon and/or a design solution

5.1.4 Ability to recognize that computational models such as simulations are built on mathematical models that incorporate the underlying science principles being studied

### Disciplinary Core Idea Assessment Targets

#### PS4.A.7

* Identify and describe the mathematical values for frequency, wavelength, and speed of waves traveling in various media
* Show that the product of the frequency and the wavelength of a particular type of wave in a given medium is constant, and identify this relationship as the wave speed according to the mathematical relationship *v = f l*
* Use data to show that the wave speed for a particular type of wave changes as the medium through which the wave travels changes
* Predict the relative change in wavelength of a wave when it moves from one medium to another using the terms cause and effect
* Use the mathematical relationship *v = f l* to assess claims about any of the three quantities when the other two quantities are known for waves traveling in various specified media
* Use mathematical relationships to distinguish between cause and correlation with respect to the supported claims

### Crosscutting Concept Assessment Target(s)

CCC2 Identify empirical evidence to differentiate between cause and correlation and make claims about specific causes and effects

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a computer simulation that generates waves travelling at different speeds, presenting the speed, frequency, and wavelength for each generated wave in a table:

* Selects the mathematical model that is best supported by the data (5.1.1, PS4.A.7, and CCC2)

Task provides students with different statements that describe the mathematical model *v = f l*:

* Identifies the statement that correctly explains the model (5.1.1, PS4.A.7, and CCC2)

Task provides graphs of different waves traveling through the same medium. The graphs provide information on wavelength, frequency, and amplitude:

* Describes the relationship between these three wave characteristics when the medium remains constant (5.1.4, PS4.A.7, and CCC2)

Task provides graphs of different waves traveling through different mediums. The graphs provide information on wavelength, frequency, and amplitude:

* Describes how wavelength and frequency are related to the change in the medium (5.1.4, PS4.A.7, and CCC2)

Task provides a simulation of a wave pulse traveling along a thin rope that will eventually travel into a thicker and heavier section of rope. Wavelength, frequency, amplitude, and wave speed are provided for each simulation before and after the pulse reaches the thicker and heavier section of rope:

* Selects the simulation modeling mathematically and visually the specific scientific phenomenon for the pulse traveling along the varied mediums (5.1.4, PS4.A.7, and CCC2)

Task provides a simulation of two waves that are traveling towards each other. The waves combine with constructive interference, but the amplitude of the combined wave is incorrect:

* Cites the scientific principle demonstrated when the waves interact and can interact and adjust the simulation to produce the correct amplitude (5.1.4, PS4.A.7, and CCC2)

Task provides data from an earthquake study, with certain data about the seismic waves missing. Student is provided a simulation where they can change the speed, frequency, and wavelength of a traveling sound wave as well as the medium through which the wave is traveling:

* Uses the simulation to fill in missing data points for either frequency, wavelength, or speed in order to evaluate whether the missing data follows the mathematical model of *v = f l* (5.1.4, PS4.A.7, and CCC2)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Electromagnetic radiation traveling through glass
* Electromagnetic radiation traveling through a vacuum
* Sound waves traveling through air and water
* Seismic waves traveling through the Earth
* A transverse wave of a slinky oscillating in the plane of the ground
* A water wave moving through water of different salinity levels

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Waves act as if they are solid objects in a collision, bouncing off each other.
* Constructive interference can only be applied if the peaks of the waves interact.
* Waves stop traveling when encountering an object or media.
* The speed of a wave is dependent upon its frequency and/or its wavelength.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS4-1 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS4-1 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS4-1%20Evidence%20Statements%20June%202015%20asterisks.pdf)

The *2016 Science Framework for California Public Schools Kindergarten through Grade 12*

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade 12 <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

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