

HS-PS4-4 Waves and their Applications in Technologies for Information Transfer

California Science Test—Item Content Specifications

# HS-PS4-4 Waves and their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

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 limited to qualitative descriptions.*]

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Obtaining, Evaluating, and Communicating Information  Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.  Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. | PS4.B: Electromagnetic Radiation  10. When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. | Cause and Effect  Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. |

## 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.

8.1 Ability to comprehend and evaluate text in terms of its validity, reliability, and sources

### 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.

8.1.1 Ability to obtain relevant information through conducting searches in print and online sources and evaluate the reliability of the obtained information

8.1.2 Ability to recognize, interpret, and critique key ideas in scientific and engineering text, including a mix of words, symbols, tables, diagrams, and graphs

### Disciplinary Core Idea Assessment Targets

#### PS4.B.10

* Describe the relationship between the wavelength of electromagnetic radiation and its energy
* Categorize electromagnetic radiation of similar wavelengths/frequencies into bands on the EM spectrum
* Describe the process by which photons can alter the energy state of electrons within atoms, potentially leading to ionization
* Qualitatively describe the relationship between the wavelength of electromagnetic radiation and the degree to which that radiation can penetrate matter (both living cells and non-living shielding materials)
* Describe known methods for preventing interactions between electromagnetic radiation and sensitive tissue
* Contrast electromagnetic radiation leading to ionization to generating radiation leading to thermal energy transfer and identify indicators of each occurring

### Crosscutting Concept Assessment Target(s)

CCC2 Suggest and predict cause and effect relationships for complex natural and human-designed systems by examining what is known about smaller-scale mechanisms within the system

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides both an image describing the electromagnetic spectrum and some assortment of published materials asserting that some technology that uses radio or microwaves poses a risk of cell damage due to ionization:

* Critiques (or selects an appropriate critique of) the provided materials on the basis that, while all the types of radiation can cause damage by burning, only ultraviolet rays, X-rays, and gamma rays may damage DNA through ionization (8.1.1, PS4.B.10, and CCC2)

Task provides excerpts from relevant resources describing potentials risks to living tissue due to exposure to electromagnetic radiation as well as describing known methods for mitigating that risk. Task also provides two claims regarding the use of that technology:

* Identifies parts of the provided sources that can serve as evidence to validate or critique one or more of the claims (8.1.2, PS4.B.10, and CCC2)

Task provides excerpts from a source of unclear reliability describing potential risks to living tissue due to exposure to electromagnetic radiation as well as describing known methods for mitigating those risks:

* Identifies if the source should be considered reliable based on the following:
  + The source has sound or unsound scientific reasoning (8.1.2, PS4.B.10, and CCC2)
  + The claims of the source can or cannot be verified experimentally (or from some other appropriate methodology) (8.1.2, PS4.B.10, and CCC2)
  + The source was produced by some party that may have had a relevant bias (8.1.2, PS4.B.10, and CCC2)

Task provides materials that describe an investigation into the risks of using a particular technology that makes use of electromagnetic radiation:

* Critiques (or selects a critique of) the methodologies used or the conclusions drawn by the investigation (8.1.2, PS4.B.10, and CCC2)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Cooking of food in microwave ovens
* Use of X-rays to examine the human body and use of shielding to protect against unnecessary exposure
* Effects of different kinds of ultraviolet radiation (i.e., UVA and UVB) on human skin
* Effects of Earth’s atmosphere (including the ozone layer) on the penetrating ability of solar radiation
* Use of gamma rays to kill malignant tumors

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Only objects that are glowing and/or are hot can transfer energy in the form of electromagnetic radiation.
* Only hot or warm objects transfer thermal energy.
* Only the Sun transfers energy in the form of electromagnetic radiation.
* The term radiation only refers to harmful sources.
* Different types of electromagnetic radiation travel at different speeds.
* UV is the most dangerous form of radiation.
* Infrared is ionizing radiation.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS4-4 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS4-4 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS4-4%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>

Posted by the California Department of Education, March 2021 (updated February 2024)