HIGH SCHOOL PHYSICS: INFORMATION

Standards Bundle

Standards are listed within the bundle. Bundles are created with potential instructional use in mind, based upon potential for related phenomena that can be used throughout a unit.

HS-PS4-2 Evaluate questions about the advantages of using a digital transmission and storage of information. (SEP: 1; DCI: PS4.A; CCC: Stability/Change, Technology) [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-PS4-5 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. (SEP: 8; DCI: PS3.D, PS4.A, PS4.B, PS4.C; CCC: Cause/Effect, Technology) [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.]*

Content Overview

This section provides a generic overview of the content or disciplinary core ideas as an entry point to the standards.

Electromagnetic waves can be used to send information worldwide and have become an integral part of our society. It is important to determine the full impact of the advantages and disadvantages of our current use of and exposure to electromagnetism.

Phenomena

Phenomena can be used at varying levels of instruction. One could be used to anchor an entire unit, while another might be more supplemental for anchoring just a unit. Please remember that phenomena should allow students to engage in the SEP and use the CCC/DCI to understand and explain the phenomenon.

- An MRI, utilizing radio waves, can show brain or knee images.
- A solar powered radio can be used in remote areas.
- Solar powered pathway lights are often used to illuminate areas.
- Plant pigment based solar cells
- AM radio signals travel further than FM radio signals.
- Several methods exist to transfer data on a cell phone such as AirDrop, text message, or email.
- Compare light and electron photomicrograph of the same object.
- Any metal objects on a worker servicing a microwave tower heat up.
- Strength of passwords for digital devices are often rated. Users are often encouraged to use a mix of letters, numbers, and symbols.
- Cell phones can be wirelessly charged.
- Pixels and digital photo image quality

- HD and 4K television screen images appear different from older television screens.

Storyline

This section aims to decode not only the DCI connections, but also the SEP and CCC in a detailed account of how they possibly fit together in a progression for student learning, including both rationale and context for the bundle.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems ● Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. **Obtaining, Evaluating, and Communicating Information** ● Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically)	**PS3.D: Energy in Chemical Processes** ● Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. **PS4.A: Wave Properties** ● Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. **PS4.B: Electromagnetic Radiation** ● Photoelectric materials emit electrons when they absorb light of a high-enough frequency. **PS4.C: Information Technologies and Instrumentation** ● Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.	**Cause and Effect** ● Systems can be designed to cause a desired effect. **Stability and Change** ● Systems can be designed for greater or lesser stability.

When light with a high enough frequency is shined on photoelectric material it causes electrons to be ejected. This phenomena is utilized in the making of solar voltaic cells which can be used to capture the sun's energy and produce electricity. Arguments can be made for the increased use of solar energy through the interpretation of data and the evaluation of the suitability of different designs for energy production. The cause and effect relationships of these energy systems can be evaluated. Arguments can be developed and communicated through a variety of different formats in support of different energy technologies such as solar energy.

Information can be digitized and stored. This information can then be transferred over long distances through the use of electromagnetic waves. The electromagnetic spectrum is limited. Problems in the digital communication system's stability may arise as more technologies are developed that compete for

bandwidth. The development of new communication technologies causes older communication technologies to be phased out. The transition between communication technologies can be evaluated through the interpretation of data as the stability of the communication system is considered as a whole.

Many different technologies utilizing waves and their interactions with matter are part of the modern world. For example, medical imaging such as Magnetic Resonance Imagery, rely on electromagnetic waves and their interaction with matter to produce images. Digital scanners capture and store information which may be quickly transferred from place to place. Technical information about these technologies may be evaluated and communicated in a variety of formats. Furthermore, the systems themselves and their overall effect on society can be evaluated and those results communicated in a variety of formats.

Formative Assessment

Formative assessment is crucial because all learners benefit from timely and focused feedback from others. It promotes self-reflection, self-explanation, and social learning. It can also make learning more relevant. Each of the questions below might be used throughout the formative assessment process. Specific prompts may focus on individual practices, core ideas, or crosscutting concepts, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given bundle, standard or lesson-level performance expectation.

SEP Asking Questions and Defining Problems

- How can the security of storage of information be improved?
- How can using digital transmission of information be an advantage to the use of non-digital transmission?

SEP Obtaining, Evaluating, and Communicating Information

- Research using several sources how technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
- Evaluate the accuracy and reliability of various sources used for research.

CCC Cause and Effect

- Demonstrate using curved solid plastic tubing to simulate fiber optic cable and a laser, how total internal reflection allows information to be sent long distances using visible light.
- Use lenses to view up close the structure of the pixels on a computer screen and determine how color addition principles allow computers/TVs/iPads/calculator screens/cell phones to generate any color.

CCC Stability and Change

- Research and communicate in a variety of formats how the competition for bandwidth between emerging wireless technologies and existing wireless technologies can be balanced to keep communication systems stable.
- Research and communicate in a variety of formats how renewable energy sources such solar energy from the sun can help future energy stability.

Performance Outcomes

These are statements of how students use knowledge and are similar to the standards in how they blend DCI, SEP, and CCC, but at a smaller grain-size. These are potential outcomes for instruction as it plays out in lessons and activities in the classroom. It is important to also think of these as smaller outcomes that build toward the larger goal of mastering the standards.

- **Evaluate** questions about the *dependence* of modern civilization on technological systems. **Evaluate arguments** for the advantages and disadvantages *caused* by the storing and transmitting digital information using waves.
- **Ask questions and evaluate designs** about modifications engineers make to *improve* technology in terms of improved performance *versus cost and risk*.
- **Research and communicate in a variety of formats** how the competition for bandwidth between emerging wireless technologies and existing wireless technologies utilizing wave impulses can be balanced to keep communication *systems stable*.
- **Research and communicate in a variety of formats** how renewable energy sources such solar energy from the sun utilizing photoelectric materials can help future energy *stability*.