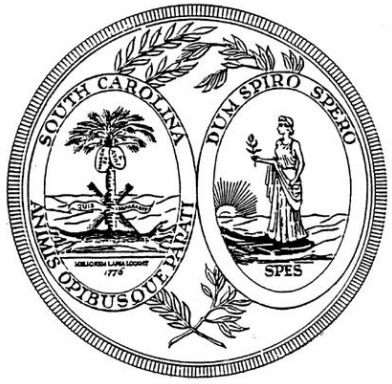
South Carolina Academic Standards and Performance Indicators for Science 2014



Instructional Unit Resource

Physics

South Carolina Academic Standards and Performance Indicators for Science 2014 Physics Instructional Unit Resource

As support for implementing the *South Carolina Academic Standards and Performance Indicators for Science 2014*, the standards for Physics have been grouped into possible units. In the Overview of Units below, the titles for those possible units are listed in columns. Refer to the Overview document to note these unit titles and how Standards, Conceptual Understandings, Performance Indicators, Science and Engineering Practices, and Crosscutting Concepts align. Following the Overview of Units, an Instructional Unit document is provided that delivers guidance and possible resources in teaching our new *South Carolina Academic Standards and Performance Indicators for Science 2014*. The purpose of this document is to provide guidance as to how all the standards in this grade may be grouped into units and how those units might look. Since this document is merely guidance, districts should implement the standards in a manner that addresses the district curriculum and the needs of students. This document is a living document and instructional leaders from around the state will continuously update and expand these resource documents. These documents will be released throughout the 2016-2017 school year with the intentionality of staying ahead of instruction. Teachers should also note that links to the Standards document, A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, the SEP Support Document, and the Support Document 2.0 are embedded throughout the Instructional Unit format for reference.

Acknowledgments

Jean Baptiste Massieu, famous deaf educator, made a statement that is now considered a French proverb. “Gratitude is the memory of the heart. Indeed, appreciation comes when you feel grateful from the depths of your heart. The head keeps an account of all the benefits you received and gave. But the heart records the feelings of appreciation, humility, and generosity that one feels when someone showers you with kindness.” It is with sincere appreciation that we humbly acknowledge the dedication, hard work and generosity of time provided by teachers and instructional leaders across the state that have made and are continuing to make the Instructional Unit Resources possible.

Physics Overview of Units

Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
FORCES AND MOTION	WORK, ENERGY, AND MOMENTUM	ELECTRICITY AND MAGNETISM	WAVES	LIGHT AND OPTICS	THERMODYNAMICS	NUCLEAR AND MODERN PHYSICS
Standard	**Standard**	**Standard**	**Standard**	**Standard**	**Standard**	**Standard**
H.P.1 H.P.2	H.P.1 H.P.2 H.P.3	H.P.1 H.P.2 H.P.3	H.P.1 H.P.3	H.P.1 H.P.3	H.P.1 H.P.3	H.P.1 H.P.3
Conceptual Understanding	**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**
H.P.2A H.P.2B H.P.2C	H.P.2B H.P.3A H.P.3B	H.P.2D H.P.3E	H.P.3D	H.P.3F	H.P.3C	H.P.3G
Performance Indicators	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**
H.P2A.1 H.P.2A.2 H.P.2A.3 H.P.2A.4 H.P.2A.5 H.P.2A.6 H.P.2B.1 H.P.2B.2 H.P.2B.3	H.P.2B.8 H.P.2B.9 H.P.2B.10 H.P.2C.1 H.P.2C.2 H.P.2C.3 H.P.2C.4 H.P.2C.5	H.P.2B.4 H.P.2B.5 H.P.2B.6 H.P.2B.7 H.P.3A.1 H.P.3A.2	H.P.3A.3 H.P.3A.4 H.P.3A.5 H.P.3B.1 H.P.3B.2 H.P.3B.3	H.P.2D.1 H.P.2D.4 H.P.2D.5 H.P.2D.7 H.P.3E.1 H.P.3E.2 H.P.3E.3 H.P.3E.4	H.P.3E.5 H.P.3E.6 H.P.3E.7	H.P.3D.1 H.P.3D.2 H.P.3D.3 H.P.3D.4	H.P.3F.1 H.P.3F.2 H.P.3F.3 H.P.3F.4 H.P.3F.5 H.P.3F.6	H.P.3C.1 H.P.3C.2 H.P.3C.3 H.P.3D.1	H.P.3G.1 H.P.3G.2 H.P.3G.3 H.P.3G.4 H.P.3G.5
***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**
S.1A.2 S.1A.5 S.1A.3 S.1A.6 S.1A.4 S.1A.8	S.1A.2 S.1A.7 S.1A.3 S.1A.8 S.1A.5	S.1A.2 S.1A.6 S.1A.3 S.1A.8 S.1A.5 S.1B.1	S.1A.2 S.1A.5 S.1A.3 S.1A.6	S.1A.1 S.1A.5 S.1A.2 S.1A.6 S.1A.3 S.1A.8	S.1A.1 S.1A.4 S.1A.2 S.1A.3	S.1A.2 S.1A.8 S.1A.5 S.1A.6
***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**
1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5,	2, 3, 5, 6, 7	1, 2, 3, 5, 6, 7	1, 2, 3, 5, 6, 7	1,2,3,4,5,6,7	1,2,3,4,5,6,7

**Teachers have the discretion to enhance the selected SEP's and CCCs.*

Unit Title
Waves
Standard http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf
H.P.3 The student will demonstrate an understanding of how the interactions among objects can be explained and predicted using the concept of the conservation of energy.

Conceptual Understanding
H.P.3D Sound is a mechanical, longitudinal wave that is the result of vibrations (kinetic energy) that transfer energy through a medium.
New Academic Vocabulary **Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/) and further inquiry into the terms can be found there.**

Frequency	Pitch	Compression	Resonance	Medium	Harmonic
Amplitude	Wave Speed	Rarefaction	Standing Wave	Doppler Effect	Destructive Inference
Wavelength	Node	Longitudinal Wave	Open pipe	Electromagnetic wave	Constructive Inference
Intensity	Antinode	Transverse Wave	Closed Pipe	Oscillate	Absorption
Analog signals					

Performance Indicators Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's.
H.P.3D.1 *Develop and use models* (such as drawings) to exemplify the interaction of mechanical waves with different boundaries (sound wave

interference) including the formation of standing waves and two-source interference patterns.
H.P.3D.2 *Use the principle of superposition* to *explain* everyday examples of resonance (including musical instruments and the human voice).
H.P.3D.3 *Develop and use models* to explain what happens to the observed frequency of a sound wave when the relative positions of an observer and wave source changes (Doppler effect).
H.P.3D.4 *Use mathematical and computational thinking* to analyze problems that relate the frequency, period, amplitude, wavelength, velocity, and energy of sound waves.

***Science and Engineering Practices**

Support for the guidance, overviews of grade level progressions, and explicit details of each SEP can be found in the Science and Engineering Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.

H.P.1A.2 Develop and use models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others
H.P.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses based on credible scientific information, (2) identify materials, procedures, and variables, (3) use appropriate laboratory equipment, technology, and techniques to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.
H.P.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) express relationships between variables for models and investigations, and (3) use grade-level appropriate statistics to analyze data.
H.P.1A.6 Construct Explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.

***Cross Cutting Concepts** **(http://www.nap.edu/read/13165/chapter/8)**

The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) The text in blue and *italicized/underlined* below provides a brief explanation of how the specific content ties to the CCC's.

1. Patterns: The National Research Council states "Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them" (p. 84). *Frequency and periods are inverses of each other.*

2. Cause and effect: Mechanism and explanation: The National Research Council (2012) states that "events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are

mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts" (p. 84). *The higher the pitch of a sound the greater the frequency of the wave.*

3. Scale, proportion, and quantity: The National Research Council (2012) states that "in considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance" (p. 84). *The amplitude of a wave is directly proportional to the energy of the wave.*

5. Energy and matter: Flows, cycles, and conservation: The National Research Council (2012) states that "tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations" (p. 84). *Waves transfer energy at different rates through different mediums.*

6. Structure and function: The National Research Council (2012) states that "the way in which an object or living thing is shaped and its substructure determine many of its properties and functions" (p. 84). *The frequency of a sound wave appears to increase when the distance between the source and the listener decreases.*

7. Stability and change: The National Research Council (2012) states that "For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study" (p. 84). *The intensity of a sound wave can be changed with constructive or destructive interference.*

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Prior Knowledge
• 8.P.3 Wave characteristics, properties of waves, amplitude, medium
Subsequent Knowledge
• N/A

Possible Instructional Strategies/Lessons
Strategies and lessons that will enable students to master the standard and/or indicator.

- H.P.3D.1
  - Music in a Bottle Lab: Students can determine the mathematical relationship between the length of the air column and the frequency of sound produced. This lab can be found at http://www.physicsclassroom.com/getattachment/lab/sound/s7tg.pdf

- Wave Interference: Interactive simulation that allows students to examine the interaction of waves with a boundary or with other sources of waves. The simulation allows students to adjust the location, number of slits and width of the barrier. This simulation can be found at https://phet.colorado.edu/en/simulation/legacy/wave-interference

- Wave on a String: This interactive simulation exposes students to mechanical waves with different boundaries, i.e. interference patterns and standing waves. Students will be able to model what they learned from the simulations with a Slinky, jump ropes, snakies, etc. This simulation can be found at https://phet.colorado.edu/en/simulation/wave-on-a-string

- H.P.3D.2
  - *Wave Superposition*: Bozeman Science video explaining the basics of wave interference. This video can be found at https://www.youtube.com/watch?v=LJbpXx8fMUk

  - *Superposition of Sound*: Video with examples and explanation of interference of sound waves (beats). This video can be found at https://www.youtube.com/watch?v=k6rHkl8AO9Q

- H.P.3D.3
  - Doppler Effect Model: Using the Doppler Effect device (see Resources), students develop models to explain what happens to the observed frequency of a sound wave when the relative positions of an observer and wave source changes. This device can be found at http://www.exploratorium.edu/snacks/doppler-effect

  - Activity: Doppler Effect: In this activity, students will use a simulation model of an object and its waves approaching the ears. This activity can be found at http://websites.uwlax.edu/ssallmen/ss_teaching/astro_workshop/doppler.pdf

- H.P.3D.4
  - Guitar Fundamentals: Wavelength, Frequency, and Speed: Students will use mathematical and computational thinking to calculate the speed of the waves traveling on a guitar string (other instruments and/or handmade instruments can be used). They will measure the wavelength of a guitar string (other instrument) and measure the frequency with a tuner to calculate speed. This activity can be found at http://www.sciencebuddies.org/science-fair-projects/project_ideas/Music_p010.shtml#procedure

- Wave properties virtual lab: Students will use mathematical and computational thinking to determine the relationship between wavelength and frequency of a wave and the relationship between the amplitude of the wave and the disturbance of the medium. This activity can be found at http://www.glencoe.com/sites/common_assets/science/virtual_labs/E05/E05.html

- Slinky Wave Lab: Students will use mathematical and computational thinking to identify the wavelength, frequency, speed, and types of waves. This activity can be found at http://www.mrschamberlain.com/PHYS/WAVESandCOSMOS/Slinky lab.pdf

Resources

- Interactive Applet Activities and Videos This resource contains interactive Applet activities, short video clips and simulations. This resource can be found at http://w3.shorecrest.org/~Lisa_Peck/Physics/syllabus/soundlight/ch25waves/ch25_applets_videos/ch25_vid_applets.htm

- Physics for Kids: Waves: This website contains background information, illustrations, and activities about waves including wave characteristics, properties and behaviors. This resource can be found at http://www.ducksters.com/science/physics/waves.php

- Resource for Wave Interference: The Physics Classroom has explanations, illustrations and interactive simulations about wave interference and superposition as well as other concepts related to waves. This resource can be found at http://www.physicsclassroom.com/class/waves/Lesson-3/Interference-of-Waves

- Pendulum Motion: This page contains information, illustrations, animations, and examples of pendulum motion. This resource can be found at http://www.physicsclassroom.com/class/waves/Lesson-0/Pendulum-Motion

- Wave Activities: This document contains the unit plans for waves that include demonstrations, lab activities, interactive simulations and clicker questions. This resource can be found at https://phet.colorado.edu/services/download-servlet?filename=%2Factivities%2F3023%2Fphet-contribution-3023-6649.PDF

- The Speed of a Wave (Physics Classroom): This resource can be used for review information related to wave speed, frequency, wavelength, amplitude, and energy. There are sample problems for students to review in preparation for using mathematical and computational thinking. This resource can be found at http://www.physicsclassroom.com/class/waves/Lesson-2/The-Speed-of-a-Wave

- Device to create Doppler Effect: This website provides directions to allow students and/or teachers to create a device to assist in studying the Doppler Effect. This website is http://www.exploratorium.edu/snacks/doppler-effect

- Waves and Optics Tic-Tac-Toe Project: Students must complete 3 of the 9 activities given on the tic-tac-toe grid. This project gives students the opportunity to explore topics that they find interesting but may not have time to cover in class. This activity can be found at https://pantherfile.uwm.edu/edyburn/www/WavesTTT.pdf

- Waves and Wave Properties: Lesson plans for teaching waves and wave properties including notes, demonstrations, worksheets and assessments. This resource can be found at http://www.teachengineering.org/view_lesson.php?url=collection/clem_/lessons/clem_waves_lessons/clem_waves_lesson02.xml

- Online Tone Generator: Students can create a pure tone sine wave. This resource can be found at http://onlinetonegenerator.com/

- Jeopardy template: Allows teacher to create review questions. This resource can be found at https://www.superteachertools.net/jeopardyx/

- Waves Unit: This is a unit plan with several resources for teaching waves. This resource can be found at http://www.myips.org/cms/lib8/IN01906626/Centricity/Domain/8123/wunit.pdf

Sample Formative Assessment Tasks/Questions

Additional sample formative assessment tasks/questions for grade bands are located at the end of each of the SEP Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf)

- Provide students with situations such as “High Amplitude, High Pitch” and have students draw the wave. This can be done on paper and turned in or done on individual white boards.

- Label types of waves and parts of waves - Use this as an exit slip activity, a quiz, or have students make posters to hang in the classroom.

- Speed of Sound Problems - Post problems around the classroom. Have students work in pairs to solve various problems and check them

with the teacher as they go.

- Create your own Musical Instrument Project.
- Use a jeopardy style review game for a specific topic or for the entire unit.
- Minute to Win it! (Challenge: Waving Rope)-Students will have one minute to transfer a ring down a rope using a wave motion.
- Have students create a 4 panel cartoon explaining a specific concept or a concept of their choice from this unit.
- Have students create their own wave properties (crest, trough, and wavelength) and trade papers with another student. The students then have to draw the wave from the properties they were given.

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