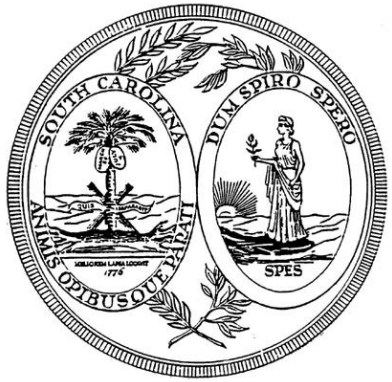
# South Carolina Academic Standards and Performance Indicators for Science 2014




## 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<br>H.P.2B<br>H.P.2C | H.P.2B<br>H.P.3A<br>H.P.3B | H.P.2D<br>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.2B.8<br>H.P.2A.2 H.P.2B.9<br>H.P.2A.3 H.P.2B.10<br>H.P.2A.4 H.P.2C.1<br>H.P.2A.5 H.P.2C.2<br>H.P.2A.6 H.P.2C.3<br>H.P.2B.1 H.P.2C.4<br>H.P.2B.2 H.P.2C.5<br>H.P.2B.3 | H.P.2B.4 H.P.3A.3<br>H.P.2B.5 H.P.3A.4<br>H.P.2B.6 H.P.3A.5<br>H.P.2B.7 H.P.3B.1<br>H.P.3A.1 H.P.3B.2<br>H.P.3A.2 H.P.3B.3 | H.P.2D.1 H.P.3E.5<br>H.P.2D.4 H.P.3E.6<br>H.P.2D.5 H.P.3E.7<br>H.P.2D.7<br>H.P.3E.1<br>H.P.3E.2<br>H.P.3E.3<br>H.P.3E.4 | H.P.3D.1<br>H.P.3D.2<br>H.P.3D.3<br>H.P.3D.4 | H.P.3F.1<br>H.P.3F.2<br>H.P.3F.3<br>H.P.3F.4<br>H.P.3F.5<br>H.P.3F.6 | H.P.3C.1<br>H.P.3C.2<br>H.P.3C.3 | H.P.3G.1<br>H.P.3G.2<br>H.P.3G.3<br>H.P.3G.4<br>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<br>S.1A.3 S.1A.6<br>S.1A.4 S.1A.8 | S.1A.2 S.1A.7<br>S.1A.3 S.1A.8<br>S.1A.5 | S.1A.2 S.1A.6<br>S.1A.3 S.1A.8<br>S.1A.5 S.1B.1 | S.1A.2 S.1A.5<br>S.1A.3 S.1A.6 | S.1A.1 S.1A.5<br>S.1A.2 S.1A.6<br>S.1A.3 S.1A.8 | S.1A.1 S.1A.4<br>S.1A.2<br>S.1A.3 | S.1A.2 S.1A.8<br>S.1A.5<br>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 | 1,2,3,5,6,7 | 1,2,3,5,6,7 |

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

| **Unit Title** |
|---|
| Thermodynamics |
| **Standard**<br>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.3C When there is a temperature difference between two objects, an interaction occurs in the form of a transfer of thermal energy (heat) from the hotter object to the cooler object. Thermal energy is the total internal kinetic energy of the molecules and/or atoms of a system and is related to temperature, which is the average kinetic energy of the particles of a system. Energy always flows from hot to cold through the processes of conduction, convection, or radiation. |
| **New Academic Vocabulary**<br>**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.** |

| | | | | | |
|---|---|---|---|---|---|
| Conduction | Convection | Heat | Temperature | Thermal Equilibrium | Isovolumetric |
| Joule | Isothermal | Specific Heat Capacity | Heat of Fusion | Heat of Vaporization | Latent Heat |
| Thermal Conduction | Adiabatic process | Cyclic Process | Entropy | 1st Law of Thermodynamics | 2nd Law of Thermodynamics |
| Radiation | | | | | |

| **Performance Indicators**<br>**Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's.** |
|---|
| H.P.3C.1 *Plan and conduct controlled scientific investigations* to determine the variables that affect the rate of heat transfer between two objects.<br>H.P.3C.2 Analyze and interpret data to describe the thermal conductivity of different materials.<br>H.P.3C.3 Develop and use models (such as a drawing or a small-scale greenhouse) to exemplify the energy balance of the Earth (including |

conduction, convection, and radiation).

***Science and Engineering Practices**

**Support for the guidance, overviews of grade level progressions, and explicit details of each SEP can 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.1 Ask questions to (1) generate hypotheses for scientific investigations; (2) refine models, explanations, or designs; or (3) extend the results of investigations or challenge scientific arguments or claims.

H.P.1A.2 Develop, use, and refine 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.4 Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning; (2) support or refute hypotheses, explanations, claims, or designs; or (3) evaluate the strength of conclusions.

***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). *Water atoms are arranged in a geometric pattern.*

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 2nd law of thermodynamics is consistent with the greenhouse effect which is directly observed.*

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 thermal current is directly proportional to the coefficient of thermal conductivity.*

5. Energy and matter: The National Research Council states, "Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations" (p. 84). *Heat flows from areas of high temperature to areas of low temperature*.

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 rate at which heat moves through a material depends on the composition of the atoms of the material.*

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). *When two objects with different temperatures are in contact, the heat from one object will gradually spread out until the two objects reach thermal equilibrium.*

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

| **Prior Knowledge** |
|---|
| • 6.P.3 Heat, Heat Transfer, Conduction, Convection, and Radiation |
| **Subsequent Knowledge** |
| • NA |

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

- H.P.3C.1
  - Heat Transfer Lab: Students can plan and conduct an experiment to determine the heat transferred when a piece of hot metal is placed into a cup of cold water. Have students brainstorm the variables that affect the rate of heat transfer prior to designing their experiments. Students can then present their experiments and results to the class and discuss how the different groups varied their experiments.

- Thermodynamics of Homemade Ice Cream: Students can study how lowering the freezing point of water freezes an ice cream mixture.

- H.P.3C.2
  - Thermal Conductivity of Different Materials: Students can expand on the *Heat Transfer Lab* by manipulating the material (metals of different types, ceramic, or glass) by heating them to a specific temperature and analyzing the amount of heat transferred into the water.

  - What insulator will keep ice lasting longer?: Students are to design an experiment to test different insulators (paper, Styrofoam, aluminum foil, plastic and cardboard) that will keep an ice cube from melting. Students can create a poster or infographic of their results and present their findings to the class.

- H.P.3C.3
  - Greenhouse Models: Students could build greenhouse designs to minimize the heat loss within the greenhouse. Models should include labels and explanations of the three heat processes occurring within the greenhouse (radiation entering the greenhouse, convection occurring as air is circulated within the greenhouse, and conduction occurring in substances within the greenhouse such as metal shelves, etc.) show an increase in temperature as the air temperature increases. Students could collect temperature data through probes, etc. in various locations within the greenhouse and use this data as evidence of the three processes occurring.

  - Conduction, Convection and Radiation Poster Project: Students are to create a project that shows heat transfer by means of conduction, convection, and radiation. Students should define the heat transfer and draw an illustration that clearly demonstrates the heat transfer.

**Resources**

- physics4kids.com: This tutorial is a complete unit that deals with energy transfers to enthalpy and entropy. This resource can be found at http://www.physics4kids.com/files/thermo_intro.html.

- What is Thermodynamics?: This site contains information about thermodynamics . There are online tutorials and lab activities. This resource can be found at https://www.grc.nasa.gov/www/k-12/airplane/thermo.html.

- Phun Physics: This site contains information on Thermal Conductivity that can be used for students at all levels. It also includes

demonstrations with instructions. This resource can be found at http://phun.physics.virginia.edu/topics/thermal.html.

- Flinn Videos: Flinn Scientific has videos in the Teacher Resource section. This resource can be found at https://www.flinnsci.com/teacher-resources/teacher-resource-videos/best-practices-for-teaching-chemistry/heat,-energy,-and-thermodynamics/.

- The Expert System for Thermodynamics: This is a visual platform to analyze thermofluid problems. This resource can be found at http://www.thermofluids.net/.

- Guide to Heat and Energy Activities in the Classroom: This resource contains a variety of activities that can be used to teach and/or reinforce energy transfer and heat capacity. This resource can be found at https://media.asf.alaska.edu/uploads/pdf/alisonheat_energy_classroom.pdf.

- Heat and Energy games and videos: http://www.learninggamesforkids.com/heat-energy-games/conduction-radiation.html

- Heat Transfer - Radiation video: This is a video from Doodle Science that explains radiation. This resource can be found at https://www.youtube.com/watch?v=tZliZyoYT80.

- Heat Transfer - Conduction and Convection: This is a video from Doodle Science that explains conduction and convection. This resource can be found at https://www.youtube.com/watch?v=Gyj444FK0zs.

- Transfer of Thermal Energy: This is a video that gives real-life examples of the three methods of heat transfer. This resource can be found at https://www.youtube.com/watch?v=-7SRr-bnsKY.

**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)**

- Analyze and interpret data to describe the thermal conductivity of different materials.

- Draw a small scale greenhouse to exemplify the energy balance of the Earth including labels and explanations of the different heat transfer processes.

- See greenhouse models in the instructional strategies section.
- Heat Transfer Cartoon: Students create a cartoon that uses a real-world example to explain one or more of the methods of heat transfer.
- Create drawings that illustrate the radiation energy that comes from the Sun.
- Post photos around the room of various situations involving heat transfer. Students rotate and describe the heat transfer process for each photo.

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