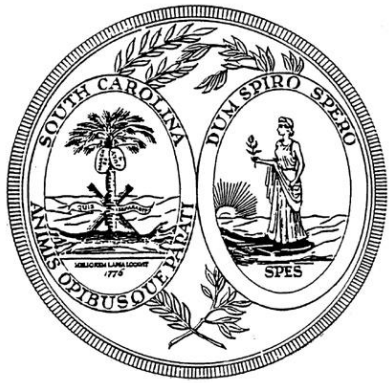
South Carolina Academic Standards and Performance Indicators for Science 2014



Instructional Units Resource

Chemistry

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

As support for implementing the *South Carolina Academic Standards and Performance Indicators for Science 2014*, the standards for Chemistry 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.

Chemistry Overview of Units

Unit 1		Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
ATOMIC STRUCTURE AND NUCLEAR PROCESSES		BONDING AND CHEMICAL FORMULAS	STATES OF MATTER	SOLUTIONS, ACIDS, AND BASES	CHEMICAL REACTIONS	THERMOCHEMISTRY AND CHEMICAL KINETICS
Standard		**Standard**	**Standard**	**Standard**	**Standard**	**Standard**
H.C.2		H.C.3	H.C.4	H.C.5	H.C.6	H.C.7
Conceptual Understanding		**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**
H.C.2A	H.C.2B	H.C.3A	H.C.4A	H.C.5A	H.C.6A	H.C.7A
Performance Indicators		**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**
H.C.2A.1 H.C.2A.2 H.C.2A.3	H.C.2B.1 H.C.2B.2 H.C.2B.3 H.C.2B.4	H.C.3A.1 H.C.3A.2 H.C.3A.3 H.C.3A.4 H.C.3A.5 H.C.3A.6 H.C.3A.7	H.C.4A.1 H.C.4A.2 H.C.4A.3	H.C.5A.1 H.C.5A.2 H.C.5A.3 H.C.5A.4	H.C.6A.1 H.C.6A.2 H.C.6A.3 H.C.6A.4	H.C.7A.1 H.C.7A.2 H.C.7A.3 H.C.7A.4
***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.6 S.1A.4 S.1A.8 S.1A.5		S.1A.2 S.1A.6 S.1A.3 S.1A.4	S.1A.2 S.1A.3 S.1A.4	S.1A.4 S.1A.5 S.1A.8	S.1A.2 S.1A.3 S.1A.5	S.1A.2 S.1A.5 S.1A.3 S.1A.4
***Crosscutting Concepts**		***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**
1, 2, 3, 4, 5, 6, 7		1, 4, 6	2, 4, 5	2, 3, 6	1, 2, 3, 4, 7	2, 3, 4, 6, 7

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

Unit Title
Chemistry: Atomic Structure and Nuclear Processes
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.C.2 The student will demonstrate an understanding of atomic structure and nuclear processes.

Conceptual Understanding
H.C.2A. The existence of atoms can be used to explain the structure and behavior of matter. Each atom consists of a charged nucleus, consisting of protons and neutrons, surrounded by electrons. The interactions of these electrons between and within atoms are the primary factors that determine the chemical properties of matter. In a neutral atom the number of protons is the same as the number of electrons.
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 link below and further inquiry into the terms can be found there. http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/**

Atom	Periodic Table	Valence electron	Bohr model	Energy level
Subatomic particle	Electron cloud	Electron configuration	Quantum mechanical model	Emission spectra
Proton	Atomic number	Ionization energy	Orbital	Wave
Neutron	Average atomic mass	Electron Affinity	Electron-Dot Structure	Photon
Electron	Mass number	Ionic radii	Lewis Dot Diagram	Frequency
Nucleus	Isotope	Ion	Isotope Notation	Wavelength

Performance Indicators **Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's**
H.C.2A.1 *Obtain and communicate information* to describe and compare subatomic particles with regard to mass, location, charge, electrical attractions and repulsions, and impact on the properties of an atom.

H.C.2A.2 *Use the Bohr and quantum mechanical models* of atomic structure to exemplify how electrons are distributed in atoms.
H.C.2A.3 *Analyze and interpret* absorption and emission spectra to support explanations that electrons have discrete energy levels.

***Science and Engineering Practices**

Support for the guidance, overviews of learning 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.

S.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
S.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.
S.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

***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 (2012) states that "observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them" (p. 84). *The emission spectra of an element is a unique pattern of bright lines or bands and can be used to identify an element. Flame tests are based on an element's emission spectrum.*

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). *In the study of atomic structure, models are much larger than the actual structure. Each atom contains a specific number of protons, neutrons, and electrons.*

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). *Matter is made up of atoms. Atoms contain high-energy electrons.*

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). *Matter is made up of structures called atoms. Atoms contain subatomic particles, protons, neutrons, and electrons, which determine what how the atom behaves and interacts with other atoms.*

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). *Isotopes are atoms of the same element, containing the same number of protons and electrons. However, they contain a different number of neutrons.*

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

Prior Knowledge
● 7.P.2A.1 Atomic Models ● 7.P.2A.2 Organization of the Periodic Table ● 8.P.3A.2 Basic Properties of Waves
Subsequent Knowledge
● N/A

Possible Instructional Strategies/Lessons

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

- Teaching Atomic Structure Using Cooperative Learning Students become experts on a particular aspect of an atom. They teach their group about the part for which they are responsible. This resource can be found at http://pumas.jpl.nasa.gov/examples/index.php?id=80

- Element Math Game Students practice determining protons, neutrons and electrons in an isotope of an element. This resource can be found at http://education.jlab.org/elementmath/.

- Candium Lab In this activity, students will calculate the atomic mass of candium, a mix of Skittles, Reeses Pieces, and M&Ms. Various examples of this activity can be found by searching the web for the title listed. This resource can be found at http://gjhs.mesa.k12.co.us/departments/documents/AtomicMassofCandium2013.pdf

- Periodic Law Lab Students receive clues to lead students to the correct element on the periodic table. They use the known information to predict the other properties and trends of the elements. This resource can be found at http://www.bensalemsd.org/site/handlers/filedownload.ashx?moduleinstanceid=3683&dataid=13949&FileName=Periodic%20Law%20Lab.pdf

- Atomic Emission Spectrum Lab Activity This activity allows students to determine the wavelength of different elements based on the photons of energy released. Various examples of this activity can be found by searching the web for the title listed. This resource can be found at http://www.chicagomilitaryacademy.org/apps/search/?cx=008260185677602921877%253ATEMP_SEARCH_ID&cof=FORID%253A9&q=atomic+emission+spectrum+lab&sa.x=0&sa.y=0&sa=Search

- Electronic Configurations and Flame Tests This activity walks students through the flame tests. This resource can be found at http://www.nsta.org/publications/news/story.aspx?id=50902

Possible Online Simulations- There are several resources that teachers may search for online that may be used to enhance student learning in a blended learning classroom setting. The teacher may search using the keywords below.

- Online Simulation of Bohr model There are several simulations that allow the user to shoot a light source through an atom in order to measure the energy and wavelengths of light that are emitted by the atom.
- Online Simulation on Electron Configuration There are several simulations that allow the user to manipulate and view the electron configurations of many elements, some include orbital shapes.
- Online Simulations of Building Elements There are several simulations that allow the user to use subatomic particles to build elements. As the number of protons, neutrons, and electrons changes, information

- Half-Life Investigate the decay of a radioactive substance. The half-life and the number of radioactive atoms can be adjusted, and theoretical or random decay can be observed. Data can be interpreted visually using a dynamic graph, a bar chart, and a table. Determine

the half-lives of two sample isotopes as well as samples with randomly generated half-lives." This resource can be found at https://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=369

Resources

- Build an Atom Simulation In the simulation, students determine the appropriate number of protons, neutrons, and electrons for each atom. This resource can be found at https://phet.colorado.edu/en/simulation/build-an-atom

- History of the Atom Mr. Andersen details the history of modern atomic theory (Anderson, 2011).This resource can be found at http://www.bozemanscience.com/history-of-the-atom

- Atoms & the Periodic Table - Mr. Andersen describes atomic structure and tours the periodic table (Anderson, 2011). This resource can be found at http://www.bozemanscience.com/atoms-the-periodic-table

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)

- Whiteboards - isotope notation and protons, neutrons and electrons practice

- **Atomic Model Animation**- Create an animation that explains the development of the Atomic Theory: include one of the following in detail: J.J. Thompson's Plum Pudding Model, Ernst Rutherford's Gold Foil Experiment, Niels Bohr's Planetary Model or the Quantum Mechanical Model. This resource can be found at http://honorschemistrymb.weebly.com/assignment-22.html

Unit Title

Chemistry: Atomic Structure and Nuclear Processes

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.C.2 The student will demonstrate an understanding of atomic structure and nuclear processes.

Conceptual Understanding

H.C.2B. In nuclear fusion, lighter nuclei combine to form more stable heavier nuclei and in nuclear fission heavier nuclei are split to form lighter nuclei. The energies in fission and fusion reactions exceed the energies in usual chemical reactions.

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 link below and further inquiry into the terms can be found there. http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/

Alpha radiation	Beta radiation	Gamma radiation	Nuclear fission
Nuclear fusion	Transmutation		

Performance Indicators

Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's

H.C.2B.1 *Obtain and communicate information* to compare alpha, beta, and gamma radiation in terms of mass, charge, penetrating power, and their practical applications (including medical benefits and associated risks.

H.C.2B.2 *Develop models* *to exemplify* radioactive decay and use the models to explain the concept of half-life and its use in determining the age of materials (such as radiocarbon dating or the use of radioisotopes to date rocks).

H.C.2B.3 *Obtain and communicate information* to compare and contrast nuclear fission and nuclear fusion and to explain why the ability to produce low energy nuclear reactions would be a scientific breakthrough.

H.C.2B.4 *Use mathematical and computational thinking* to explain the relationship between mass and energy in nuclear reactions (E=mc2).

***Science and Engineering Practices**

Support for the guidance, overviews of learning 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.

S.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.

S.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.
S.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. **Communicate** using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

***Cross Cutting Concepts**

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.

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). *Nuclear fusion and fission have different causes, but the result of both is the release of large amounts of energy. New elements can be formed in both reactions.*

4. Systems and systems models: The National Research Council (2012) states that "Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering" (p. 84). *Nuclear fusion and nuclear fission can be represented by models and those models can be used to explain what happens in the two reactions.*

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). *Nuclear reactions produce a tremendous amount of energy, but in both fission and fusion reactions illustrate the first law of thermodynamics.*

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 substructure of an atom determines what happens in a nuclear reaction and in radioactive decay.*

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

Prior Knowledge
• 7.P.2A.1 Atomic Models
Subsequent Knowledge
• H.E.4A Dating methods to estimate geologic time; Isotopic ratios • H.P.3G Radioactive Decay; Applications of Radioactive Decay

Possible Instructional Strategies/Lessons **Strategies and lessons that will enable students to master the standard and/or indicator.**
• Alphas-Betas-Gammas-Oh My Students will explore radioactive decay and transmutation reactions. The activity includes a reading passage, practice problems and a graphic analysis of the natural transmutation of Uranium-235. This resource can be found at http://www.nuclearscienceweek.org/wp-content/uploads/2014/09/Alphas-Betas-Gammas-Oh-My.pdf • Half-Life of Pennies With the Half-Life Laboratory, students gain a better understanding of radioactive dating and half-lives. This resource can be found at http://www.nuclearconnect.org/in-the-classroom/for-teachers/half-life-of-paper-mms-pennies-or-puzzle-pieces • Foldables Types of radiation (alpha, beta, and gamma) with notes on mass, charge, penetrating power and practical applications • Nuclear Energy Town Council Meeting Nuclear energy is a polarizing topic with advocates who support and advocates against nuclear power. Assign students to different groups, both for and against nuclear energy. Groups must research the pros and cons and develop an argument with evidence to support their argument. Hold a Town Council meeting in which each group presents their arguments in a debate-style meeting. *Note*: Teachers can choose what the goal/outcome/product of the debate/meeting will be.
Resources
• Fission vs Fusion Ideas for various strategies concerning fission and fusion. This resource can be found at http://teachnuclear.ca/resources-db/files/Fission-vs-Fusion-Lesson-Plan.pdf Video contrasting fusion and fission http://www.scientificamerican.com/article/fusion-difference-between-fission/ http://www.pbslearningmedia.org/resource/phy03.sci.phys.energy.fission/nuclear-reaction-fission/ This video explains fission and provides real-life examples.

- Radiation and Radioactive Decay Bozeman Science video about radiation and radioactive decay with examples of alpha and beta decay. This resource can be found at https://www.youtube.com/watch?v=oFdR_yMKOCw

- Socratic: Chemistry Tyler Dewitt videos regarding nuclear equations, half-life, transmutation, and applications of nuclear chemistry. This resource can be found at https://socratic.org/chemistry/nuclear-chemistry

- Nuclear Science Week This site provides a number of lessons and activities about nuclear energy, radioactive decay, and half-life. This resource can be found at http://www.nuclearscienceweek.org/get-involved/lessons_and_resources/

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)

- Whiteboard examples Project incomplete nuclear equations. Students complete the equation on individual white boards.

- Have students illustrate what they know about alpha, beta and gamma radiation on individual white boards. Then have students group together and discuss their drawings and decide on the best way to illustrate these concepts and share their illustrations with the class. This can be followed by a discussion with re-teaching if necessary.

- KWL - Know, Want to Know, Learned - Have students create a KWL chart about nuclear energy prior to lesson. Complete the "Learned" column after lesson.

- Exit Slip - Give students a sticky note (or they may use a sheet of paper) and have them write one thing they feel very good about and one thing they still need help with.

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