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AGENDA
Academic Standards & Assessments Subcommittee

Monday, November 18, 2013
10:00 AM, Room 433, Blatt Building

I.	Welcome and Introductions	Dr. Merck
II.	Approval of the Minutes of September 16, 2013	Dr. Merck
III.	Action Item: Revisions to the Science Standards	Mrs. Barton
	Public Comment Period	
IV.	Action Item: Cyclical Review of the Accountability System	Mrs. Barton
	Adjournment	Dr. Merck

Academic Standards and Assessments Subcommittee Members:
Dr. Danny Merck, Chairman
Sen. Mike Fair
Mrs. Barbara Hairfield
Sen. Wes Hayes
Ms. Ann Marie Taylor

Other:
Neil Robinson

Neil C. Robinson, Jr.
CHAIR
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Evelyn R. Perry
J. Roland Smith
Patti Tate
John Warner
David Whittemore
Mick Zais

Melanie D. Barton
EXECUTIVE DIRECTOR

SOUTH CAROLINA EDUCATION OVERSIGHT COMMITTEE
Subcommittee on Academic Standards and Assessments

Minutes of the Meeting
September 16, 2013
10:00 AM, Room 201 Blatt Building

Subcommittee Members Present:	Dr. Danny Merck (chair), Sen. Mike Fair, Ms. Barbara Hairfield, and Sen. Wes Hayes,
EOC Staff Present:	Kevin Andrews, Melanie Barton, Dana Yow and Hope Johnson-Jones

Welcome and Introductions
Dr. Merck welcomed members and guests to the meeting.

Minutes of May 20, 2013
The minutes of May 20, 2013 were approved as distributed.

3rd Grade Reading and Graduation Rates

The Subcommittee reviewed a report comparing the graduation rates of students who as third graders took the 2000 Palmetto Achievement Challenge Test (PACT) in English language arts (ELA) in third grade and scored either Below Basic 1, Below Basic 2, Basic, Proficient or Advanced.

The first result of this investigation was that students who scored at the lower achievement levels were more difficult to locate in successive years. The data appear to show that lower-achieving students, as defined by their third grade ELA scores, are much more mobile. Of students who scored Below Basic 1 in 2000 on the 3rd grade ELA PACT assessment, 44 percent could be located as grade 11 students in 2008 in public schools. In contrast 73 percent of students who scored Advanced in 2000 could be located as grade 11 students in 2008 in public schools.

Considering only the group of students who were continuously enrolled from grade 3 to 11 in South Carolina public schools, students who scored higher on the 3rd grade ELA PACT graduated at substantially higher rates than students who scored at Below Basic. Of students who scored Below Basic 1 on PACT ELA and who could be located, 56% graduated in either 2009 or 2010. Of students who scored Advanced on PACT in 2000 and who could be located, 91% graduated in either 2009 or 2010.

In looking at the original 3rd grade cohort, 37 percent of the students who initially scored Below Basic 1 on the 2000 3rd grade PACT ELA assessment and who could be located graduated in 2009, 2010 or 2011. Finally, projecting over time the mobility of students based upon their actual enrollment declines, it was projected that approximately 61 percent of the students who scored Below Basic 1 on the 2000 3rd grade PACT ELA assessment are projected to have persevered and graduated.

Discussion focused on the need for additional instruction for students who are reading substantially below grade level in third grade, noting that the instruction must be qualitatively different from the instruction already provided, as it has not proven to be effective – a "reinforcement year". Related issues discussed included mandatory retention in grade 3, the responsibilities and abilities of Reading Specialists, the relative benefits of flexibility for schools with large numbers of students reading at low levels, the focus of accountability on Reading and Math only at grade 3, and how to ensure that early childhood teachers have the skills to assist students in improving emerging literacy.

Senator Hayes asked if there was any information on how many of the students who scored Below Basic 1 received a GED. Mrs. Hairfield noted that most teachers are linguistic learners and have difficulty diagnosing struggling readers and differentiating instruction to non-linguistic learners.

Assessment and Accountability Follow-up

Members discussed the presentations made by ACT, the College Board (SAT), and the Department of Education on behalf of the Smarter Balanced Assessment Consortium (SBAC) on September 9, 2013 to members of the EOC and the State Board of Education.

Representatives from the College Board indicated that the organization did not currently have plans to develop assessments at the elementary or middle grades levels and therefore could not be considered as an option to fulfill state or federal requirements.

The presentation by ACT was summarized for having the following characteristics: (1) development of an assessment, Aspire, in grades 3 through 8 by the spring of 2014; (2) Aspire will be delivered using computers and hand-held devices but will not be a computer adaptive test (CAT); (3) the Explore, PLAN, Quality Core, WorkKeys and ACT system of assessments is focused on college and career readiness; college readiness, (4) the tests are written to content determined by ACT through their curriculum survey, which may not be the same as the Common Core State Standards.

The SBAC assessments were recognized for: (1) being written explicitly to asses the Common Core State Standards: (2) having a pencil/paper testing option during the initial years; and (3) containing more assessment options (interim and formative) than summative.

Discussion focused on the relative merits of ACT including content in 4 areas (including Science but not Social Studies), whereas the SBAC assessment will not assess either Science or Social Studies. The Subcommittee also discussed options for how to replace the High School Assessment Program. Members wanted more information on the services provided by each assessment and the related costs.

Questions were raised regarding how statewide field test data would be obtained from each assessment, and how and when this information would be available for the EOC to review in order to approve either assessment for statewide use, and whether a move away from SBAC would be perceived as a move away from CCSS.

There being no further business, the Subcommittee adjourned.

EDUCATION OVERSIGHT COMMITTEE

Subcommittee: Academic Standards and Assessments

Date: November 18, 2013

INFORMATION/RECOMMENDATION

Science Standards Revision

PURPOSE/AUTHORITY

The statutory authority for the report is from the EAA, as amended in 2008 (Act 282 of 2008):

SECTION 59-18-350.

(A) The State Board of Education, in consultation with the Education Oversight Committee, shall provide for a cyclical review by academic area of the state standards and assessments to ensure that the standards and assessments are maintaining high expectations for learning and teaching. At a minimum, each academic area should be reviewed and updated every seven years. After each academic area is reviewed, a report on the recommended revisions must be presented to the Education Oversight Committee and the State Board of Education for consideration. After approval by the Education Oversight Committee and the State Board of Education, the recommendations may be implemented. However, the previous content standards shall remain in effect until approval has been given by both entities. As a part of the review, a task force of parents, business and industry persons, community leaders, and educators, to include special education teachers, shall examine the standards and assessment system to determine rigor and relevancy.

(B) The State Department of Education annually shall convene a team of curriculum experts to analyze the results of the assessments, including performance item by item. This analysis must yield a plan for disseminating additional information about the assessment results and instruction and the information must be disseminated to districts not later than January fifteenth of the subsequent year.

CRITICAL FACTS

On October 9, 2013 the State Board of Education gave first reading to the attached South Carolina Academic Standards and Performance Indicators for Science. The standards are now before the EOC for consideration.

TIMELINE/REVIEW PROCESS

June 2012 – EOC adopts *Report on the Review of the South Carolina Science Academic Standards*

April to January 2013 – SCDE revises science standards

February 2013 - SCDE publishes draft standards published and online feedback survey tool designed to get input from educators

May to July 2013 - SCDE revised and edited draft standards per public comments

October 9, 2013 - -State Board gives first reading to approve standards

ECONOMIC IMPACT FOR EOC

Cost: Absorbed in operating budget

Fund/Source:

ACTION REQUEST

☒ **For approval** ☐ **For information**

ACTION TAKEN

☐ **Approved** ☐ **Amended**

☐ **Not Approved** ☐ **Action deferred (explain)**

SOUTH CAROLINA
STATE DEPARTMENT
OF EDUCATION

Proposed Timeline for the Review and Revision of the *South Carolina Academic Standards and Performance Indicators for Science 2013*

2011-12 School Year	
January	Solicit recommendations for review and writing panels from district superintendents, instructional leadership and professional organizations; South Carolina Department of Education (SCDE) notifies the State Board of Education (SBE) of the timeline by which the SC Academic Standards for Science will be updated
February	Select and notify writing and review panel members for the SCDE and the EOC; begin development of electronic field review survey tool internally
March—April	Convene SCDE and EOC panels to review current standards; panel reports submitted to SCDE and EOC
April—July	Revise standards based on feedback from SCDE and EOC review panels (by the SCDE writing panel)
2012-13 School Year	
August—February	Continued revision of standards based on feedback from SCDE and EOC review panels (by the SCDE writing panel); plan regional or virtual information sessions held to inform schools and districts about the standards document and the field review process period
January—February	Develop online feedback survey tool
March—May	Conduct field review through online feedback survey posted to SCDE web site; offer regional or virtual information sessions to inform schools and districts about the draft standards document and the field review process period
May	Compile field review feedback
May—July	Revise and edit draft standards based on field review feedback
2013-14 School Year	
September 2013	Submit synopsis and draft standards to the SBE for inclusion on the agenda
October 9, 2013	Submit standards to SBE for first reading approval
November 18, 2013	Submit standards to the ASA of the EOC for committee recommendation to the full EOC
December 9, 2013	Submit standards to full EOC for approval
January 8, 2014	Submit standards to SBE for second reading approval
January—July	Develop and provide professional development to support the understanding and implementation of the revised standards; Use revised standards in classrooms during the 2014-15 school year
2014-15 School Year	
August	Teachers use the *South Carolina Academic Standards and Performance Indicators for Science 2013* as adopted by the SBE

Note:
References to SBE meeting dates are subject to change based on SBE schedule changes.
References to professional development activities and assessment item development are contingent upon approval from the SCDE Offices of Teacher Effectiveness and Assessment.

Updated September 18, 2013

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MEMORANDUM

TO: Mrs. Meka Childs
Dr. Briana Timmerman

FROM: Melanie Barton *Melanie Barton*

DATE: October 11, 2013

IN RE: Revised Science Standards

Please find attached questions and information that the Education Oversight Committee (EOC) is requesting to assist the Academic Standards and Assessment Subcommittee as well as the full EOC in reviewing the proposed science standards. We would respectfully ask that, if at all possible, the information and answers are provided by November 1. The EOC will also offer an opportunity for public input; however, the mechanism for getting that input has not yet been determined.

If you have any questions, please let me know. The EOC staff looks forward to working with you and your staff on making sure that our state's science standards are rigorous and nationally recognized!

Neil C. Robinson, Jr.
CHAIR

Barbara B. Hairfield
VICE CHAIR

J. Phillip Bowers

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Melanie D. Barton
EXECUTIVE DIRECTOR

Information to Assist EOC in Reviewing the South Carolina Academic Standards and Performance Indicators for Science as Approved by the State Board of Education on October 11, 2013

Please provide to the EOC by November 1, 2013:

1. The comments, excluding any confidential information on the respondents, to the draft science standards that received public comments in the spring of 2013.

2. Any analysis that staff at the South Carolina Department of Education (SCDE) has done to compare the existing *2005 South Carolina Science Academic Standards* with the proposed *South Carolina Academic Standards and Performance Indicators for Science*. For example, when the social studies standards were last revised, SCDE provided summative information on number of standards changed, etc. If such documents do not exist, just let us know. We will assign staff and outside experts to get the information.

3. Timelines for: (1) implementation of the science standards, (2) design of the assessment including cost projections if available; and (3) implementation of the science assessment. Information provided to the Standards, Learning and Accountability Subcommittee of the State Board of Education stated that the assessment would be an online, technology-enhanced assessment but that the timeline had not yet been determined.

4. Answers to the following questions:
   - Will the South Carolina Department of Education develop instructional support documents, curriculum guides, and pacing guides for the standards?

   - Will SCDE conduct training and professional development on the new standards and assessments? If so, what are the projected timelines?

   - Can SCDE explain why the draft standards do not use the Core Disciplinary Ideas from the A Framework for K-12 Science Education (2012), Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads (2011) given that national resources based on the Framework could be available for educators?

   - The overriding goal of standards is to improve the teaching and learning of content. While the Introduction to the revised standards states that "it is critical that educators understand that the Science and Engineering Practices are not to be taught in isolation," the Science and Engineering Practices standard is reiterated *at* each grade level, much like the "Scientific Inquiry" standard of the 2005 science standards. The review panel had recommended that the inquiry standards be integrated into the standards as well as engineering skills and technology be included into the standards rather than stand-alone-standards. What was the rationale for not adopting this recommendation?

   - The revised standards are entitled, "South Carolina Academic Standards and Performance Indicators for Science." The timeline for the review and revision of the standards as well as other documentation always referred to their development as the "South Carolina Academic Standards for Science and Engineering 2013." Can SCDE explain whether the title reflects a change in the focus of the standards as well from the original intent?

Analysis of Proposed South Carolina Science Standards

Dr. Bert Ely

Dr. Bert Ely served as a member of the National Review Panel that the Education Oversight Committee convened to review the 2005 science standards. He is also a professor of Biological Sciences at the University of South Carolina

Potential impact of the 2013 proposed SC science standards

Overall, the proposed standards include most of the same topics as the current SC science standards, but the proposed standards encourage greater depth of learning through the use of higher order thinking skills. If these standards are adopted and faithfully implemented, science instruction will be greatly improved. In addition, if the science assessments do not reward memorization, then teachers will be motivated to implement the new standards as they are intended with the result that there will be a greater depth of student learning.

Proposed K-5 science standards

Most of the topics present in the current K-5 science standards are included in the proposed science standards. However, the indicators of expected student performance in the current SC science standards are expressed using verbs such as: compare, recognize, match, identify, summarize, classify, illustrate, recall, exemplify, and explain. Infer and predict are each used only once in all of the K-5 indicators. In contrast, the proposed K-5 science standards use phrases such as: obtain and communicate information, conduct experiments, develop and use models, analyze and interpret data, construct explanations, define problems, ask and answer questions, use mathematical and computational thinking, construct scientific arguments using evidence, plan and conduct scientific investigations, and design and test possible devices or solutions. Clearly the proposed standards are designed to promote active learning rather than the passive methods that are encouraged by the current standards. The students will be responsible for obtaining information, collecting data, and interpreting the information and data that they obtain. Thus, instead of being a source of information, teachers will focus more on helping students develop their higher order thinking skills. This change will require that teachers become active learners and will certainly result in improved instruction. However, considerable professional development will be needed to help the teachers make this transition.

K-5 standards that need clarification

1.E.3A.1 Analyze and interpret data from observations to describe and predict seasonal patterns of sunrise and sunset. Obviously, first graders cannot collect a year’s worth of sunrise and sunset using only their own observations. Suggested revision – Match data from personal observations with available sunrise and sunset data to describe and predict seasonal patterns of sunrise and sunset.

1.E.3A.2 Revise in as manner similar to that recommended for **1.E.3A.1 –** since young children have little opportunity to observe the all the phases of the moon without disrupting bedtimes.

3.P.3A.2 Develop and use models to describe the path of an electric current in a complete simple circuit as it accomplishes a task (such as lighting a bulb or making a sound). Building electric circuits has been challenging for 4th grade students. There is a concern that some 3rd graders may not have the necessary dexterity for assembling the components.

Proposed middle school science standards

Again the indicators of expected student performance in the current SC science standards are expressed using verbs such as: compare, recognize, match, identify, summarize, classify, illustrate, recall, exemplify, and explain. In contrast, the proposed SC science standards use phrases such as: obtain and communicate information, conduct experiments, develop and use models, analyze and interpret data, construct explanations, define problems, ask and answer questions, use mathematical and computational thinking, construct scientific arguments using evidence, plan and conduct scientific investigations, and design and test possible devices or solutions. In the 6th grade standards, modeling is emphasized as a way providing more content depth. In 7th grade, additional indicators in genetics will provide more depth by requiring mathematical thinking and the development of scientific arguments based on data. Similarly, modeling is emphasized in the ecosystem indicators to promote depth of understanding. In 8th grade, additional indicators include the use of modeling to understand weathering processes, an investigation of how data from new technology are adding to our knowledge of the solar system and the universe, and the use of data to predict the consequences of plate tectonic movements and then generate ideas that could mitigate the problems caused by shifts that impact human structures.

Specific middle school standards

6.L.5A.1 Analyze and interpret data from observations to compare how the structures of protists (including euglena, paramecium, and amoeba) allow them to obtain energy and move.
6.L.5B.1 Develop and use models to describe commonly found fungi by growth habit (yeast or filamentous) or fruiting structure (such as mushroom or puffball). A lot of subject matter is included in 6th grade science. These two indicators are of minor importance that could be eliminated to provide more time for depth in other areas.

Proposed high school science standards

As in the lower grades, the current SC science standards are expressed using verbs such as: recall, summarize, compare, explain, recognize, illustrate, and exemplify. “Predict” is used in one indicator in each course. In contrast, the proposed SC science standards use phrases such as: obtain and communicate information, conduct experiments, develop and use models, analyze and interpret data, construct explanations, use mathematical and computational thinking, construct scientific arguments using evidence, plan and conduct scientific investigations, and design solutions. Most of indicators in the current high school course standards can be tested using multiple choice questions and answered with memorized facts. In contrast, the proposed standards will require the students to demonstrate a greater depth of understanding by working with data and information and assembling it into a larger context. Therefore, improved instruction and student learning will be required to fulfill the expectations of the proposed standards. As in the early grades, professional development will be needed to help the teachers make the transition and new types of assessment will be needed so that the students can demonstrate their ability to use scientific practices.

Specific high school standards

H.B.5A.2 Construct explanations of ways scientists use data from a variety of sources to investigate and critically analyze aspects of the theory of biological evolution. This indicator could be improved by asking students actually do what scientists do. Delete the first five words and change it to: Use data from a variety of sources to investigate and critically analyze aspects of the theory of biological evolution.

H.E.4A.5 Develop and use models of various dating methods (including index fossils, ordering of rock layers, and radiometric dating) to estimate geologic time. The way this indicator is written makes it difficult to understand. It could be restated : Use data from various dating methods (including index fossils, ordering of rock layers, and radiometric dating) to estimate geologic time at a specific location.

H.E.2B.1 Analyze and interpret data to compare the properties of Earth and other planets (including composition, density, surface expression of tectonics, climate, and conditions necessary for life).

H.E.4A.1 Construct scientific arguments to support claims that the physical conditions of Earth enable the planet to support carbon-based life. It seems to me that H.E.4A.1 is included in H.E.2B.1. Perhaps they should be combined.

Summary

The proposed SC science standards would make only minor changes in the content that is included in the current science standards. The major change would be in the expectations for student performance. The students would be expected to become active learners who use science and engineering practices to generate and use scientific data. These changes are consistent with the expectations published by the National Research Council in their recent report *"A Framework for K-12 Science Education"*. Adoption of these standards would help South Carolina maintain its reputation for high quality science standards.

Report on the Review of the South Carolina Science Academic Standards

SC EDUCATION
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Presented to the
Education Oversight Committee
June 11, 2012

INTRODUCTION

The South Carolina Education Accountability Act of 1998 establishes an accountability system for public education that focuses on improving teaching and learning so that students are equipped with a strong foundation in the four primary academic disciplines and a strong belief in lifelong learning. Academic standards are used to focus schools and districts toward higher performance by aligning the state assessment to those standards. The implementation of quality standards in classrooms across South Carolina is dependent upon systematic review of adopted standards, focused teacher development, strong instructional practices, and a high level of student engagement. Pursuant to Section 59-18-350(A) of the Education Accountability Act, the Education Oversight Committee (EOC) and the State Board of Education are responsible for reviewing South Carolina's standards and assessments to ensure that high expectations for teaching and learning are being maintained.

> The State Board of Education, in consultation with the Education Oversight Committee, shall provide for a cyclical review by academic area of the state standards and assessments to ensure that the standards and assessments are maintaining high expectations for learning and teaching. At a minimum, each academic area should be reviewed and updated every seven years. After each academic area is reviewed, a report on the recommended revisions must be presented to the Education Oversight Committee and the State Board of Education for consideration. After approval by the Education Oversight Committee and the State Board of Education, the recommendations may be implemented. However, the previous content standards shall remain in effect until approval has been given by both entities. As a part of the review, a task force of parents, business and industry persons, community leaders, and educators, to include special education teachers, shall examine the standards and assessment system to determine rigor and relevancy.

In March of 2012, the EOC activities under the cyclical review of the South Carolina Science Academic Standards were completed. This document presents recommendations for modifications to the 2005 South Carolina Science Academic Standards from the Education Oversight Committee. These recommendations were compiled under the advisement of three review teams: a national review team of science educators who have worked with national or other state organizations; a parent, business, and community leaders' team drawn from various geographical areas in South Carolina; and a team of educators and parents of students with disabilities and students with limited English proficiency. At the same time that these three committees were meeting, the State Department of Education assembled a team of SC science educators from around the state to review the standards.

It is important to note that the adopted South Carolina Science Academic Standards represent the work of many educators, and that this review of the standards was undertaken to identify ways in which their work could be strengthened and supported. The Education Oversight Committee expresses its appreciation to those educators and commends their utilization of national source documents and their belief in the achievement of all students. The Education Oversight Committee intends to enhance the work of school level educators and, ultimately, to ensure that all students are knowledgeable and capable.

I. CYCLICAL REVIEW PROCESS

The review of the South Carolina Science Academic Standards began with focus on the accomplishment of goals articulated in the Education Accountability Act (EAA) of 1998. The law, as amended through 2008, specifies: "The standards must be reflective of the highest level of academic skills with rigor necessary to improve the curriculum and instruction in South Carolina's schools so that students are encouraged to learn at unprecedented levels and must be reflective of the highest level of academic skills at each grade level." (Article 3, 59-18-300)

The Standard Operating Procedures for the Review of Standards (SOP) agreed upon by the State Department of Education (SDE) and the Education Oversight Committee (EOC) during the summer 2003 were followed for this review. A time line established during the fall of 2011 outlined the time frame in which the required review teams were to review the standards adopted in 2005 by the end of spring 2012. The SOP also outlines the steps to be taken to revise the current standards should the completion of the reviews indicate that revision is needed.

A. CRITERIA DESCRIPTIONS

The South Carolina Science Academic Standards Review Process followed by all four review teams emphasized the application of the criteria addressing comprehensiveness/balance, rigor, measurability, manageability, and organization/ communication. SDE representatives, district and university curriculum leaders, and EOC staff collaborated to identify the standards review criteria. Decisions on the criteria to be used were based on a comprehensive review of professional literature, and the goals for the standards review as specified in the Education Accountability Act of 1998. The identified criteria were each applied through the four review panels: (1) leaders in the discipline drawn from across the nation; (2) science educators from South Carolina's education community; (3) special educators from the South Carolina's education community; and (4) parents, business representatives, and community leaders.

CRITERION ONE: COMPREHENSIVENESS/BALANCE
The criterion category for Comprehensiveness/Balance is concerned with how helpful the South Carolina Science Academic Standards document is to educators in designing a coherent curriculum. The criterion is directed at finding evidence that the standards document clearly communicates what constitutes Science content, that is, what all students should know and be able to do in science by the time they graduate. The criterion includes consideration of the following areas:

- The standards address essential content and skills of science;
- The standards are aligned across grades as appropriate for content and skills;
- The standards have an appropriate balance of the content and skills needed for mastery of each area in science; and
- The standards reflect diversity (especially for ethnicity and gender) as appropriate for the subject area.

CRITERION TWO: RIGOR
This criterion calls for standards that require students to use thinking and problem-solving skills that go beyond knowledge and comprehension. Standards meeting this criterion require students to perform at both national and international benchmark levels.

- Standards should focus on cognitive content and skills (not affect);

- Standards should be developmentally appropriate for the grade level;
- Standards should include a sufficient number of standards that require application of learning (application, analysis, synthesis, and evaluation);
- Standards should be informed by the content and skills in national and international standards; and,
- Standards should be written at a level of specificity that will best inform instruction for each grade level.

CRITERION THREE: MEASURABILITY
Knowledge and skills presented in the standards are assessable for school, district and state accountability. The primary element of measurability is:

- The content and skills presented in the standards should be assessable (are observable and demonstrable).

CRITERION FOUR: MANAGEABILITY
This criterion applies to instructional feasibility, that is, whether the complete set of science standards at a particular grade level can reasonably be taught and learned in the class time allotted during one year. The primary element of manageability is:

- The number and scope of the standards for each grade level should be realistic for teaching, learning, and student mastery within the academic year.

CRITERION FIVE: ORGANIZATION/COMMUNICATION
The Organization/Communication criterion category stipulates that the expectations for students are to be clearly written and organized in a manner understandable to all audiences and by teachers, curriculum developers, and assessment writers. Organization includes the following components:

- The content and skills in the standards should be organized in a way that is easy for teachers to understand and follow;
- The format and wording should be consistent across grades;
- The expectations for student learning should be clearly and precisely stated for each grade; and,
- The standards should use the appropriate terminology of the field but be as jargon free as possible.

B. PANEL MEMBERSHIP

The EOC's cyclical review of the 2005 South Carolina Science Academic Standards was conducted by the following three panels during February and March 2012.

The national review team members consisted of recognized leaders in science education, who have participated in the development/writing of national and state science standards. As national leaders on science standards all have reviewed a number of state science standards. Comments and recommendations included in this document are based in part on *The State of the State Standards 2012* from the Fordham Institute, *International Standards Benchmarking Report* (2010), *A Framework for K-12 Science Education* (2012), *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads* (2011), *Surrounded by Science: Learning Science in Informal Settings* (2010), and *Project 2061* (1989) along with additional current research documents, classroom experiences, knowledge of students' developmental stages and an understanding of expectations for student learning in the area of science. Members of the team received the materials for the review in early January and received communications concerning the process of the review through March. After an independent review period, the members of the panel participated in a telephone conference call that produced through consensus, a set of findings listed later in this document. Members of the National Review Panel included:

- Dr. Melanie Cooper, Department of Engineering and Science Education, Clemson University
- Dr. Robert T. Dillon, Jr., Associate Professor, Department of Biology, College of Charleston
- Dr. Bert Ely, Professor of Biological Sciences, University of South Carolina
- Dr. Ursula Goodenough, Professor of Biology, Washington University, St. Louis, MO
- Dr. Lawrence S. Lerner, Professor Emeritus, Department of Physics and Astronomy, California State University, Long Beach, CA
- Dr. Christine Lotter, Associate Professor, Instruction and Teacher Education, Department of Education, University of South Carolina
- Dr. James Wanliss, Department of Physics and Computer Science, Presbyterian College

The EOC contacted all school district superintendents and instructional leaders in the state as well as EOC members for nominations to the following panels. Approximately 162 names were provided to the EOC. First, the Science Parent/Business/Community Leader Review Task Force was composed of twenty one parents, business representatives and community leaders. Task force members provided individual responses to the standards review and attended a one-day session on March 30, 2012 conducted by Kay Gossett, EOC review coordinator and Melanie Barton, Interim Director of EOC. The task force reached consensus on insights and specific recommendations about the 2005 South Carolina Science Academic Standards. Members of the task force included:

Libby Baker, Pageland
George Brown, Hemingway
Patricia Caldwell, Newberry
Rose Choice, Estill
Dave Coggins, Spartanburg
Mike Fair, Columbia
Adrian Grimes, Summerville
Jennifer Hawthorned, Monks Corner
Hugo Linares, Greer
Edward Lott, Florence
Collette McBride, Salters
Robert McClinton, Greenwood
Jerome McCray, Bishopville
Jordana Megonigal, Greer
Robert Oliver, Pinewood
Scott Owens, Horatio
Angela Peters, Orangeburg
Khushru Tata, Columbia
Mike Taylor, Batesburg-Leesville
Jamie Thon, Summerville
Kim Williams-Carter, Clinton

The Community/Business panel represented policymakers, clergy, engineers, organization leaders, state educators, industry representatives, and business leaders.

Each school district also was invited to recommend members of their respective special education communities to the Science Special Education and English Language Learners Review Task Force. Twenty seven special education teachers, English Language Learners teachers and parents participated in the cyclical review process. After reviewing the science standards according to the cyclical review criteria, the task force members attended a one day meeting on March 26, 2012 facilitated by Kay Gossett, EOC review coordinator and Melanie Barton, Interim Director of EOC. The task force through discussion determined a series of findings and recommendations about the 2005 South Carolina Science Academic Standards. Members of the task force included:

Kyle Blankenship, Aiken
Sharon Jackson, Anderson 4
Lauren McClellan, Anderson 5
Wanda Coleman, Barnwell 29
Robin Boyleston, Barnwell 45
Rachel Amey, Charleston
Nicole Adams, Charter Schools
Melissa Cruse, Dorchester 2
Mary Atkins, Hampton, 2
Marie Fernandez, Jasper
Casey Spain, Laurens 56
Carla Stegall, Lexington 1
Emmylou Todd, Lexington 2
Debra Hall, Lexington 3
Pauline Morris, Marlboro
Cheryl Parr, Newberry
Liana Calloway, Orangeburg 3
Juliett Stoute-White, Orangeburg 5
Sandy Frazier, Richland 1
Teisha Hair, Spartanburg 2
Teresa Brown, Spartanburg 3
Sharon Glenn, Spartanburg 6
Vaughn Vick, Spartanburg 7
Albertha Bannister, Sumter
Barbara Greene, Williamsburg
Susan Conrad, York 3
Carmen Belei, York 3

The State Department of Education also gathered a panel of science educators from around the state to review the SC science standards. This group consisted of classroom teachers from all grade levels, university professors, curriculum specialists, administrators, and State Department of Education personnel. Meeting in March and April 2012, the state department's review team followed the same criteria as the three review teams conducted by the EOC and reached consensus on their recommendations.

C. THE STANDARDS DOCUMENT

The 2005 South Carolina Science Academic Standards are organized by grade levels for grades kindergarten through the eighth grade to include discipline areas of life science, earth science, and physical science and five high school core areas: physical science, biology, chemistry, physics, and earth science. An overview describing specific subject matter and themes is provided on the first page of the standards' document for each grade and high school core area.

http://ed.sc.gov/agency/pr/standards-and-curriculum/documents/sciencestandardsnov182005_001.pdf.

The statements of the academic standards themselves are newly constructed. Each standard is now stated as one full sentence that begins with the clause "The student will demonstrate an understanding of …" and goes on to specify the particular topics to be addressed by that standard. The area from which each of the content standards is drawn is specified in parenthesis immediately following the statement of the standard. Following each of the academic standards are indicators, which are intended to help meet teachers' needs for specificity. The main verbs in the indicators are taxonomic – that is, they identify specific assets of the cognitive process as described in the revised Bloom's Taxonomy. The term *including* appears frequently in parenthetical statements in the science indicators to introduce a list of specifics that are intended to clarify and focus the teaching and learning of the particular concept.

In addition to the content standards, each grade and high school core area has a separate scientific inquiry standard, with indicators that are now differentiated across grade levels and core ideas. The skills, processes, and tools specified in the scientific inquiry indicators are also embedded in the content standards and indicators wherever appropriate.

Fifth Grade Example:

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

> **5-1.3 Plan and conduct controlled scientific investigations, manipulating one variable at a time.**

The State Department of Education developed a curriculum support document providing in-depth content information, prerequisite skills and prior knowledge needed for the content after the State Board of Education adoption of these standards.

II: ISSUE WITH THE STANDARDS PRIOR TO THE REVIEW

As stated earlier, South Carolina Science Academic Standards are well-regarded by national experts and has been the model for standards development in many other states. However, the reality of the science standards is found in the student performance results. Unfortunately, too few students have reached the expectations set for them causing us to determine issues to be addressed as the current standards are reviewed. The following table documents the percentage of students scoring Not Met, Met and Exemplary on the Palmetto Assessment of State Standards (PASS) test in science in 2011. The percentage of students scoring Not Met on the PASS science exam fluctuates from a low of 28.3 percent in seventh grade to a high of 39.2 percent in third grade. By law, the student performance levels are defined accordingly:

> Not Met means that the student did not meet the grade level standard;
> Met means that the student met the grade level standard; and
> Exemplary means that the student demonstrated exemplary performance in meeting the grade level standards. (Section 59-18-900)

Table 1
2011 PASS Science, % of Students Scoring:

Grade	Number of Test Takers	Not Met	Met	Exemplary
03	26,828	39.2	36.8	24.0
04	55,006	29.1	54.8	16.0
05	27,683	35.1	46.5	18.5
06	27,018	35.1	50.5	14.4
07	53,464	28.3	44.7	27.0
08	25,952	29.9	33.2	36.9

Source: South Carolina Department of Education, http://ed.sc.gov/data/pass/2011/.

A concern found in reviewing the SC science standards revolves around the breadth of the standards versus the depth. National science standards and input from state science educators provided the content to be included in the 2005 science standards. The science standards provide a wealth of content to be learned from kindergarten through high school. All science content is considered important because science builds on prior background knowledge. In order for students to obtain a true understanding of science concepts, a determination needs to be made as to what content is essential for the students to be successful in their school careers as well as in the work careers

Another concern deals with how students learn science best. In order to grasp an understanding of science concepts and skills, students must be engaged in science. Currently, inquiry standards are separate from the content standards in all grades and high school courses. In order for students to be sufficiently prepared for post-secondary science work, students must move beyond recall and memory-work in the science classes. They must be engaged in the "doing" of science. Science must promote current science practices, modern science content, and an infusion of the most current technological instruments.

III: FINDINGS

The discussion below summarizes reviews of panel members, and presents consensus findings and examples for each criterion.

A: COMMENDATIONS

1. The SC science standards are well-written and highly regarded. According to *The State of State Science Standards 2012* by the Fordham Institute, South Carolina has "produced a set of workmanlike standards of consistent, high quality." In this review of the science standards, Fordham Institute granted South Carolina an A- grade for providing "science standards that are clear and succinct, but that also outline most of the essential K-12 content that students need to learn."

   http://www.edexcellencemedia.net/publications/2012/2012-State-of-State-Science-Standards/2012-State-of-State-Science-Standards-FINAL.pdf.

2. The standards are consistent across grade levels and increase in appropriate complexity. The standards develop appropriately through advancing grades with clear and logical progression.

3. The science standards are clearly written using Bloom's verbs that show the level of performance required of students; thus, they are observable and assessable.

4. The standards are informed by content and skills in national standards developed in 1996 and additional science education research documents from the early 2000's.

5. The standards are easy to follow and user friendly for teachers. A logical progression is followed throughout the standards, building science concepts from grade to grade and defining what students should know.

   .

6. The science support document provides teachers with additional content and instructional information. The standards are presented clearly and are linked to support documents, providing for teachers specific details of the content and clarifying what students should know and be able to do.

   http://ed.sc.gov/agency/pr/standards-and-curriculum/Science.cfm

B: CONCERNS COMMON TO ALL REVIEW PANELS

1. SC must improve the learning of science by going deeper rather than broader with standards.
2. Students do not appear to be appropriately prepared for postsecondary education as reflected by state and national evaluators of the science standards. This may be a result of a shallow understanding of science content due to the number of standards or even from the lack of student engagement in learning science.
3. SC should use the most recent and relevant information when amending the standards which includes the new science framework as well current research on international science standards.
4. The standards must be incorporate engineering and real-life applications.
5. Inquiry must be integrated with the content standards to bring meaning to science.

C: ADDITIONAL FINDINGS OF THE NATIONAL REVIEW TEAM

1. The standards provide clear content and skills learning objectives from the early grades through high school but are based on prior research from the 1990's. Current emphases in more recent national and international research is on the use of key core ideas in developing science standards and a focus on combining content and practices to make it explicit what it is that students should be able to know and do. In a recent publication, *A Framework for K-12 Science Education* (NRC 2012), national science experts recognize that *"although the existing national documents on science content for grades K-12 (developed in the early to mid-1990s) were an important step in strengthening science education, there was much room for improvement. Not only has science progressed, but the education community has learned important lessons for 10 years of implementing standards-based education, and there is a new and growing body of research on learning and teaching in science that can inform a revision of the standards and revitalized science education."*

2. Use of big core ideas in the standards would decrease the scale of standards and indicators and allow depth of content to be the focus, not the breadth. Standards using "recall, summarize, know, etc…." should be removed and combine these ideas to formulate higher level standards.

3. Revisit the use of Bloom's taxonomy in the standards which is not intuitive to teachers. Use performance verbs that say exactly what science knowledge students should have.

4. For teachers to successfully implement the standards, the learning progressions must be made clearer and show teachers how to integrate content and practices in performance.

5. Inquiry skills can only enhance student learning if they are meaningfully linked to content. The current separate inquiry skills need to be integrated into the content standards to ensure inclusion of science practices into the knowledge of science.

6. The science indicators and support documents should be revised to include engineering terminology and make engineering instruction more explicit.

7. Assessment needs to align with the level of thinking wanted from students in order for true instructional change to occur. Move away from multiple choice tests which measure lower level learning from students.

8. Based on the need to assess student performance in science, investigate the use of adaptive computer assessments that incorporate simulations and critical thinking applications needed to assess the higher level standards.

9. Review the standards for redundancy such as found in the population and ecology sections and other areas.

10. The standards need to be checked for consistency in wording and review glossary terms for accuracy.

11. To address diversity in the standards, the standards could state "using appropriate examples that include a variety of cultures, genders, and ethnicities…." to build connections between curriculum and students' cultures especially in standards that address human impact on the environment.

12. Introduce some basic concepts earlier (ex. Move DNA to 7^{th} grade) which would free more time to focus on genetic engineering and more cutting edge genetic applications in biology.

13. Physiology content is lacking and needs to be included throughout the upper grades. For example, physiology has strong coverage in the seventh grade standards; nothing appears after that year on this important topic and is completely omitted from high school biology materials.

14. All standards must be treated equally. Only once in the standards is the phrase "critically analyze" found which is in B-5.6 on biological evolution. Recommendations made during the review of the 2005 SC standards included using the phrase in additional indicators to Standard B-5. Most of the recommendations were not accepted leaving standard B-5 slightly weaker than any other science standard in the K-12 curriculum.

15. Chemistry standards do not reflect how chemistry is practiced by modern chemists. Students taught in this manner will merge with a surface level understanding of chemistry that will not be useful to them in future studies.

D. ADDITIONAL FINDINGS OF THE PARENT/BUSINESS/COMMUNITY LEADER REVIEW PANEL

1. The world is changing at an ever-increasing pace, especially as it relates to issues taught through science and an ongoing review seems necessary to keep pace with the changes. The review would prioritize what is best to teach during the limited time available.

2. The standards/indicators need to address the rapid changes in science-based careers and prepare students to be adaptable to fit jobs that have not been created at this time.

3. Engineering based scientific argument and engineering skills need to be added and connected to the science standards.

4. Math is a critical component in learning science concepts and practices. Science and Common Core math should be aligned for appropriate learning opportunities.

5. Emphasis needs to be placed on technology beginning in early grades and continuing through high school. Knowledge of different technological instruments is essential to the understanding of science.

6. Content and skills should be written into one document to appropriately inform instruction. Incorporating science practices and content with scientific concepts will make expectations much clearer.

7. An essential part of science is laboratory based. An active laboratory component can provide engagement and motivation for science leading to extended interest in post-secondary education and careers. Schools must be provided the resources and equipment for a viable science laboratory focus.

8. Measurability of the science standards are constrained by use of standardized tests.

9. Instructional time for science needs to be mandated in order for adequate time to be allocated to science.

10. Standards are necessary to ensure that all SC students are receiving the same basic education but the key to improved student performance is execution of the standards. Teachers who teach science without a science background will hinder successful implementation of the standards.

E. ADDITIONAL FINDINGS OF THE TEACHERS AND PARENTS OF STUDENTS WITH DISABILITIES (SPED) AND ENGLISH LANGUAGE LEARNERS (ELL)

1. The number of application standards needs to be increased to address diversity among the student population. By integrating inquiry standards in with the content standards, SPED and ELL students would gain from the hands on approach to learning.

2. The standards document needs a simplified continuum of standards added to inform teachers, especially SPED and ELL teachers, of the prerequisite skills and application level of the standards across grade levels.

3. The relationship between the science standards and other content areas needs to be investigated. A cross over document would benefit SPED and ELL teachers in thematic or integrated instruction.

4. Standards sometimes contain verbiage that can be confusing. More specific language which uses explicit and direct words as well as words that do not have multiple meanings is needed by instructors of and students with disabilities or language limitations.

5. More inquiry skills need to be built into the standards to support the use of hands on learning for SPED and ELL students. These students especially need additional examples, models, and visuals to be used in the standards.

6. Performance based assessments which allow students' drawings to indicate understanding could be used to assess students. Current assessments are not appropriate for mainstream, ELL, or special education students.

7. Some standards are not repeated often enough while others are taught only once at a specific grade level. The standards need to be built on a progression of learning to meet the needs of students of all abilities.

8. Science should make connections to the "real world." There is a need to explain "why" students are being instructed on these standards and "how" they will be relevant to the students now and in the future and is particularly beneficial to students with disabilities.

9. There is a need for more examples and visuals within the standards instruction highlighting the cultural diversity and disabled population found in the community, families, state, nation, and world.

F: CRITERIA-BASED FINDINGS AND RECOMMENDATIONS

Listed below are the specific findings based on the criteria presented earlier in this report. Findings were reached by the National Review Panel, the Parent/Business/ Community Review Panel and the Special Education/English Language Learners Review Panel. The complete Criteria description may be found on pages 2 and 3 of this document.

Criterion One: Comprehensiveness/Balance
Findings/Recommendations

1. *The standards reflect essential science content and skills.*
2. *The standards should address the low level standards and redundancy in the content across grade levels in an effort to reduce the number of standards.*
3. *The standards need to reflect current research in science education and how students learn.*
4. *The standards should include current people of note and engineering.*

Criterion Two: Rigor
Findings/Recommendations:

1. *Indicators are written at a low level of Bloom's Taxonomy (cognitive demand) and needs to move to the application level (or higher).*
2. *Currently the inquiry standards are separate and need to be integrated into the content standards.*
3. *Develop a means for spiraling standards across grade levels to increase rigor.*
4. *The standards are informed by content and skills in national standards but should include recent research on incorporating science practices into the standards.*
5. *Balance the specificity of standards within and across standards.*

Criterion Three: Measurability
Findings/Recommendations:

1. *Indicators are written so that they are easily understandable and assessable. Use of high level performance verbs (cognitive demand) in the standards will allow for assessments items at a higher level.*
2. *Investigate adaptive computer assessments capable of assessing high level standards for students of all abilities.*

Criterion Four: Manageability
Findings/Recommendations:

1. *The numbers of standards should be reduced to allow for more in-depth teaching and depth of student understanding.*
2. *An adequate amount of time needs to be given to science instruction.*

Criterion Five: Organization/Communication
Findings/Recommendations:

1. *The format is easy to understand and follow for all teachers.*
2. *Consider using themes or disciplines for organization which will lead to integration of standards and content areas.*
3. *Currently, teachers are using the standards as check-off lists instead of understanding the value of using activities to integrate the standards.*
4. *The standards need to be checked for consistency of wording.*

IV. EOC RECOMMENDATIONS

The EOC stands firmly behind the premise that students must learn science at the highest level in order to be prepared for college and successfully compete in careers today and those to be created in the future. The recommendations that are listed below are based on the detailed review of the South Carolina Science Academic Standards and are supported by the evidence and detailed comments that appear in the criteria-based and individual task force findings included in this report.

1. According to national and international research, science standards should be built upon key core ideas in science; limiting the breadth of "good to know" content and focusing on the depth of the standards for increased student understanding. Limit the number of key

ideas explored each year while increasing their depth and revisiting the concepts periodically.

2. Decreasing the scale of standards and indicators of standards allows for removal of “recall” standards by combining the ideas to formulate higher level standards. By using explicit performance verbs, a progression of learning is established from grade to grade providing all students with exactly what it is that students should be able to do.

3. Science is innately an activity based content area. Students are more engaged and motivated through hands-on opportunities. The inquiry standards must be integrated into the science standards to ensure inclusion of science practices in instruction.

4. As standards are written at a higher level, assessments must appropriately measure the performance of students at higher levels. New adaptive computer assessments that incorporate simulations and critical thinking applications are needed to adequately measure these standards.

5. Science should make connections to the “real world.” There is a need to explain to students of all ability levels “why” students are being instructed on the standards and “how” they will be relevant to all students now and in the future. Therefore teachers must be aware how modern science is addressed in the work world.

6. Alignment of standards with other content areas is greatly needed. In elementary grades, teachers face the dilemma of more content to be taught in a given year than there is time. In all grades, math is a critical component of learning science concepts and practices. Cross-over documents need to be developed to align standards for appropriate learning opportunities.

7. Engineering skills and technology are integral components of modern science education. Deliberate inclusion of these skills and materials into the standards should be addressed.

8. Attention should be given to teacher preparation for all teachers instructing in the science areas. The key to improved science performance is execution of the standards. Teachers who teach science without a science background hinder successful implementation of the standards. Efforts should be made to work closely with post-secondary science educators in providing a student based instructional model for pre-service opportunities.

9. The ongoing implementation of these revised standards must be accompanied by:
    a. Changes in state assessment to reflect that what is assessed is aligned with what is to be taught;
    b. Sample demonstrations of what students should be able to do based on the explicit standards for assessment purpose;
    c. An intensive set of professional development activities for both teachers and administrators that broaden both awareness of and capacity to implement these standards and includes video examples of science activities;
    d. Widespread encouragement and support to adopt newer curriculum materials that are better aligned with the content and process standards; and
    e. Development of supplemental/support documents and materials for use in the classroom to assist teachers in instructing all students towards learning the

stands; this would include a curriculum guide and an adaptability document for special education teachers and teachers of English Language Learners.

A FRAMEWORK FOR K-12 SCIENCE EDUCATION

Practices, Crosscutting Concepts, and Core Ideas

Committee on a Conceptual Framework for New K-12 Science Education Standards

Board on Science Education

Division of Behavioral and Social Sciences and Education

NATIONAL RESEARCH COUNCIL
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SUMMARY

Science, engineering, and technology permeate nearly every facet of modern life, and they also hold the key to meeting many of humanity's most pressing current and future challenges. Yet too few U.S. workers have strong backgrounds in these fields, and many people lack even fundamental knowledge of them. This national trend has created a widespread call for a new approach to K-12 science education in the United States.

The Committee on a Conceptual Framework for New K-12 Science Education Standards was charged with developing a framework that articulates a broad set of expectations for students in science. The overarching goal of our framework for K-12 science education is to ensure that by the end of 12th grade, *all* students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology.

Currently, K-12 science education in the United States fails to achieve these outcomes, in part because it is not organized systematically across multiple years of school, emphasizes discrete facts with a focus on breadth over depth, and does not provide students with engaging opportunities to experience how science is actually done. The framework is designed to directly address and overcome these weaknesses.

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The framework is based on a rich and growing body of research on teaching and learning in science, as well as on nearly two decades of efforts to define foundational knowledge and skills for K-12 science and engineering. From this work, the committee concludes that K-12 science and engineering education should focus on a limited number of disciplinary core ideas and crosscutting concepts, be designed so that students continually build on and revise their knowledge and abilities over multiple years, and support the integration of such knowledge and abilities with the practices needed to engage in scientific inquiry and engineering design.

The committee recommends that science education in grades K-12 be built around three major dimensions (see Box S-1 for details of each dimension). These dimensions are

- Scientific and engineering practices
- Crosscutting concepts that unify the study of science and engineering through their common application across fields
- Core ideas in four disciplinary areas: physical sciences; life sciences; earth and space sciences; and engineering, technology, and applications of science

To support students' meaningful learning in science and engineering, all three dimensions need to be integrated into standards, curriculum, instruction, and assessment. Engineering and technology are featured alongside the natural sciences (physical sciences, life sciences, and earth and space sciences) for two critical reasons: (1) to reflect the importance of understanding the human-built world and (2) to recognize the value of better integrating the teaching and learning of science, engineering, and technology.

The broad set of expectations for students articulated in the framework is intended to guide the development of new standards that in turn guide revisions to science-related curriculum, instruction, assessment, and professional development for educators. A coherent and consistent approach throughout grades K-12 is key to realizing the vision for science and engineering education embodied in the framework: that students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of each field's disciplinary core ideas.

The framework represents the first step in a process that should inform state-level decisions and provide a research-grounded basis for improving science teaching and learning across the country. It is intended to guide standards developers, curriculum designers, assessment developers, state and district science

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BOX S-1

THE THREE DIMENSIONS OF THE FRAMEWORK

1 Scientific and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

2 Crosscutting Concepts

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

3 Disciplinary Core Ideas

Physical Sciences
PS1: Matter and its interactions
PS2: Motion and stability: Forces and interactions
PS3: Energy
PS4: Waves and their applications in technologies for information transfer

Life Sciences
LS1: From molecules to organisms: Structures and processes
LS2: Ecosystems: Interactions, energy, and dynamics
LS3: Heredity: Inheritance and variation of traits
LS4: Biological evolution: Unity and diversity

Earth and Space Sciences
ESS1: Earth's place in the universe
ESS2: Earth's systems
ESS3: Earth and human activity

Engineering, Technology, and Applications of Science
ETS1: Engineering design
ETS2: Links among engineering, technology, science, and society

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administrators, professionals responsible for science teacher education, and science educators working in informal settings.

The report also identifies the challenges inherent in aligning the components of K-12 science education with this new vision for science and engineering education, provides recommendations for standards development, and lays out a research agenda that would generate the insights needed to update the framework and inform new standards in the future. The committee emphasizes that greater improvements in K-12 science and engineering education will be made when all components of the system—from standards and assessments, to support for new and established teachers, to providing sufficient time for learning science—are aligned with the framework's vision.

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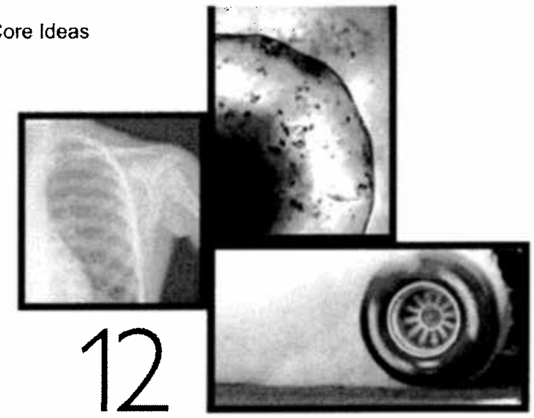

12

GUIDANCE FOR STANDARDS DEVELOPERS

The preceding chapters of this report describe the scientific and engineering practices, crosscutting concepts, and disciplinary core ideas—taken together, the framework—that should be the focus of K-12 science and engineering education. In this chapter, we offer guidance for developing standards based on that framework. The committee recognizes that several layers of interpretation occur between the outline articulated in the framework and actual instruction in the classroom, with the first layer being the translation of the framework into a set of standards. In this translation, it is important to keep in mind the possibilities and constraints of K-12 science education in the United States and to consider how standards can play a role in promoting *coherence* in science education—an element that is critical to ensuring an effective science education for all students, as discussed in Chapter 10 on implementation.

The emphasis on coherence includes consistency across standards for different subject areas. Given the large number of states that have adopted the Common Core Standards for mathematics and English/language arts, standards for K-12 science intended for multistate adoption need to parallel the expectations for development of mathematics and English/language arts competency reflected in corresponding standards [1].

The framework is designed to support coherence across the science and engineering education system by providing a template that incorporates what is known about how children learn these subjects. The committee's choice to organize the framework around the scientific and engineering practices, crosscutting concepts, and disciplinary core ideas is intended to facilitate this coherence. By

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consistently focusing on these practices, concepts, and ideas and by drawing on research to inform how they can be supported through instruction and developed over multiple grades, the framework promotes cumulative learning for students, coordinated learning experiences across years, more focused preparation and professional development for teachers, and more coherent systems of assessment.

The committee recognizes that simply articulating the critical practices, concepts, and core ideas for K-12 science education does not by itself provide sufficient guidance for developing standards. In that spirit, the recommendations outlined in this chapter are intended to offer more detailed guidance that will help ensure fidelity to the framework. These recommendations are based on previous research syntheses published by the National Research Council (NRC)—including *How People Learn* [2], *Systems for State Science Assessment* [3], *Taking Science to School* [4], and *Learning Science in Informal Environments* [5]—and they draw particularly on a list of characteristics for science content standards developed in *Systems for State Science Assessment* [3]. According to that report, science content standards should be clear, detailed, and complete; reasonable in scope; rigorously and scientifically correct; and based on sound models of student learning. These standards should also have a clear conceptual framework, describe performance expectations, and identify proficiency levels.

RECOMMENDATIONS

Recommendation 1: Standards should set rigorous learning goals that represent a common expectation for all students.

At a time when nearly every aspect of human life is shaped by science and engineering, the need for all citizens to understand these fields is greater than ever before. Although many reports have identified the urgent need for a stronger workforce in science and engineering so that the United States may remain economically competitive, the committee thinks that developing a scientifically literate citizenry is equally urgent. Thus the framework is designed to be a first step toward a K-12 science education that will provide *all* students with experiences in science that deepen their understanding and appreciation of scientific knowledge and give them the foundation to pursue scientific or engineering careers if they so choose. A growing evidence base demonstrates that students across economic, social, and other demographic groupings can and do learn science when provided with appropriate opportunities [4-7]. These opportunities include learning the requisite literacy and numeracy skills required for science.

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Because the committee proceeded on the assumption that the framework and resulting standards identify those practices, crosscutting concepts, and disciplinary core ideas that are required for all students, some topics covered in advanced or specialized courses may not be fully represented. That is, the framework and resulting standards are not intended to represent all possible practices, concepts, and ideas covered in the full set of science courses offered through grade 12 (e.g., Advanced Placement or honors courses; technology courses; computer science courses; and social, behavioral, or economic science courses). Rather, the framework and standards represent the set of scientific and engineering practices, concepts, and ideas that all students should encounter as they move through required course sequences in the natural sciences.

Recommendation 2: Standards should be scientifically accurate yet also clear, concise, and comprehensible to science educators.

Standards for K-12 science education (a) provide guidance to education professionals about the priorities for science education and (b) articulate the learning goals that must be pursued in curricula, instruction, and assessments.

Scientific rigor and accuracy are paramount because standards serve as reference points for other elements of the system. Thus any errors in the standards are likely to be replicated in curricula, instruction, and assessments. Similarly, standards should clearly describe the scientific practices in which students will engage in classrooms [3]. Clarity is important because curriculum developers, textbook and materials selection committees, assessment designers, and others need to develop a shared understanding of the outcomes their efforts are intended to promote [3].

At the same time, standards related to the framework's concepts, ideas, and practices must be described in language that is comprehensible to individuals who are not scientists. Even though some of the professionals who play a role in interpreting standards do not have deep expertise in science, they nevertheless need to develop ways to support students' learning in science and to determine whether students have met the standards. Standards also provide a mechanism for communicating educational priorities to an even broader set of stakeholders, including parents, community members, business people, and policy leaders at the state and national levels. Thus, although standards need to communicate accurately important scientific ideas and practices, they must

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be written with these broader (nonscience) audiences in mind. Furthermore, the broad goals and major intent should be clear to any reader.

Recommendation 3: Standards should be limited in number.

The framework focuses on a limited set of scientific and engineering practices, crosscutting concepts, and disciplinary core ideas, which were selected by using the criteria developed by the framework committee (and outlined in Chapter 2) as a filter. We also drew on previous reports, which recommended structuring K-12 standards around core ideas as a means of focusing the K-12 science curriculum [3, 4]. These reports' recommendations emerged from analyses of existing national, state, and local standards as well as from a synthesis of current research on learning and teaching in science.

Standards developers should adhere to the framework by concentrating on the set of practices, concepts, and core ideas described here, although undoubtedly there will be pressure from stakeholder groups to expand that set. The above-mentioned criteria can be used in determining whether a proposed addition should be accepted. An overarching consideration is whether *all* students need to learn the proposed idea or practice and if there would be a significant deficiency in citizens' knowledge if it were not included. Another consideration should be recognition of the modest amount of time allotted to science in the K-12 grades. There is a limit to what can be attained in such time, and inclusion of additional elements of a discipline will always be at the expense of other elements, whether of that discipline or of another.

Recommendation 4: Standards should emphasize all three dimensions articulated in the framework—not only crosscutting concepts and disciplinary core ideas but also scientific and engineering practices.

The committee emphasized scientific and engineering practices for several reasons. First, as discussed in Chapter 2, competency in science involves more than knowing facts, and students learn key concepts in science more effectively when they engage in these practices. Second, there is a body of knowledge about science—for example, the nature of evidence, the role of models, the features of a sound scientific argument—that is best acquired through engagement in these practices. Third, emerging evidence suggests that offering opportunities

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for students to engage in scientific and engineering practices increases participation of underrepresented minorities in science [8-12].

The importance of addressing both knowledge and practice is not unique to this framework. In 1993, the *Benchmarks for Science Literacy* of the American Association for the Advancement of Science provided standards for students' engagement in scientific inquiry [13]. In 1996, the *National Science Education Standards* of the NRC emphasized five essential features of scientific inquiry [14]. Two more recent NRC reports also recommended that students' learning experiences in science should provide them with opportunities to engage in specific practices [4, 5]. The contribution of this framework is the provision of a set of scientific and engineering practices that are appropriate for K-12 students and moreover that reflect the practices routinely used by professional scientists.

Recommendation 5: Standards should include performance expectations that integrate the scientific and engineering practices with the crosscutting concepts and disciplinary core ideas. These expectations should include criteria for identifying successful performance and require that students demonstrate an ability to use and apply knowledge.

Chapter 9 further provides two examples of how performance expectations for particular life science and physical science component ideas could be integrated with core ideas, as well as with concepts and practices, across the grades (see Tables 9-1 and 9-2).

Developing performance expectations is a major task for standards developers, but it is an effort worth making; performance expectations and criteria for successful performance are essential in order for standards to fulfill their role of supporting assessment development and setting achievement standards [3]. An exhaustive description of every performance level for every standard is unrealistic, but at a minimum the performance expectations should describe the major criteria of successful performance [3].

Recommendation 6: Standards should incorporate boundary statements. That is, for a given core idea at a given grade level, standards developers should include guidance not only about what needs to be taught but also about what does *not* need to be taught in order for students to achieve the standard.

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By delimiting what is included in a given topic in a particular grade band or grade level, boundary statements provide insights into the expected curriculum and thus aid in its development by others. Boundary statements should not add to the scope of the standards but rather should provide clear guidance regarding expectations for students. Such boundaries should be viewed as flexible and subject to modification over time, based on what is learned through implementation in the classroom and through research. However, it is important to begin with a set of statements that articulate the boundaries envisioned by standards developers.

Boundary statements can signal where material that traditionally has been included could instead be trimmed. For example, in the physical sciences, the progressions indicate that density is not stressed as a property of matter until the 6-8 grade band; at present, it is often introduced earlier and consumes considerable instructional time to little avail. Boundary statements may also help define which technical definitions or descriptions could be dispensed with in a particular grade band. Thus the boundary statements are a useful mechanism for narrowing the material to be covered, even within the core idea topics, in order to provide time for more meaningful development of ideas through engagement in practices. In other words, being explicit about what should *not* be taught helps clarify what *should* be taught.

Recommendation 7: Standards should be organized as sequences that support students' learning over multiple grades. They should take into account how students' command of the practices, concepts, and core ideas becomes more sophisticated over time with appropriate instructional experiences.

As noted in the introduction, the framework is designed to help students continually build on and revise their knowledge and abilities, starting from initial conceptions about how the world works and their curiosity about what they see around them. The framework's goal is thus to provide students with opportunities to learn about the practices, concepts, and core ideas, of science and engineering in successively more sophisticated ways over multiple years [4]. This perspective should prompt educators to decide how topics ought to be presented at each grade level so that they build on prior student learning and support continuing conceptual restructuring and refinement.

There is one overarching set of boundaries or constraints across the progressions for the disciplinary core ideas. Early work in science begins by exploring

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the visible and tangible macroscopic world. Then the domain of phenomena and systems considered is broadened to those that students cannot directly see but that still operate at the scales of human experience. Students then move to exploring or envisioning things that are too small to see or too large to readily imagine, and they are aided by models or specialized tools for measurement and imaging.

This overarching progression informs the grade band endpoints in the framework. Grades K-2 focus on visible phenomena with which students are likely to have some experience in their everyday lives or in the classroom. Grades 3-5 explore macroscopic phenomena more deeply, including modeling processes and systems that are not visible. Grades 6-8 move to microscopic phenomena and introduce atoms, molecules, and cells. Grades 9-12 move to the subatomic level and to the consideration of complex interactions within and among systems at all scales.

Recommendation 8: Whenever possible, the progressions in standards should be informed by existing research on learning and teaching. In cases in which insufficient research is available to inform a progression or in which there is a lack of consensus on the research findings, the progression should be developed on the basis of a reasoned argument about learning and teaching. The sequences described in the framework can be used as guidance.

Because research on these progressions is relatively recent, there is not a robust evidence base about appropriate sequencing for every concept, core idea, or practice identified in the framework. When evidence was available, the committee used it to guide the thinking about the progression in question. When evidence was not available, we made judgments based on the best knowledge available, as supported by existing documents such as the NAEP *2009 Science Framework* [15], the *College Board Standards for College Success* [16], and the AAAS *Atlas of Science Literacy* [17]. There is also a body of research on the intuitive understanding that children bring to school and on how that intuitive knowledge influences their learning of science [4]; this evidence base should be considered when developing standards.

Each progression described in the framework represents a particular vision of one possible pathway by which students could come to understand a specific core idea. The committee recognizes that there are many possible alternate paths and also that there are interplays among the ideas that here are subdivided into disciplines and component ideas within a discipline. In any case, progressions

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developed in the standards should be based on the available research on learning, an understanding of what is appropriate for students at a particular grade band based on research and on educators' professional experience, and logical inferences about how learning might occur.

Recommendation 9: The committee recommends that the diverse needs of students and of states be met by developing grade band standards as an overarching common set for adoption by multiple states. For those states that prefer or require grade-by-grade standards, a suggested elaboration on grade band standards could be provided as an example.

Given the incomplete nature of the evidence base, the committee could not specify grade-by-grade steps in the progressions. Indeed, for some ideas it was difficult just to develop research-based progressions at the grade band level; in those cases, we relied on expert judgment and previous standards documents. And even if grade-by-grade standards were feasible, research has shown that, within a particular grade, different students are often at different levels of achievement; thus expectations that every student will reach understanding of a core idea by the end of that grade may not be warranted. Across a grade band, however, students can continue to build on and develop core ideas over multiple school years; by the end of the grade band, they are more likely to have reached the levels of understanding intended.

In the committee's judgment, grade band standards are also more appropriate than grade-by-grade ones for systemic reasons, particularly for standards that may be adopted and implemented in numerous states. Because schools across the country vary both in their degree of organization, in their human and physical resources, and in the topics they have traditionally included at various grades, a national-level document's universal and homogeneous prescription for grade-by-grade standards may be too difficult for the schools in some states to meet, and it would perhaps be inappropriate for those localities to begin with. By contrast, specification by grade bands gives curriculum developers, states, districts, schools, and teachers the professional autonomy to ensure that content can be taught in a manner appropriate to the local context. This autonomy includes choosing from various possible strategies for course sequences and course organization at the middle and high school levels.

However, because it is recognized that many states require grade-by-grade standards for K-8 and course standards at the high school level, an example set

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of such standards may need to be provided. The intent of this recommendation is that states or districts wishing to offer alternative course sequences and organization at the high school level or alternative within grade band organization of content at the K-8 level can adopt the grade band standards.

This recommendation should not be interpreted as suggesting that students in some areas need not or cannot learn particular topics until later grade levels, but rather that the transition to a single common set of grade-by-grade standards is perhaps more onerous for schools and districts in term of curriculum materials, equipment, and teacher professional development needs than a transition to the somewhat more flexible definition of sequence given by grade band standards.

Recommendation 10: **If grade-by-grade standards are written based on the grade band descriptions provided in the framework, these standards should be designed to provide a coherent progression within each grade band.**

The content described in the framework is designed to be distributed over each grade band in a manner that builds on previous learning and is not repetitive. If standards developers choose to create grade-by-grade standards, it is necessary that these standards provide clear articulation of the content across grades within a band and attend to the progression of science learning from grade to grade within the band. At the middle and high school levels, course standards and suggested course sequences may be more appropriate than grade-level standards.

Recommendation 11: **Any assumptions about the resources, time, and teacher expertise needed for students to achieve particular standards should be made explicit.**

In designing the framework, the committee tried to set goals for science education that would not only improve its quality but also be attainable under current resources and other constraints. In addition, the committee intended for the framework's goals to act as levers for much-needed improvement in how schools are able to deliver high-quality science education to all students. For example, in order to meet the goals for science education in the elementary grades, more time may need to be devoted to science than is currently allocated. The committee recognizes as well that new curricula aligned to the framework will need to be developed and that professional development for teachers will need to be updated.

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Standards developers should be cautious about limiting the rigor of standards in response to perceptions about the system's constraints. Research clearly demonstrates that all students have the capacity to learn science when motivated to do so and provided with adequate opportunities to acquire the requisite literacy and numeracy skills [4, 5]. Thus standards should catalyze change in the system when necessary, motivating states, school districts, and schools to ensure that all students have access to rich learning experiences.

Recommendation 12: The standards for the sciences and engineering should align coherently with those for other K-12 subjects. Alignment with the Common Core Standards in mathematics and English/language arts is especially important.

As noted earlier, achieving coherence within the system is critical for ensuring an effective science education for all students. An important aspect of coherence is continuity across different subjects within a grade or grade band. By this we mean "sensible connections and coordination [among] the topics that students study in each subject within a grade and as they advance through the grades" [3, p. 298]. The underlying argument is that coherence across subject areas contributes to increased student learning because it provides opportunities for reinforcement and additional uses of practices in each area.

For example, students' writing and reading, particularly nonfiction, can cut across science and literacy learning. Uses of mathematical concepts and tools are critical to scientific progress and understanding. Examples from history of how scientists developed and argued about evidence for different scientific theories could support students' understanding of how their own classroom scientific practices play a role in validating knowledge. Similarly, there should be coherence between science and social studies (as these terms are currently used in schools). Applications of natural sciences and engineering to address important global issues—such as climate change, the production and distribution of food, the supply of water, and population growth—require knowledge from the social sciences about social systems, cultures, and economics; societal decisions about the advancement of science also require a knowledge of ethics. Basically, a coherent set of science standards will not be sufficient to prepare citizens for the 21st century unless there is also coherence across all subject areas of the K-12 curriculum.

Greater coherence may also enhance students' motivation because their development of competence is better supported. And it could increase teacher

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effectiveness across subjects, as teachers could be mutually supportive of one another in weaving connections across the curriculum [3]. All in all, better alignment across the standards in the different subjects would contribute to the development of the knowledge and skills that students need in order to make progress in each of their subjects.

Recommendation 13: In designing standards and performance expectations, issues related to diversity and equity need to be taken into account. In particular, performance expectations should provide students with multiple ways of demonstrating competence in science.

As discussed in Chapter 11, the committee is convinced that, given appropriate opportunities to learn and sufficient motivation, students from all backgrounds can become competent in science. It is equally important that all students be provided with opportunities to demonstrate their competence in ways that do not create unnecessary barriers. Standards should promote broadening participation in science and engineering by focusing the education system on inclusive and meaningful learning as well as on assessment experiences that maintain high academic expectations for all students.

Previous standards for K-12 science education have been criticized for obscuring the educational histories and circumstances of specific cultural groups [18]. Diversity should be made visible in the new standards in ways that might, for example, involve (a) presenting some performance tasks in the context of historical scientific accomplishments, which include a broad variety of cultural examples and do not focus exclusively on scientific discoveries made by scientists in a limited set of countries; (b) addressing the educational issues encountered by English language learners when defining performance expectations; (c) attending to the funds of knowledge that specific communities possess with regard to specific core ideas and practices (e.g., knowledge of ecosystem dynamics in Native American communities, knowledge of living organisms in agricultural communities) and with regard to performance expectations; (d) drawing on examples that are not dominated by the interests of one gender, race, or culture; (e) ensuring that students with particular learning disabilities are not excluded from appropriate science learning; and (f) providing examples of performance tasks appropriate to the special needs of such students.

The variety of issues raised by the above list illustrates the challenges of providing learning opportunities and assessments that support all students in their

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development of competence and confidence as science learners. To ensure equity in a diverse student population, these challenges must be directly addressed not only by teachers in the classroom but also in the design and implementation of the standards, the curricula that fulfill them, the assessment system that evaluates student progress, and the accompanying research on learning and teaching in science.

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SOUTH CAROLINA
SCIENCE ACADEMIC STANDARDS

South Carolina Department of Education
Columbia, South Carolina

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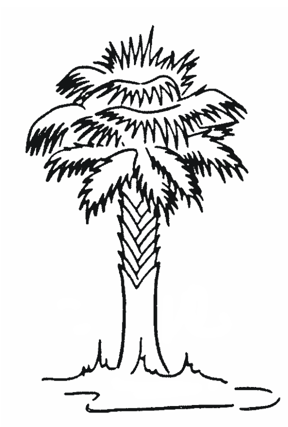
Contents



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State Science Panel

The members of the State Science Panel reviewed and recommended revisions to the 2000 standards document, *South Carolina Science Curriculum Standards.* The panel's report and a listing of the State Panel members are online at http://www.myscschools.com/offices/cso/science/StandardsRevision2004.cfm.

South Carolina Education Oversight Committee

Dr. Jo Anne Anderson, executive director of the South Carolina Education Oversight Committee (EOC), and Dr. Paul Horne, the EOC's director of curriculum and program overview, facilitated the work of three science review teams, which included national experts, parents, and business leaders. The EOC report on the review of the 2000 standards is published online at http://www.myscschools.com/offices/cso/science/StandardsRevision2004.cfm.

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State Department of Education

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Introduction

Science is a method of learning about the physical universe by applying the principles of the scientific inquiry, which includes making empirical observations, proposing hypotheses to explain those observations, and testing those hypotheses in valid and reliable ways. Science is also, therefore, the organized body of knowledge that results from scientific inquiry. This document, *South Carolina Science Academic Standards*, contains the academic standards in science for the state's students in kindergarten through grade twelve.

Beginning in 2004, the term for the state-approved expectations for student learning and academic performance in South Carolina was changed from *curriculum standards* to *academic standards.* In accordance with the South Carolina Education Accountability Act of 1998 (S.C. Code Ann. § 59-18-110), State Board of Education Regulation 43-234 explains the purpose of academic standards thusly:

> Each school district board of trustees will ensure quality schooling by providing a rigorous, relevant curriculum for all students.
>
> Each school district must use the academic achievement standards adopted by the State Board of Education to push schools and students toward high performance by aligning the state assessments to those standards and linking policies and criteria for performance standards, accreditation, reporting, school rewards, and targeted assistance.

The *South Carolina Science Academic Standards* is not a curriculum. The academic standards in this document are not sequenced for instruction, do not prescribe classroom activities or materials, and do not dictate instructional strategies, approaches, and practices. A science curriculum support document, issued by the SDE, will assist the districts in constructing their own standards-based science curriculum, allowing them to add or expand topics they feel are important and to organize the content to fit their students' needs and materials. The support document will include suggested materials and resources for use in the classroom.

Development and Review of the South Carolina Science Standards

The State Department of Education (SDE), in partnership with Mid-Continent Research for Education and Learning, developed the academic standards and indicators for science utilizing a number of resources. Central among these resources were the *South Carolina Science Curriculum Standards*, published by the SDE in 2000, and the 2004 recommendations of the State Science Panel and the Education Oversight Committee (EOC) panel on science.

The *National Science Education Standards*, produced by the National Research Council and published in 1996 by the National Academy Press in Washington, DC (available at http://www.nap.edu/readingroom/books/nses/html/) was the foundation of the 2000 South Carolina science standards and continues as the primary basis for the 2005 standards and the supporting indicators. The following national documents were utilized in addition:

> *Atlas of Science Literacy*, produced by Project 2061 and the National Science Teachers Association (Washington, DC: American Association for the Advancement of Science, 2001).

Benchmarks for Science Literacy, produced by Project 2061 and the American Association for the Advancement of Science (New York: Oxford University Press, 1993).

Content Knowledge: A Compendium of Standards and Benchmarks for K–12 Education, by John S. Kendall and Robert J. Marzano. 3rd ed. (Aurora, CO : Mid-Continent Regional Educational Laboratory, 2000).

NSTA Pathways to the Science Standards, edited by Lawrence F. Lowery. Elementary School Edition (Arlington VA: National Science Teachers Association, 1998).

NSTA Pathways to the Science Standards: Guidelines for Moving the Vision into Practice, edited by Steven J. Rakow. Middle School Edition (Arlington, VA: National Science Teachers Association, 1998).

NSTA Pathways to the Science Standards, edited by Julliana Texley and Ann Wild. High School Edition (Arlington, VA: National Science Teachers Association, 1998).

Science Assessment and Exercise Specifications for the National Assessment of Educational Progress, developed by the Council of Chief State School Officers, NAEP Science Consensus Project (Washington, DC: National Assessment Governing Board, U.S. Department of Education, n.d.).

Science Framework for the 1996 and 2000 National Assessment of Educational Progress, developed by the Council of Chief State School Officers with the National Center for Improving Science Education and the American Institutes for Research; edited by Mark D. Musick (Washington, DC: National Assessment Governing Board, U.S. Department of Education, 1999). Available online at http://www.nagb.org/pubs/96-2000science/toc.html.

Operating procedures for the review of all newly revised South Carolina academic standards were agreed upon by the SDE and the EOC during the summer of 2003. Those procedures (accessible online at http://www.myscschools.com/offices/cso/) were used in the field review of the first draft of the revised South Carolina science standards, conducted from April through June 2005. Feedback from that review was incorporated into the final draft, which was presented to the State Board of Education in fall 2005.

Changes in the South Carolina Science Standards Document

The structure and organization of the South Carolina science standards document have been changed in several ways:

- An overview describing specific subject matter and themes is now provided on a cover page for each grade and each high school core area.

- The number of standards—which ranges from five to seven for each grade or high school core area—has been significantly reduced.

- Academic standards are specified for nine grade levels (kindergarten through grade eight) and five high school core areas: physical science, biology, chemistry, physics, and earth science.

- The standards for kindergarten through the eighth grade are no longer organized by content area—life science, earth science, or physical science. However, the specific area from which each of the content standards is drawn is specified in parenthesis immediately following the statement of the standard.

- The statements of the academic standards themselves are newly constructed.

  Each standard is now stated as one full sentence that begins with the clause "The student will demonstrate an understanding of . . ." and goes on to specify the particular topics to be addressed by that standard. The verb phrase "to demonstrate an understanding of" is used with its general, everyday meaning and does not describe a cognitive category from the taxonomy.

  Following each of the academic standard statements are indicators, which are intended to help meet teachers' needs for specificity. These indicators are statements of the specific cognitive processes (expressed in the main verbs) and the content knowledge and skills that students must demonstrate in order to meet the grade-level or high school core area standard.

  The main verbs in the indicators are taxonomic—that is, they identify specific aspects of the cognitive process as described in the revised Bloom's taxonomy, which is included in this standards document in appendix B. Use of this new taxonomy will allow teachers to identify the kind of content (knowledge) addressed in the indicators (as factual, conceptual, procedural, or metacognitive) and will help teachers to align their lessons with both the content and the cognitive process identified in the indicators.

  Many of the indicators in science address conceptual knowledge and fall under the second category of cognitive processing, *understanding*, which fosters transfer and meaningful learning rather than rote learning and memorization. These revised science standards also contain some indicators that require students to *analyze* or *evaluate* data and/or the results of investigations so that they must use understanding as they demonstrate even more cognitively complex learning.

  The term *including* appears frequently in parenthetical statements in the science indicators to introduce a list of specifics that are intended to clarify and focus the teaching and learning of the particular concept. That is, within these parenthetical *including* statements are specified the components of the indicator that are critical for the specific grade level or core area with regard both to the state assessments and to the management of time in the classroom. Teachers must focus their instruction on the entire indicator, but they also need to include in the instruction the components specified in the parenthetical *including* statements.

- In addition to the content standards, each grade and high school core area has a separate *scientific inquiry* standard, with indicators that are now differentiated across grade levels and core areas. The skills, processes, and tools specified in the scientific inquiry indicators are also embedded in the content standards and indicators wherever appropriate.

  Unlike the content standards, however, scientific inquiry is a process standard with indicators that specify the tools and equipment, safety procedures, and investigative skills and approaches that students must master in conjunction with the topics identified in the content standards for the particular grade level or high school core area. Magnifiers, thermometers, graduated cylinders, and spring scales are examples of tools that students must learn to use accurately, safely, and appropriately. Teachers should note that only those tools that have *not* been introduced in earlier grades are listed in the scientific inquiry indicators at the higher levels.

Scientific inquiry requires an understanding of scientific methodology. As the authors of *National Science Education Standards* put it, “Full inquiry involves asking a simple question, completing an investigation, answering the question, and presenting the results to others.” Though the specific parts of this process may be explicitly mentioned in only a few standards and indicators in the scientific inquiry sections of the South Carolina science standards, they are primary concerns in state assessments in science and, therefore, in classroom instruction.

Statewide Assessments

The science standards for grades three through eight will be used as the basis for the questions on the Palmetto Achievement Challenge Tests (PACT) in science. The science standards for the high school core areas of physical science and biology will be used as the basis for items on the state-required end-of-course examination for Biology 1 and Applied Biology 2 and the end-of-course examination for Physical Science.

The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and in most cases will measure the specific cognitive process stated in the main verb in the indicator. However, some indicators may be assessed through items that address other appropriate cognitive processes within the same category as the main verb in the indicator or may address processes in categories of lower cognitive complexity. For example, the assessment of an indicator that requires students to classify minerals—which would fall in the second cognitive category, *understand*—might also ask the student to demonstrate other related cognitive processes such as comparing minerals or giving examples of particular minerals. Or a PACT item might require students to recall specific minerals, which falls into the first cognitive category, *remember*. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

The skills of scientific inquiry, including an understanding of the use of particular tools, will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed cumulatively. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators from all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

Format of Standards for All Grade Levels and the High School Core Areas

This is the introductory page for the third-grade science standards. The text of each of the introductory pages gives an overview of the subject matter and themes for the particular grade level or high school core area.

Grade 3

Overview

Science in grade three focuses on students' conducting investigations in which they collect and analyze data and communicate their findings. Learning to observe and analyze through hands-on experiments, students gain new insights into how scientists understand our world. Third-grade students explore the life, earth, and physical sciences within the framework of the following topics: "Habitats and Adaptations" (physical and behavioral adaptations); "Earth's Materials and Changes" (rocks, soil, water, fossils); "Heat and Changes in Matter" (sources of heat, solids, liquids, gases); and "Motion and Sound" (position, effects of force, vibrations, and pitch).

The science standards for grade three provide for a rich variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students' individual differences. Students are actively engaged in their learning by observing, interacting with materials and with people, and asking questions as they examine new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

This is academic standard 3-5, the fifth standard for grade 3. The term in parentheses indicates the area in which the particular standard is centered. The fifth standard for grade 3 is a *physical science* standard.

Standard 3-5: ------------------------ (Physical Science)

The indicators illustrated, 3-5.1 and 3-5.2, are the first two indicators of the fifth standard for grade 3.

Indicators

3-5.1 ---
3-5.2 ---

GRADE-LEVEL STANDARDS

Kindergarten

Overview

The focus of science in kindergarten is to provide students with hands-on experiences that will utilize their natural curiosity at the beginning of their development of scientific knowledge. Kindergarten students need to expand their observation skills as they learn about the life, earth, and physical sciences. These students will explore the sciences within the framework of the following topics: “Characteristics of Organisms” (basic needs of organisms and life cycles); “My Body” (body structures and functions); “Seasonal Changes” (weather from day to day and season to season); and “Exploring Matter” (observable properties).

The standards for kindergarten describe only a core of knowledge that must be brought to life and enhanced through a wide variety of learning experiences, materials, and instructional strategies that accommodate the broad range of individual differences. These standards support active engagement in learning. Students should observe, interact with materials and with people, and ask questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, the scientific inquiry indicators will be assessed *cumulatively*. Students must therefore demonstrate the skills and the knowledge of the use of the tools and equipment designated for kindergarten in preparation for grade one. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

KINDERGARTEN

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Kindergarten students must therefore demonstrate an understanding of the specific content of these indicators. A table of the K–12 of scientific inquiry standards and indicators is provided in appendix A.

Standard K-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

K-1.1 Identify observed objects or events by using the senses.
K-1.2 Use tools (including magnifiers and eyedroppers) safely, accurately, and appropriately when gathering specific data.
K-1.3 Predict and explain information or events based on observation or previous experience.
K-1.4 Compare objects by using nonstandard units of measurement.
K-1.5 Use appropriate safety procedures when conducting investigations.

KINDERGARTEN

Characteristics of Organisms

Standard K-2: The student will demonstrate an understanding of the characteristics of organisms. (Life Science)

Indicators

K-2.1 Recognize what organisms need to stay alive (including air, water, food, and shelter).
K-2.2 Identify examples of organisms and nonliving things.
K-2.3 Match parents with their offspring to show that plants and animals closely resemble their parents.
K-2.4 Compare individual examples of a particular type of plant or animal to determine that there are differences among individuals.
K-2.5 Recognize that all organisms go through stages of growth and change called life cycles.

KINDERGARTEN

My Body

Standard K-3: The student will demonstrate an understanding of the distinct structures of human body and the different functions they serve. (Life Science)

Indicators

K-3.1 Identify the distinct structures in the human body that are for walking, holding, touching, seeing, smelling, hearing, talking, and tasting.

K-3.2 Identify the functions of the sensory organs (including the eyes, nose, ears, tongue, and skin).

KINDERGARTEN

Seasonal Changes

Standard K-4: The student will demonstrate an understanding of seasonal weather changes. (Earth Science)

Indicators

K-4.1 Identify weather changes that occur from day to day.
K-4.2 Compare the weather patterns that occur from season to season.
K-4.3 Summarize ways that the seasons affect plants and animals.

KINDERGARTEN

Exploring Matter

Standard K-5: The student will demonstrate the understanding that objects can be described by their observable properties. (Physical Science)

Indicators

K-5.1 Classify objects by observable properties (including size, color, shape, magnetic attraction, heaviness, texture, and the ability to float in water).

K-5.2 Compare the properties of different types of materials (including wood, plastic, metal, cloth, and paper) from which objects are made.

Grade 1

Overview

The goal of science in grade one is to provide the opportunity for students to develop the skills of wondering, questioning, investigating, and communicating as the means of making sense of the world. Students will use scientific tools to gather data and carry out investigations and will continue to develop their observation skills as they learn about the life, earth, and physical sciences. First-grade students will explore the sciences within the framework of the following topics: “Plants” (basic needs, structures and life cycles); “Sun and Moon” (features and changes in appearance); “Earth Materials” (composition and properties); and “Exploring Motion” (push or pull and movement).

The grade-one science standards provide richness and a wide variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students’ individual differences. Students will actively engage in their learning by observing, interacting with materials and with people, and asking questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—from all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

GRADE 1

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 1-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

1-1.1 Compare, classify, and sequence objects by number, shape, texture, size, color, and motion, using standard English units of measurement where appropriate.
1-1.2 Use tools (including rulers) safely, accurately, and appropriately when gathering specific data.
1-1.3 Carry out simple scientific investigations when given clear directions.
1-1.4 Use appropriate safety procedures when conducting investigations.

GRADE 1

Plants

Standard 1-2: The student will demonstrate an understanding of the special characteristics and needs of plants that allow them to survive in their own distinct environments. (Life Science)

Indicators

1-2.1 Recall the basic needs of plants (including air, water, nutrients, space, and light) for energy and growth.
1-2.2 Illustrate the major structures of plants (including stems, roots, leaves, flowers, fruits, and seeds).
1-2.3 Classify plants according to their characteristics (including what specific type of environment they live in, whether they have edible parts, and what particular kinds of physical traits they have).
1-2.4 Summarize the life cycle of plants (including germination, growth, and the production of flowers and seeds).
1-2.5 Explain how distinct environments throughout the world support the life of different types of plants.
1-2.6 Identify characteristics of plants (including types of stems, roots, leaves, flowers, and seeds) that help them survive in their own distinct environments.

GRADE 1

Sun and Moon

Standard 1-3: The student will demonstrate an understanding of the features of the sky and the patterns of the Sun and the Moon. (Earth Science)

Indicators

1-3.1 Compare the features of the day and night sky.
1-3.2 Recall that the Sun is a source of heat and light for Earth.
1-3.3 Recognize that the Sun and the Moon appear to rise and set.
1-3.4 Illustrate changes in the Moon's appearance (including patterns over time).

GRADE 1

Earth Materials

Standard 1-4: The student will demonstrate an understanding of the properties of Earth materials. (Earth Science)

Indicators

1-4.1 Recognize the composition of Earth (including rocks, sand, soil, and water).
1-4.2 Classify rocks and sand by their physical appearance .
1-4.3 Compare soil samples by sorting them according to properties (including color, texture, and the capacity to nourish growing plants).
1-4.4 Recognize the observable properties of water (including the fact that it takes the shape of its container, flows downhill, and feels wet).
1-4.5 Illustrate the locations of water on Earth by using drawings, maps, or models.
1-4.6 Exemplify Earth materials that are used for building structures or for growing plants.

GRADE 1

Exploring Motion

Standard 1-5: The student will demonstrate an understanding of the positions and motions of objects. (Physical Science)

Indicators

1-5.1 Identify the location of an object relative to another object.
1-5.2 Explain the importance of pushing and pulling to the motion of an object.
1-5.3 Illustrate the fact that sound is produced by vibrating objects.
1-5.4 Illustrate ways in which objects can move in terms of direction and speed (including straight forward, back and forth, fast or slow, zigzag, and circular).

Grade 2

Overview

The science standards for grade two focus on instilling in students the understanding that everyone has the ability to participate in science and to explore scientific ideas. Students begin to build on the concept that in science it is helpful to collaborate with others, to work as a team and to share thoughts, ideas, and discoveries. Second graders explore the life, earth, and physical sciences within the framework of the following topics: “Animals” (basic needs, environments, and life cycles); “Weather” (weather terminology and weather conditions); “Properties and Changes in Matter” (solids and liquids); and “Magnetism” (attracting and repelling).

The science standards for grade two provide richness and a wide variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students’ individual differences. Students actively engage in learning by observing, interacting with materials and with people, and asking questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, the scientific inquiry indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

GRADE 2

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 2-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

2-1.1 Carry out simple scientific investigations to answer questions about familiar objects and events.
2-1.2 Use tools (including thermometers, rain gauges, balances, and measuring cups) safely, accurately, and appropriately when gathering specific data in US customary (English) and metric units of measurement.
2-1.3 Represent and communicate simple data and explanations through drawings, tables, pictographs, bar graphs, and oral and written language.
2-1.4 Infer explanations regarding scientific observations and experiences.
2-1.5 Use appropriate safety procedures when conducting investigations.

GRADE 2

Animals

Standard 2-2: The student will demonstrate an understanding of the needs and characteristics of animals as they interact in their own distinct environments. (Life Science)

Indicators

2-2.1 Recall the basic needs of animals (including air, water, food, and shelter) for energy, growth, and protection.
2-2.2 Classify animals (including mammals, birds, amphibians, reptiles, fish, and insects) according to their physical characteristics.
2-2.3 Explain how distinct environments throughout the world support the life of different types of animals.
2-2.4 Summarize the interdependence between animals and plants as sources of food and shelter.
2-2.5 Illustrate the various life cycles of animals (including birth and the stages of development).

GRADE 2

Weather

Standard 2-3: The student will demonstrate an understanding of daily and seasonal weather conditions. (Earth Science)

Indicators

2-3.1 Explain the effects of moving air as it interacts with objects.
2-3.2 Recall weather terminology (including temperature, wind direction, wind speed, and precipitation as rain, snow, sleet, and hail).
2-3.3 Illustrate the weather conditions of different seasons.
2-3.4 Carry out procedures to measure and record daily weather conditions (including temperature, precipitation amounts, wind speed as measured on the Beaufort scale, and wind direction as measured with a windsock or wind vane).
2-3.5 Use pictorial weather symbols to record observable sky conditions.
2-3.6 Identify safety precautions that one should take during severe weather conditions.

GRADE 2

Properties and Changes in Matter

Standard 2-4: The student will demonstrate an understanding of the properties of matter and the changes that matter undergoes. (Physical Science)

Indicators

2-4.1 Recall the properties of solids and liquids.
2-4.2 Exemplify matter that changes from a solid to a liquid and from a liquid to a solid.
2-4.3 Explain how matter can be changed in ways such as heating or cooling, cutting or tearing, bending or stretching.
2-4.4 Recognize that different materials can be mixed together and then separated again.

GRADE 2

Magnetism

Standard 2-5: The student will demonstrate an understanding of force and motion by applying the properties of magnetism. (Physical Science)

Indicators

2-5.1 Use magnets to make an object move without being touched.
2-5.2 Explain how the poles of magnets affect each other (that is, they attract and repel one another).
2-5.3 Compare the effect of magnets on various materials.
2-5.4 Identify everyday uses of magnets.

Grade 3 Overview

Science in grade three focuses on students' conducting investigations in which they collect and analyze data and communicate their findings. Learning to observe and analyze through hands-on experiments, students gain new insights into how scientists understand our world. Third-grade students explore the life, earth, and physical sciences within the framework of the following topics: "Habitats and Adaptations" (physical and behavioral adaptations); "Earth's Materials and Changes" (rocks, soil, water, fossils); "Heat and Changes in Matter" (sources of heat, solids, liquids, gases); and "Motion and Sound" (position, effects of force, vibrations, and pitch).

The science standards for grade three provide for a rich variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students' individual differences. Students are actively engaged in their learning by observing, interacting with materials and with people, and asking questions as they examine new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 3

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 3-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

3-1.1 Classify objects by two of their properties (attributes).
3-1.2 Classify objects or events in sequential order.
3-1.3 Generate questions such as "what if?" or "how?" about objects, organisms, and events in the environment and use those questions to conduct a simple scientific investigation.
3-1.4 Predict the outcome of a simple investigation and compare the result with the prediction.
3-1.5 Use tools (including beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes) safely, accurately, and appropriately when gathering specific data.
3-1.6 Infer meaning from data communicated in graphs, tables, and diagrams.
3-1.7 Explain why similar investigations might produce different results.
3-1.8 Use appropriate safety procedures when conducting investigations.

GRADE 3

Habitats and Adaptations

Standard 3-2: The student will demonstrate an understanding of the structures, characteristics, and adaptations of organisms that allow them to function and survive within their habitats. (Life Science)

Indicators

3-2.1 Illustrate the life cycles of seed plants and various animals and summarize how they grow and are adapted to conditions within their habitats.

3-2.2 Explain how physical and behavioral adaptations allow organisms to survive (including hibernation, defense, locomotion, movement, food obtainment, and camouflage for animals and seed dispersal, color, and response to light for plants).

3-2.3 Recall the characteristics of an organism's habitat that allow the organism to survive there.

3-2.4 Explain how changes in the habitats of plants and animals affect their survival.

3-2.5 Summarize the organization of simple food chains (including the roles of producers, consumers, and decomposers).

GRADE 3

Earth’s Materials and Changes

Standard 3-3: The student will demonstrate an understanding of Earth’s composition and the changes that occur to the features of Earth’s surface. (Earth Science)

Indicators

3-3.1 Classify rocks (including sedimentary, igneous, and metamorphic) and soils (including humus, clay, sand, and silt) on the basis of their properties.
3-3.2 Identify common minerals on the basis of their properties by using a minerals identification key.
3-3.3 Recognize types of fossils (including molds, casts, and preserved parts of plants and animals).
3-3.4 Infer ideas about Earth’s early environments from fossils of plants and animals that lived long ago.
3-3.5 Illustrate Earth’s saltwater and freshwater features (including oceans, seas, rivers, lakes, ponds, streams, and glaciers).
3-3.6 Illustrate Earth’s land features (including volcanoes, mountains, valleys, canyons, caverns, and islands) by using models, pictures, diagrams, and maps.
3-3.7 Exemplify Earth materials that are used as fuel, as a resource for building materials, and as a medium for growing plants.
3-3.8 Illustrate changes in Earth’s surface that are due to slow processes (including weathering, erosion, and deposition) and changes that are due to rapid processes (including landslides, volcanic eruptions, floods, and earthquakes).

GRADE 3

Heat and Changes in Matter

Standard 3-4: The student will demonstrate an understanding of the changes in matter that are caused by heat.

Indicators

3-4.1 Classify different forms of matter (including solids, liquids, and gases) according to their observable and measurable properties.

3-4.2 Explain how water and other substances change from one state to another (including melting, freezing, condensing, boiling, and evaporating).

3-4.3 Explain how heat moves easily from one object to another through direct contact in some materials (called conductors) and not so easily through other materials (called insulators).

3-4.4 Identify sources of heat and exemplify ways that heat can be produced (including rubbing, burning, and using electricity).

GRADE 3

Motion and Sound

Standard 3-5: The student will demonstrate an understanding of how motion and sound are affected by a push or pull on an object and the vibration of an object. (Physical Science)

Indicators

3-5.1 Identify the position of an object relative to a reference point by using position terms such as “above,” “below,” “inside of,” “underneath,” or “on top of” and a distance scale or measurement.
3-5.2 Compare the motion of common objects in terms of speed and direction.
3-5.3 Explain how the motion of an object is affected by the strength of a push or pull and the mass of the object.
3-5.4 Explain the relationship between the motion of an object and the pull of gravity.
3-5.5 Recall that vibrating objects produce sound and that vibrations can be transferred from one material to another.
3-5.6 Compare the pitch and volume of different sounds.
3-5.7 Recognize ways to change the volume of sounds.
3-5.8 Explain how the vibration of an object affects pitch.

Grade 4

Overview

Science in grade four focuses on providing students with the opportunity to learn age-appropriate concepts and skills in the life, earth, and physical sciences and to acquire scientific attitudes and habits of mind. The students' study of science includes observing, measuring, recording, questioning, analyzing, identifying, and drawing conclusions. Through their explorations, students develop an understanding of and an ability to apply the components of the scientific method. Specifically, fourth graders explore the sciences within the framework of the following topics: "Organisms and Their Environments" (patterns of behavior and changes in the environment); "Astronomy" (Earth, Sun, Moon and planets); "Weather" (water cycle, clouds, and severe weather); and "Properties of Light and Electricity" (reflection, refraction, and series and parallel circuits).

The science standards for grade four provide richness and a wide variety of learning experiences, materials, and instructional strategies to accommodate a broad range of student's individual differences. Students are actively engaged in their learning by observing, interacting with materials and with people, and asking questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 4

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 4-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

4-1.1 Classify observations as either quantitative or qualitative.
4-1.2 Use appropriate instruments and tools (including a compass, an anemometer, mirrors, and a prism) safely and accurately when conducting simple investigations.
4-1.3 Summarize the characteristics of a simple scientific investigation that represent a fair test (including a question that identifies the problem, a prediction that indicates a possible outcome, a process that tests one manipulated variable at a time, and results that are communicated and explained).
4-1.4 Distinguish among observations, predictions, and inferences.
4-1.5 Recognize the correct placement of variables on a line graph.
4-1.6 Construct and interpret diagrams, tables, and graphs made from recorded measurements and observations.
4-1.7 Use appropriate safety procedures when conducting investigations.

GRADE 4

Organisms and Their Environments

Standard 4-2: The student will demonstrate an understanding of the characteristics and patterns of behavior that allow organisms to survive in their own distinct environments. (Life Science)

Indicators

4-2.1 Classify organisms into major groups (including plants or animals, flowering or nonflowering plants, and vertebrates [fish, amphibians, reptiles, birds, and mammals] or invertebrates) according to their physical characteristics.

4-2.2 Explain how the characteristics of distinct environments (including swamps, rivers and streams, tropical rain forests, deserts, and the polar regions) influence the variety of organisms in each.

4-2.3 Explain how humans and other animals use their senses and sensory organs to detect signals from the environment and how their behaviors are influenced by these signals.

4-2.4 Distinguish between the characteristics of an organism that are inherited and those that are acquired over time.

4-2.5 Explain how an organism's patterns of behavior are related to its environment (including the kinds and the number of other organisms present, the availability of food and other resources, and the physical characteristics of the environment).

4-2.6 Explain how organisms cause changes in their environment.

GRADE 4

Astronomy

Standard 4-3: The student will demonstrate an understanding of the properties, movements, and locations of objects in the solar system. (Earth Science)

Indicators

4-3.1 Recall that Earth is one of many planets in the solar system that orbit the Sun.
4-3.2 Compare the properties (including the type of surface and atmosphere) and the location of Earth to the Sun, which is a star, and the Moon.
4-3.3 Explain how the Sun affects Earth.
4-3.4 Explain how the tilt of Earth's axis and the revolution around the Sun results in the seasons of the year.
4-3.5 Explain how the rotation of Earth results in day and night.
4-3.6 Illustrate the phases of the Moon and the Moon's effect on ocean tides.
4-3.7 Interpret the change in the length of shadows during the day in relation to the position of the Sun in the sky.
4-3.8 Recognize the purpose of telescopes.

GRADE 4

Weather

Standard 4-4: The student will demonstrate an understanding of weather patterns and phenomena. (Earth Science)

Indicators

4-4.1 Summarize the processes of the water cycle (including evaporation, condensation, precipitation, and runoff).

4-4.2 Classify clouds according to their three basic types (cumulus, cirrus, and stratus) and summarize how clouds form.

4-4.3 Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

4-4.4 Summarize the conditions and effects of severe weather phenomena (including thunderstorms, hurricanes, and tornadoes) and related safety concerns.

4-4.5 Carry out the procedures for data collecting and measuring weather conditions (including wind speed and direction, precipitation, and temperature) by using appropriate tools and instruments.

4-4.6 Predict weather from data collected through observation and measurements.

GRADE 4

Properties of Light and Electricity

Standard 4-5: The student will demonstrate an understanding of the properties of light and electricity. (Physical Science)

Indicators

4-5.1 Summarize the basic properties of light (including brightness and colors).
4-5.2 Illustrate the fact that light, as a form of energy, is made up of many different colors.
4-5.3 Summarize how light travels and explain what happens when it strikes an object (including reflection, refraction, and absorption).
4-5.4 Compare how light behaves when it strikes transparent, translucent, and opaque materials.
4-5.5 Explain how electricity, as a form of energy, can be transformed into other forms of energy (including light, heat, and sound).
4-5.6 Summarize the functions of the components of complete circuits (including wire, switch, battery, and light bulb).
4-5.7 Illustrate the path of electric current in series and parallel circuits.
4-5.8 Classify materials as either conductors or insulators of electricity.
4-5.9 Summarize the properties of magnets and electromagnets (including polarity, attraction/repulsion, and strength).
4-5.10 Summarize the factors that affect the strength of an electromagnet.

Grade 5

Overview

Science in grade five focuses on scientific and technological problem solving and decision making as well as the skills of scientific inquiry: formulating usable questions and hypotheses, planning experiments and product design, conducting systematic observations, interpreting and analyzing data, drawing conclusions, and communicating the findings to others. Fifth-grade students actively investigate science concepts by predicting, observing, and recording the results of experiments, and they will generate ideas to solve problems. Specifically, students in the fifth grade learn about the life, earth, and physical sciences by exploring them within the framework of the following topics: "Ecosystems: Terrestrial and Aquatic" (characteristics and interactions); "Landforms and Oceans" (natural processes and the ocean floor); "Properties of Matter" (mixtures and solutions); and "Forces and Motion" (position, direction, and speed).

The science standards for students in grade five provide richness and a wide variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students' individual differences. Students actively engage in learning by observing, interacting with materials and with people, and asking questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 5

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 5-1: The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

Indicators

5-1.1 Identify questions suitable for generating a hypothesis.
5-1.2 Identify independent (manipulated), dependent (responding), and controlled variables in an experiment.
5-1.3 Plan and conduct controlled scientific investigations, manipulating one variable at a time.
5-1.4 Use appropriate tools and instruments (including a timing device and a 10x magnifier) safely and accurately when conducting a controlled scientific investigation.
5-1.5 Construct a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables.
5-1.6 Evaluate results of an investigation to formulate a valid conclusion based on evidence and communicate the findings of the evaluation in oral or written form.
5-1.7 Use a simple technological design process to develop a solution or a product, communicating the design by using descriptions, models, and drawings.
5-1.8 Use appropriate safety procedures when conducting investigations.

GRADE 5

Ecosystems: Terrestrial and Aquatic

Standard 5-2: The student will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

Indicators

5-2.1 Recall the cell as the smallest unit of life and identify its major structures (including cell membrane, cytoplasm, nucleus, and vacuole).

5-2.2 Summarize the composition of an ecosystem, considering both biotic factors (including populations to the level of microorganisms and communities) and abiotic factors.

5-2.3 Compare the characteristics of different ecosystems (including estuaries/salt marshes, oceans, lakes and ponds, forests, and grasslands).

5-2.4 Identify the roles of organisms as they interact and depend on one another through food chains and food webs in an ecosystem, considering producers and consumers (herbivores, carnivores, and omnivores), decomposers (microorganisms, termites, worms, and fungi), predators and prey, and parasites and hosts.

5-2.5 Explain how limiting factors (including food, water, space, and shelter) affect populations in ecosystems.

GRADE 5

Landforms and Oceans

Standard 5-3: The student will demonstrate an understanding of features, processes, and changes in Earth’s land and oceans. (Earth Science)

Indicators

5-3.1 Explain how natural processes (including weathering, erosion, deposition, landslides, volcanic eruptions, earthquakes, and floods) affect Earth’s oceans and land in constructive and destructive ways.
5-3.2 Illustrate the geologic landforms of the ocean floor (including the continental shelf and slope, the mid-ocean ridge, rift zone, trench, and the ocean basin).
5-3.3 Compare continental and oceanic landforms.
5-3.4 Explain how waves, currents, tides, and storms affect the geologic features of the ocean shore zone (including beaches, barrier islands, estuaries, and inlets).
5-3.5 Compare the movement of water by waves, currents, and tides.
5-3.6 Explain how human activity (including conservation efforts and pollution) has affected the land and the oceans of Earth.

GRADE 5

Properties of Matter

Standard 5-4: The student will demonstrate an understanding of properties of matter. (Physical Science)

Indicators

5-4.1 Recall that matter is made up of particles too small to be seen.
5-4.2 Compare the physical properties of the states of matter (including volume, shape, and the movement and spacing of particles).
5-4.3 Summarize the characteristics of a mixture, recognizing a solution as a kind of mixture.
5-4.4 Use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.
5-4.5 Explain how the solute and the solvent in a solution determine the concentration.
5-4.6 Explain how temperature change, particle size, and stirring affect the rate of dissolving.
5-4.7 Illustrate the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot easily be separated.
5-4.8 Explain how the mixing and dissolving of foreign substances is related to the pollution of the water, air, and soil.

GRADE 5

Forces and Motion

Standard 5-5: The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

Indicators

5-5.1 Illustrate the affects of force (including magnetism, gravity, and friction) on motion.
5-5.2 Summarize the motion of an object in terms of position, direction, and speed.
5-5.3 Explain how unbalanced forces affect the rate and direction of motion in objects.
5-5.4 Explain ways to change the effect that friction has on the motion of objects (including changing the texture of the surfaces, changing the amount of surface area involved, and adding lubrication).
5-5.5 Use a graph to illustrate the motion of an object.
5-5.6 Explain how a change of force or a change in mass affects the motion of an object.

Grade 6

Overview

The focus for science in grade six is to provide students with a foundation for hands-on experiences that allow for the active engagement and concrete examples that these students require in order to understand basic science concepts. Sixth graders continue to develop the investigative skills they have been acquiring since kindergarten, now expanding them to include the skill of differentiating between observation and inference. Specifically, students explore the life, earth, and physical sciences within the framework of the following topics: "Structures, Processes, and Responses of Plants" (structure and function of plants); "Structures, Processes, and Responses of Animals" (structure and function of animals); "Earth's Atmosphere and Weather" (atmospheric properties and processes); and "Conservation of Energy" (properties of energy, work, and machines).

The science standards for the sixth grade provide the foundation for a course that is based on a rich and wide variety of learning experiences that actively engage students and accommodate a broad range of student learning styles through varied materials and instructional strategies. Students should observe, interact with materials and with people, and ask questions as they explore new concepts and expand their knowledge.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 6

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 6-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

6-1.1 Use appropriate tools and instruments (including a spring scale, beam balance, barometer, and sling psychrometer) safely and accurately when conducting a controlled scientific investigation.

6-1.2 Differentiate between observation and inference during the analysis and interpretation of data.

6-1.3 Classify organisms, objects, and materials according to their physical characteristics by using a dichotomous key.

6-1.4 Use a technological design process to plan and produce a solution to a problem or a product (including identifying a problem, designing a solution or a product, implementing the design, and evaluating the solution or the product).

6-1.5 Use appropriate safety procedures when conducting investigations.

GRADE 6

Structures, Processes, and Responses of Plants

Standard 6-2: The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

Indicators

6-2.1 Summarize the characteristics that all organisms share (including the obtainment and use of resources for energy, the response to stimuli, the ability to reproduce, and process of physical growth and development).
6-2.2 Recognize the hierarchical structure of the classification (taxonomy) of organisms (including the seven major levels or categories of living things—namely, kingdom, phylum, class, order, family, genus, and species).
6-2.3 Compare the characteristic structures of various groups of plants (including vascular or nonvascular, seed or spore-producing, flowering or cone-bearing, and monocot or dicot).
6-2.4 Summarize the basic functions of the structures of a flowering plant for defense, survival, and reproduction.
6-2.5 Summarize each process in the life cycle of flowering plants (including germination, plant development, fertilization, and seed production).
6-2.6 Differentiate between the processes of sexual and asexual reproduction of flowering plants.
6-2.7 Summarize the processes required for plant survival (including photosynthesis, respiration, and transpiration).
6-2.8 Explain how plants respond to external stimuli (including dormancy and the forms of tropism known as phototropism, gravitropism, hydrotropism, and thigmotropism).
6-2.9 Explain how disease-causing fungi can affect plants.

GRADE 6

Structures, Processes, and Responses of Animals

Standard 6-3: The student will demonstrate an understanding of structures, processes, and responses of animals that allow them to survive and reproduce. (Life Science)

Indicators

6-3.1 Compare the characteristic structures of invertebrate animals (including sponges, segmented worms, echinoderms, mollusks, and arthropods) and vertebrate animals (fish, amphibians, reptiles, birds, and mammals).
6-3.2 Summarize the basic functions of the structures of animals that allow them to defend themselves, to move, and to obtain resources.
6-3.3 Compare the response that a warm-blooded (endothermic) animal makes to a fluctuation in environmental temperature with the response that a cold-blooded (ectothermic) animal makes to such a fluctuation.
6-3.4 Explain how environmental stimuli cause physical responses in animals (including shedding, blinking, shivering, sweating, panting, and food gathering).
6-3.5 Illustrate animal behavioral responses (including hibernation, migration, defense, and courtship) to environmental stimuli.
6-3.6 Summarize how the internal stimuli (including hunger, thirst, and sleep) of animals ensure their survival.
6-3.7 Compare learned to inherited behaviors in animals.

GRADE 6

Earth's Atmosphere and Weather

Standard 6-4: The student will demonstrate an understanding of the relationship between Earth's atmospheric properties and processes and its weather and climate. (Earth Science)

Indicators

6-4.1 Compare the composition and structure of Earth's atmospheric layers (including the gases and differences in temperature and pressure within the layers).
6-4.2 Summarize the interrelationships among the dynamic processes of the water cycle (including precipitation, evaporation, transpiration, condensation, surface-water flow, and groundwater flow).
6-4.3 Classify shapes and types of clouds according to elevation and their associated weather conditions and patterns.
6-4.4 Summarize the relationship of the movement of air masses, high and low pressure systems, and frontal boundaries to storms (including thunderstorms, hurricanes, and tornadoes) and other weather conditions.
6-4.5 Use appropriate instruments and tools to collect weather data (including wind speed and direction, air temperature, humidity, and air pressure).
6-4.6 Predict weather conditions and patterns based on weather data collected from direct observations and measurements, weather maps, satellites, and radar.
6-4.7 Explain how solar energy affects Earth's atmosphere and surface (land and water).
6-4.8 Explain how convection affects weather patterns and climate.
6-4.9 Explain the influence of global winds and the jet stream on weather and climatic conditions.

GRADE 6

Conservation of Energy

Standard 6-5: The student will demonstrate an understanding of the law of conservation of energy and the properties of energy and work. (Physical Science)

Indicators

6-5.1 Identify the sources and properties of heat, solar, chemical, mechanical, and electrical energy.
6-5.2 Explain how energy can be transformed from one form to another (including the two types of mechanical energy, potential and kinetic, as well as chemical and electrical energy) in accordance with the law of conservation of energy.
6-5.3 Explain how magnetism and electricity are interrelated by using descriptions, models, and diagrams of electromagnets, generators, and simple electrical motors.
6-5.4 Illustrate energy transformations (including the production of light, sound, heat, and mechanical motion) in electrical circuits.
6-5.5 Illustrate the directional transfer of heat energy through convection, radiation, and conduction.
6-5.6 Recognize that energy is the ability to do work (force exerted over a distance).
6-5.7 Explain how the design of simple machines (including levers, pulleys, and inclined planes) helps reduce the amount of force required to do work.
6-5.8 Illustrate ways that simple machines exist in common tools and in complex machines.

Grade 7

Overview

Students in grade seven continue to deepen their knowledge of the life, earth, and physical sciences through more complex investigations and explanations. The concepts they study become increasingly abstract in a developmentally appropriate manner to allow for the slow, incremental development of these cognitively complex ideas. Seventh graders also continue to develop their investigative skills by generating their own questions, recognizing and explaining the relationships among variables, and critiquing the conclusions that are drawn from scientific investigations. Specifically, these students explore the sciences within the framework of the following topics: “Cells and Heredity” (structure and function of cells and heredity), “Human Body Systems and Disease” (functions and interconnections within the human body and the breakdown of these functions due to disease); “Ecology: The Biotic and Abiotic Environment” (interactions and responses between biotic and abiotic components and organisms); and “The Chemical Nature of Matter” (classifications and properties of matter, changes in matter).

The science standards for grade seven provide the foundation for a course that is based on a rich and wide variety of learning experiences that actively engage students and accommodate a broad range of student learning styles through varied materials and instructional strategies. Students should observe, interact with materials and with people, and ask questions as they explore new concepts and expand their knowledge.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 7

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 7-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

7-1.1 Use appropriate tools and instruments (including a microscope) safely and accurately when conducting a controlled scientific investigation.
7-1.2 Generate questions that can be answered through scientific investigation.
7-1.3 Explain the reasons for testing one independent variable at a time in a controlled scientific investigation.
7-1.4 Explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation.
7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts.
7-1.6 Critique a conclusion drawn from a scientific investigation.
7-1.7 Use appropriate safety procedures when conducting investigations.

GRADE 7

Cells and Heredity

Standard 7-2: The student will demonstrate an understanding of the structure and function of cells, cellular reproduction, and heredity. (Life Science)

Indicators

7-2.1 Summarize the structures and functions of the major components of plant and animal cells (including the cell wall, the cell membrane, the nucleus, chloroplasts, mitochondria, and vacuoles).

7-2.2 Compare the major components of plant and animal cells.

7-2.3 Compare the body shapes of bacteria (spiral, coccus, and bacillus) and the body structures that protists (euglena, paramecium, amoeba) use for food gathering and locomotion.

7-2.4 Explain how cellular processes (including respiration, photosynthesis in plants, mitosis, and waste elimination) are essential to the survival of the organism.

7-2.5 Summarize how genetic information is passed from parent to offspring by using the terms *genes*, *chromosomes*, *inherited traits*, *genotype*, *phenotype*, *dominant traits*, and *recessive traits.*

7-2.6 Use Punnett squares to predict inherited monohybrid traits.

7-2.7 Distinguish between inherited traits and those acquired from environmental factors.

GRADE 7

Human Body Systems and Disease

Standard 7-3: The student will demonstrate an understanding of the functions and interconnections of the major human body systems, including the breakdown in structure or function that disease causes. (Life Science)

Indicators

7-3.1 Summarize the levels of structural organization within the human body (including cells, tissues, organs, and systems).

7-3.2 Recall the major organs of the human body and their function within their particular body system.

7-3.3 Summarize the relationships of the major body systems (including the circulatory, respiratory, digestive, excretory, nervous, muscular, and skeletal systems).

7-3.4 Explain the effects of disease on the major organs and body systems (including infectious diseases such as colds and flu, AIDS, and athlete's foot and noninfectious diseases such as diabetes, Parkinson's, and skin cancer).

GRADE 7

Ecology: The Biotic and Abiotic Environment

Standard 7-4: The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environment. (Earth Science, Life Science)

Indicators

7-4.1 Summarize the characteristics of the levels of organization within ecosystems (including populations, communities, habitats, niches, and biomes).

7-4.2 Illustrate energy flow in food chains, food webs, and energy pyramids

7-4.3 Explain the interaction among changes in the environment due to natural hazards (including landslides, wildfires, and floods), changes in populations, and limiting factors (including climate and the availability of food and water, space, and shelter).

7-4.4 Explain the effects of soil quality on the characteristics of an ecosystem.

7-4.5 Summarize how the location and movement of water on Earth's surface through groundwater zones and surface-water drainage basins, called watersheds, are important to ecosystems and to human activities.

7-4.6 Classify resources as renewable or nonrenewable and explain the implications of their depletion and the importance of conservation.

GRADE 7

The Chemical Nature of Matter

Standard 7-5: The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

Indicators

7-5.1 Recognize that matter is composed of extremely small particles called atoms.
7-5.2 Classify matter as element, compound, or mixture on the basis of its composition.
7-5.3 Compare the physical properties of metals and nonmetals.
7-5.4 Use the periodic table to identify the basic organization of elements and groups of elements (including metals, nonmetals, and families).
7-5.5 Translate chemical symbols and the chemical formulas of common substances to show the component parts of the substances (including NaCl [table salt], H_2O [water], $C_6H_{12}O_6$ [simple sugar], O_2 [oxygen gas], CO_2 [carbon dioxide], and N_2 [nitrogen gas]).
7-5.6 Distinguish between acids and bases and use indicators (including litmus paper, pH paper, and phenolphthalein) to determine their relative pH.
7-5.7 Identify the reactants and products in chemical equations.
7-5.8 Explain how a balanced chemical equation supports the law of conservation of matter.
7-5.9 Compare physical properties of matter (including melting or boiling point, density, and color) to the chemical property of reactivity with a certain substance (including the ability to burn or to rust).
7-5.10 Compare physical changes (including changes in size, shape, and state) to chemical changes that are the result of chemical reactions (including changes in color or temperature and formation of a precipitate or gas).

Grade 8

Overview

The focus of the grade-eight science standards is on providing students with the hands-on experiences that give them the active engagement and the concrete examples they require in order to understand basic science concepts. The development of eighth graders' science skills culminates with their designing an entire controlled scientific investigation, constructing explanations and drawing conclusions from data, and generating questions for further study. Specifically, students explore the life, earth, and physical sciences within the framework of the following topics: "Earth's Biological History" (Earth's biological diversity over time); "Earth's Structure and Processes" (materials and processes that alter the structure of Earth); "Astronomy: Earth and Space Systems" (characteristics, structure, and motions of celestial bodies in the universe); "Forces and Motion" (effects of forces on the motion of an object); and "Waves" (properties and behaviors of waves).

The science standards for grade eight provide the foundation for a course that is based on a rich and wide variety of learning experiences that actively engage students and accommodate a broad range of student learning styles through varied materials and instructional strategies. Students should observe, interact with materials and with people and ask questions as they explore new concepts and expand their knowledge.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 8

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 8-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

8-1.1 Design a controlled scientific investigation.
8-1.2 Recognize the importance of a systematic process for safely and accurately conducting investigations.
8-1.3 Construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation.
8-1.4 Generate questions for further study on the basis of prior investigations.
8-1.5 Explain the importance of and requirements for replication of scientific investigations.
8-1.6 Use appropriate tools and instruments (including convex lenses, plane mirrors, color filters, prisms, and slinky springs) safely and accurately when conducting a controlled scientific investigation.
8-1.7 Use appropriate safety procedures when conducting investigations.

GRADE 8

Earth's Biological History

Standard 8-2: The student will demonstrate an understanding of Earth's biological diversity over time. (Life Science, Earth Science)

Indicators

8-2.1 Explain how biological adaptations of populations enhance their survival in a particular environment.
8-2.2 Summarize how scientists study Earth's past environment and diverse life-forms by examining different types of fossils (including molds, casts, petrified fossils, preserved and carbonized remains of plants and animals, and trace fossils).
8-2.3 Explain how Earth's history has been influenced by catastrophes (including the impact of an asteroid or comet, climatic changes, and volcanic activity) that have affected the conditions on Earth and the diversity of its life-forms.
8-2.4 Recognize the relationship among the units—era, epoch, and period—into which the geologic time scale is divided.
8-2.5 Illustrate the vast diversity of life that has been present on Earth over time by using the geologic time scale.
8-2.6 Infer the relative age of rocks and fossils from index fossils and the ordering of the rock layers.
8-2.7 Summarize the factors, both natural and man-made, that can contribute to the extinction of a species.

GRADE 8

Earth's Structure and Processes

Standard 8-3: The student will demonstrate an understanding of materials that determine the structure of Earth and the processes that have altered this structure. (Earth Science)

Indicators

8-3.1 Summarize the three layers of Earth—crust, mantle, and core—on the basis of relative position, density, and composition.
8-3.2 Explain how scientists use seismic waves—primary, secondary, and surface waves—and Earth's magnetic fields to determine the internal structure of Earth.
8-3.3 Infer an earthquake's epicenter from seismographic data.
8-3.4 Explain how igneous, metamorphic, and sedimentary rocks are interrelated in the rock cycle.
8-3.5 Summarize the importance of minerals, ores, and fossil fuels as Earth resources on the basis of their physical and chemical properties.
8-3.6 Explain how the theory of plate tectonics accounts for the motion of the lithospheric plates, the geologic activities at the plate boundaries, and the changes in landform areas over geologic time.
8-3.7 Illustrate the creation and changing of landforms that have occurred through geologic processes (including volcanic eruptions and mountain-building forces).
8-3.8 Explain how earthquakes result from forces inside Earth.
8-3.9 Identify and illustrate geologic features of South Carolina and other regions of the world through the use of imagery (including aerial photography and satellite imagery) and topographic maps.

GRADE 8

Astronomy: Earth and Space Systems

Standard 8-4: The student will demonstrate an understanding of the characteristics, structure, and predictable motions of celestial bodies. (Earth Science)

Indicators

8-4.1 Summarize the characteristics and movements of objects in the solar system (including planets, moons, asteroids, comets, and meteors).

8-4.2 Summarize the characteristics of the surface features of the Sun: photosphere, corona, sunspots, prominences, and solar flares.

8-4.3 Explain how the surface features of the Sun may affect Earth.

8-4.4 Explain the motions of Earth and the Moon and the effects of these motions as they orbit the Sun (including day, year, phases of the Moon, eclipses, and tides).

8-4.5 Explain how the tilt of Earth's axis affects the length of the day and the amount of heating on Earth's surface, thus causing the seasons of the year.

8-4.6 Explain how gravitational forces are influenced by mass and distance.

8-4.7 Explain the effects of gravity on tides and planetary orbits.

8-4.8 Explain the difference between mass and weight by using the concept of gravitational force.

8-4.9 Recall the Sun's position in the universe, the shapes and composition of galaxies, and the distance measurement unit (light year) needed to identify star and galaxy locations.

8-4.10 Compare the purposes of the tools and the technology that scientists use to study space (including various types of telescopes, satellites, space probes, and spectroscopes).

GRADE 8

Forces and Motion

Standard 8-5: The student will demonstrate an understanding of the effects of forces on the motion of an object. (Physical Science)

Indicators

8-5.1 Use measurement and time-distance graphs to represent the motion of an object in terms of its position, direction, or speed.

8-5.2 Use the formula for average speed, v = d/t, to solve real-world problems.

8-5.3 Analyze the effects of forces (including gravity and friction) on the speed and direction of an object.

8-5.4 Predict how varying the amount of force or mass will affect the motion of an object.

8-5.5 Analyze the resulting effect of balanced and unbalanced forces on an object's motion in terms of magnitude and direction.

8-5.6 Summarize and illustrate the concept of inertia.

GRADE 8

Waves

Standard 8-6: The student will demonstrate an understanding of the properties and behaviors of waves. (Physical Science)

Indicators

8-6.1 Recall that waves transmit energy but not matter.
8-6.2 Distinguish between mechanical and electromagnetic waves.
8-6.3 Summarize factors that influence the basic properties of waves (including frequency, amplitude, wavelength, and speed).
8-6.4 Summarize the behaviors of waves (including refraction, reflection, transmission, and absorption).
8-6.5 Explain hearing in terms of the relationship between sound waves and the ear.
8-6.6 Explain sight in terms of the relationship between the eye and the light waves emitted or reflected by an object.
8-6.7 Explain how the absorption and reflection of light waves by various materials result in the human perception of color.
8-6.8 Compare the wavelength and energy of waves in various parts of the electromagnetic spectrum (including visible light, infrared, and ultraviolet radiation).

HIGH SCHOOL CORE AREA STANDARDS

Physical Science

Overview

The academic standards for Physical Science establish the scientific inquiry skills and core content for all Physical Science classes in South Carolina schools. The course should provide students with a conceptual understanding of the world around them—a basic knowledge of the physical universe that should serve as the foundation for other high school science courses.

Teachers, schools, and districts should use these standards to make decisions concerning the structure and content for Physical Science classes that are taught in their schools. These decisions will involve choices regarding additional content, activities, and learning strategies and will depend on the particular objectives of the individual classes. All Physical Science classes must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. In other words, students should spend more of their class time choosing the right method to solve a problem and less time solving problems that merely call for repetitive procedures.

Physical Science is a laboratory course (minimum of 30 percent hands-on investigation) that integrates principles of chemistry and physics. Physical science laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations in both the chemistry and physics portions of the course.

The standards in the physical science core area will be the basis for the development of the items on the state-required end-of-course examination for Physical Science. The skills and tools listed in the scientific inquiry sections will be assessed independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

PHYSICAL SCIENCE

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard PS-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

PS-1.1 Generate hypotheses on the basis of credible, accurate, and relevant sources of scientific information.
PS-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
PS-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
PS-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
PS-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas and dimensional analysis), graphs, models, and/or technology.
PS-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
PS-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
PS-1.8 Compare the processes of scientific investigation and technological design.
PS-1.9 Use appropriate safety procedures when conducting investigations.

PHYSICAL SCIENCE

Chemistry: Structure and Properties of Matter

Standard PS-2: The student will demonstrate an understanding of the structure and properties of atoms.

Indicators

PS-2.1 Compare the subatomic particles (protons, neutrons, electrons) of an atom with regard to mass, location, and charge, and explain how these particles affect the properties of an atom (including identity, mass, volume, and reactivity).

PS-2.2 Illustrate the fact that the atoms of elements exist as stable or unstable isotopes.

PS-2.3 Explain the trends of the periodic table based on the elements' valence electrons and atomic numbers.

PS-2.4 Use the atomic number and the mass number to calculate the number of protons, neutrons, and/or electrons for a given isotope of an element.

PS-2.5 Predict the charge that a representative element will acquire according to the arrangement of electrons in its outer energy level.

PS-2.6 Compare fission and fusion (including the basic processes and the fact that both fission and fusion convert a fraction of the mass of interacting particles into energy and release a great amount of energy).

PS-2.7 Explain the consequences that the use of nuclear applications (including medical technologies, nuclear power plants, and nuclear weapons) can have.

PHYSICAL SCIENCE

Chemistry: Structure and Properties of Matter

Standard PS-3: The student will demonstrate an understanding of various properties and classifications of matter.

Indicators

PS-3.1 Distinguish chemical properties of matter (including reactivity) from physical properties of matter (including boiling point, freezing/melting point, density [with density calculations], solubility, viscosity, and conductivity).

PS-3.2 Infer the practical applications of organic and inorganic substances on the basis of their chemical and physical properties.

PS-3.3 Illustrate the difference between a molecule and an atom.

PS-3.4 Classify matter as a pure substance (either an element or a compound) or as a mixture (either homogeneous or heterogeneous) on the basis of its structure and/or composition.

PS-3.5 Explain the effects of temperature, particle size, and agitation on the rate at which a solid dissolves in a liquid.

PS-3.6 Compare the properties of the four states of matter—solid, liquid, gas, and plasma—in terms of the arrangement and movement of particles.

PS-3.7 Explain the processes of phase change in terms of temperature, heat transfer, and particle arrangement.

PS-3.8 Classify various solutions as acids or bases according to their physical properties, chemical properties (including neutralization and reaction with metals), generalized formulas, and pH (using pH meters, pH paper, and litmus paper).

PHYSICAL SCIENCE

Chemistry: Structure and Properties of Matter

Standard PS-4: The student will demonstrate an understanding of chemical reactions and the classifications, structures, and properties of chemical compounds.

Indicators

PS-4.1 Explain the role of bonding in achieving chemical stability.
PS-4.2 Explain how the process of covalent bonding provides chemical stability through the sharing of electrons.
PS-4.3 Illustrate the fact that ions attract ions of opposite charge from all directions and form crystal lattices.
PS-4.4 Classify compounds as crystalline (containing ionic bonds) or molecular (containing covalent bonds) based on whether their outer electrons are transferred or shared.
PS-4.5 Predict the ratio by which the representative elements combine to form binary ionic compounds, and represent that ratio in a chemical formula.
PS-4.6 Distinguish between chemical changes (including the formation of gas or reactivity with acids) and physical changes (including changes in size, shape, color, and/or phase).
PS-4.7 Summarize characteristics of balanced chemical equations (including conservation of mass and changes in energy in the form of heat—that is, exothermic or endothermic reactions).
PS-4.8 Summarize evidence (including the evolution of gas; the formation of a precipitate; and/or changes in temperature, color, and/or odor) that a chemical reaction has occurred.
PS-4.9 Apply a procedure to balance equations for a simple synthesis or decomposition reaction.
PS-4.10 Recognize simple chemical equations (including single replacement and double replacement) as being balanced or not balanced.
PS-4.11 Explain the effects of temperature, concentration, surface area, and the presence of a catalyst on reaction rates.

PHYSICAL SCIENCE

Physics: The Interactions of Matter and Energy

Standard PS-5: The student will demonstrate an understanding of the nature of forces and motion.

Indicators

PS-5.1 Explain the relationship among distance, time, direction, and the velocity of an object.
PS-5.2 Use the formula v = d/t to solve problems related to average speed or velocity.
PS-5.3 Explain how changes in velocity and time affect the acceleration of an object.
PS-5.4 Use the formula $a = (v_f - v_i)/t$ to determine the acceleration of an object.
PS-5.5 Explain how acceleration due to gravity affects the velocity of an object as it falls.
PS-5.6 Represent the linear motion of objects on distance-time graphs.
PS-5.7 Explain the motion of objects on the basis of Newton's three laws of motion: inertia; the relationship among force, mass, and acceleration; and action and reaction forces.
PS-5.8 Use the formula F = ma to solve problems related to force.
PS-5.9 Explain the relationship between mass and weight by using the formula $F_W = ma_g$.
PS-5.10 Explain how the gravitational force between two objects is affected by the mass of each object and the distance between them.

PHYSICAL SCIENCE

Physics: The Interactions of Matter and Energy

Standard PS-6: The student will demonstrate an understanding of the nature, conservation, and transformation of energy.

Indicators

PS-6.1 Explain how the law of conservation of energy applies to the transformation of various forms of energy (including mechanical energy, electrical energy, chemical energy, light energy, sound energy, and thermal energy).

PS-6.2 Explain the factors that determine potential and kinetic energy and the transformation of one to the other.

PS-6.3 Explain work in terms of the relationship among the force applied to an object, the displacement of the object, and the energy transferred to the object.

PS-6.4 Use the formula $W = Fd$ to solve problems related to work done on an object.

PS-6.5 Explain how objects can acquire a static electric charge through friction, induction, and conduction.

PS-6.6 Explain the relationships among voltage, resistance, and current in Ohm's law.

PS-6.7 Use the formula $V = IR$ to solve problems related to electric circuits.

PS-6.8 Represent an electric circuit by drawing a circuit diagram that includes the symbols for a resistor, switch, and voltage source.

PS-6.9 Compare the functioning of simple series and parallel electrical circuits.

PS-6.10 Compare alternating current (AC) and direct current (DC) in terms of the production of electricity and the direction of current flow.

PS-6.11 Explain the relationship of magnetism to the movement of electric charges in electromagnets, simple motors, and generators.

PHYSICAL SCIENCE

Physics: The Interactions of Matter and Energy

Standard PS-7: The student will demonstrate an understanding of the nature and properties of mechanical and electromagnetic waves.

Indicators

PS-7.1 Illustrate ways that the energy of waves is transferred by interaction with matter (including transverse and longitudinal/compressional waves).
PS-7.2 Compare the nature and properties of transverse and longitudinal/compressional mechanical waves.
PS-7.3 Summarize characteristics of waves (including displacement, frequency, period, amplitude, wavelength, and velocity as well as the relationships among these characteristics).
PS-7.4 Use the formulas $v = f\lambda$ and $v = d/t$ to solve problems related to the velocity of waves.
PS-7.5 Summarize the characteristics of the electromagnetic spectrum (including range of wavelengths, frequency, energy, and propagation without a medium).
PS-7.6 Summarize reflection and interference of both sound and light waves and the refraction and diffraction of light waves.
PS-7.7 Explain the Doppler effect conceptually in terms of the frequency of the waves and the pitch of the sound.

Biology

Overview

The biology standards provide students with a basic knowledge of living organisms and the interaction of these organisms with the natural world. The standards establish the scientific inquiry skills and core content for all biology courses in South Carolina schools. Biology courses should serve as the foundation for higher-level science courses and should give students the science skills necessary for life science–related technical careers.

Teachers, schools, and districts should use these standards to make decisions concerning the structure and content of Biology 1 and Applied Biology 1 and 2. Educators must also determine how all biology courses in their schools, as well as individual classes, may go beyond the standards. These decisions will involve choices regarding additional content, activities, and learning strategies and will depend on the objectives of the particular courses. All biology courses must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning.

All biology courses are laboratory courses (minimum of 30 percent hands-on investigation). Biology laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations.

The standards in the biology core area will be the basis for the development of the items on the state-required end-of-course examination for Biology 1 and Applied Biology 2. The skills and tools listed in the scientific inquiry sections will be assessed independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

BIOLOGY

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard B-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

B-1.1 Generate hypotheses based on credible, accurate, and relevant sources of scientific information.

B-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

B-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

B-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

B-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics, graphs, models, and/or technology.

B-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

B-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

B-1.8 Compare the processes of scientific investigation and technological design.

B-1.9 Use appropriate safety procedures when conducting investigations.

BIOLOGY

Standard B-2: The student will demonstrate an understanding of the structure and function of cells and their organelles.

Indicators

B-2.1 Recall the three major tenets of cell theory (all living things are composed of one or more cells; cells are the basic units of structure and function in living things; and all presently existing cells arose from previously existing cells).

B-2.2 Summarize the structures and functions of organelles found in a eukaryotic cell (including the nucleus, mitochondria, chloroplasts, lysosomes, vacuoles, ribosomes, endoplasmic reticulum [ER], Golgi apparatus, cilia, flagella, cell membrane, nuclear membrane, cell wall, and cytoplasm).

B-2.3 Compare the structures and organelles of prokaryotic and eukaryotic cells.

B-2.4 Explain the process of cell differentiation as the basis for the hierarchical organization of organisms (including cells, tissues, organs, and organ systems).

B-2.5 Explain how active, passive, and facilitated transport serve to maintain the homeostasis of the cell.

B-2.6 Summarize the characteristics of the cell cycle: interphase (called G1, S, G2); the phases of mitosis (called prophase, metaphase, anaphase, and telophase); and plant and animal cytokinesis.

B-2.7 Summarize how cell regulation controls and coordinates cell growth and division and allows cells to respond to the environment, and recognize the consequences of uncontrolled cell division.

B-2.8 Explain the factors that affect the rates of biochemical reactions (including pH, temperature, and the role of enzymes as catalysts).

BIOLOGY

Standard B-3: The student will demonstrate an understanding of the flow of energy within and between living systems.

Indicators

B-3.1 Summarize the overall process by which photosynthesis converts solar energy into chemical energy and interpret the chemical equation for the process.
B-3.2 Summarize the basic aerobic and anaerobic processes of cellular respiration and interpret the chemical equation for cellular respiration.
B-3.3 Recognize the overall structure of adenosine triphosphate (ATP)—namely, adenine, the sugar ribose, and three phosphate groups—and summarize its function (including the ATP-ADP [adenosine diphosphate] cycle).
B-3.4 Summarize how the structures of organic molecules (including proteins, carbohydrates, and fats) are related to their relative caloric values.
B-3.5 Summarize the functions of proteins, carbohydrates, and fats in the human body.
B-3.6 Illustrate the flow of energy through ecosystems (including food chains, food webs, energy pyramids, number pyramids, and biomass pyramids).

BIOLOGY

Standard B-4: The student will demonstrate an understanding of the molecular basis of heredity.

Indicators

B-4.1 Compare DNA and RNA in terms of structure, nucleotides, and base pairs.
B-4.2 Summarize the relationship among DNA, genes, and chromosomes.
B-4.3 Explain how DNA functions as the code of life and the blueprint for proteins.
B-4.4 Summarize the basic processes involved in protein synthesis (including transcription and translation).
B-4.5 Summarize the characteristics of the phases of meiosis I and II.
B-4.6 Predict inherited traits by using the principles of Mendelian genetics (including segregation, independent assortment, and dominance).
B-4.7 Summarize the chromosome theory of inheritance and relate that theory to Gregor Mendel's principles of genetics.
B-4.8 Compare the consequences of mutations in body cells with those in gametes.
B-4.9 Exemplify ways that introduce new genetic characteristics into an organism or a population by applying the principles of modern genetics.

BIOLOGY

Standard B-5: The student will demonstrate an understanding of biological evolution and the diversity of life.

Indicators

B-5.1 Summarize the process of natural selection.
B-5.2 Explain how genetic processes result in the continuity of life-forms over time.
B-5.3 Explain how diversity within a species increases the chances of its survival.
B-5.4 Explain how genetic variability and environmental factors lead to biological evolution.
B-5.5 Exemplify scientific evidence in the fields of anatomy, embryology, biochemistry, and paleontology that underlies the theory of biological evolution.
B-5.6 Summarize ways that scientists use data from a variety of sources to investigate and critically analyze aspects of evolutionary theory.
B-5.7 Use a phylogenetic tree to identify the evolutionary relationships among different groups of organisms.

BIOLOGY

Standard B-6: The student will demonstrate an understanding of the interrelationships among organisms and the biotic and abiotic components of their environments.

Indicators

B-6.1 Explain how the interrelationships among organisms (including predation, competition, parasitism, mutualism, and commensalism) generate stability within ecosystems.
B-6.2 Explain how populations are affected by limiting factors (including density-dependent, density-independent, abiotic, and biotic factors).
B-6.3 Illustrate the processes of succession in ecosystems.
B-6.4 Exemplify the role of organisms in the geochemical cycles (including the cycles of carbon, nitrogen, and water).
B-6.5 Explain how ecosystems maintain themselves through naturally occurring processes (including maintaining the quality of the atmosphere, generating soils, controlling the hydrologic cycle, disposing of wastes, and recycling nutrients).
B-6.6 Explain how human activities (including population growth, technology, and consumption of resources) affect the physical and chemical cycles and processes of Earth.

Chemistry Overview

The standards for chemistry establish scientific inquiry skills and core content for all chemistry courses in South Carolina schools. In chemistry, students acquire a fundamental knowledge of the substances in our world—their composition, properties, and interactions—that should not only serve them as a foundation for the more advanced science courses in secondary and postsecondary education but should also provide them with the science skills that are necessary in chemistry-oriented technical careers.

In order for students to achieve these goals, chemistry courses must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. Teachers, schools, and districts should therefore use these standards to make decisions concerning the structure and content of all their courses in chemistry and to make choices regarding additional content, activities, and learning strategies that will be determined by the objectives of the particular courses.

All chemistry courses are laboratory courses (minimum of 30 percent hands-on investigation). Chemistry laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations.

The skills and tools listed in the scientific inquiry sections have been assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators have been assessed *cumulatively*. Therefore, as students progress through this course, they are expected to know the content of the scientific inquiry indicators—including the use of tools—from all their previous grades and science courses. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

CHEMISTRY

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard C-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

C-1.1 Apply established rules for significant digits, both in reading a scientific instrument and in calculating a derived quantity from measurement.
C-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
C-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
C-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
C-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas, scientific notation, and dimensional analysis), graphs, models, and/or technology.
C-1.6 Evaluate the results of a scientific investigation in terms of whether they verify or refute the hypothesis and what the possible sources of error are.
C-1.7 Evaluate a technological design or product on the basis of designated criteria.
C-1.8 Use appropriate safety procedures when conducting investigations.

CHEMISTRY

Standard C-2: Students will demonstrate an understanding of atomic structure and nuclear processes.

Indicators

C-2.1 Illustrate electron configurations by using orbital notation for representative elements.
C-2.2 Summarize atomic properties (including electron configuration, ionization energy, electron affinity, atomic size, and ionic size).
C-2.3 Summarize the periodic table's property trends (including electron configuration, ionization energy, electron affinity, atomic size, ionic size, and reactivity).
C-2.4 Compare the nuclear reactions of fission and fusion to chemical reactions (including the parts of the atom involved and the relative amounts of energy released).
C-2.5 Compare alpha, beta, and gamma radiation in terms of mass, charge, penetrating power, and the release of these particles from the nucleus.
C-2.6 Explain the concept of half-life, its use in determining the age of materials, and its significance to nuclear waste disposal.

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-2.7 Apply the predictable rate of nuclear decay (half-life) to determine the age of materials.
C-2.8 Analyze a decay series chart to determine the products of successive nuclear reactions and write nuclear equations for disintegration of specified nuclides.
C-2.9 Use the equation $E = mc^2$ to determine the amount of energy released during nuclear reactions.

CHEMISTRY

Standard C-3: The student will demonstrate an understanding of the structures and classifications of chemical compounds.

Indicators

C-3.1 Predict the type of bonding (ionic or covalent) and the shape of simple compounds by using Lewis dot structures and oxidation numbers.
C-3.2 Interpret the names and formulas for ionic and covalent compounds.
C-3.3 Explain how the types of intermolecular forces present in a compound affect the physical properties of compounds (including polarity and molecular shape).
C-3.4 Explain the unique bonding characteristics of carbon that have resulted in the formation of a large variety of organic structures.
C-3.5 Illustrate the structural formulas and names of simple hydrocarbons (including alkanes and their isomers and benzene rings).

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-3.6 Identify the basic structure of common polymers (including proteins, nucleic acids, plastics, and starches).
C-3.7 Classify organic compounds in terms of their functional group.
C-3.8 Explain the effect of electronegativity and ionization energy on the type of bonding in a molecule.
C-3.9 Classify polymerization reactions as addition or condensation.
C-3.10 Classify organic reactions as addition, elimination, or condensation.

CHEMISTRY

Standard C-4: The student will demonstrate an understanding of the types, the causes, and the effects of chemical reactions.

Indicators

C-4.1 Analyze and balance equations for simple synthesis, decomposition, single replacement, double replacement, and combustion reactions.
C-4.2 Predict the products of acid-base neutralization and combustion reactions.
C-4.3 Analyze the energy changes (endothermic or exothermic) associated with chemical reactions.
C-4.4 Apply the concept of moles to determine the number of particles of a substance in a chemical reaction, the percent composition of a representative compound, the mass proportions, and the mole-mass relationships.
C-4.5 Predict the percent yield, the mass of excess, and the limiting reagent in chemical reactions.
C-4.6 Explain the role of activation energy and the effects of temperature, particle size, stirring, concentration, and catalysts in reaction rates.

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-4.7 Summarize the oxidation and reduction processes (including oxidizing and reducing agents).
C-4.8 Illustrate the uses of electrochemistry (including electrolytic cells, voltaic cells, and the production of metals from ore by electrolysis).
C-4.9 Summarize the concept of chemical equilibrium and Le Châtelier’s principle.
C-4.10 Explain the role of collision frequency, the energy of collisions, and the orientation of molecules in reaction rates.

CHEMISTRY

Standard C-5: The student will demonstrate an understanding of the structure and behavior of the different phases of matter.

Indicators

C-5.1 Explain the effects of the intermolecular forces on the different phases of matter.
C-5.2 Explain the behaviors of gas; the relationship among pressure, volume, and temperature; and the significance of the Kelvin (absolute temperature) scale, using the kinetic-molecular theory as a model.
C-5.3 Apply the gas laws to problems concerning changes in pressure, volume, or temperature (including Charles's law, Boyle's law, and the combined gas law).
C-5.4 Illustrate and interpret heating and cooling curves (including how boiling and melting points can be identified and how boiling points vary with changes in pressure).

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-5.5 Analyze the energy changes involved in calorimetry by using the law of conservation of energy as it applies to temperature, heat, and phase changes (including the use of the formulas $q = mc\Delta T$ [temperature change] and $q = mLv$ and $q = mLf$ [phase change] to solve calorimetry problems).
C-5.6 Use density to determine the mass, volume, or number of particles of a gas in a chemical reaction.
C-5.7 Apply the ideal gas law ($pV = nRT$) to solve problems.
C-5.8 Analyze a product for purity by following the appropriate assay procedures.
C-5.9 Analyze a chemical process to account for the weight of all reagents and solvents by following the appropriate material balance procedures.

CHEMISTRY

Standard C-6: The student will demonstrate an understanding of the nature and properties of various types of chemical solutions.

Indicators

C-6.1 Summarize the process by which solutes dissolve in solvents, the dynamic equilibrium that occurs in saturated solutions, and the effects of varying pressure and temperature on solubility.
C-6.2 Compare solubility of various substances in different solvents (including polar and nonpolar solvents and organic and inorganic substances).
C-6.3 Illustrate the colligative properties of solutions (including freezing point depression and boiling point elevation and their practical uses).
C-6.4 Carry out calculations to find the concentration of solutions in terms of molarity and percent weight (mass).
C-6.5 Summarize the properties of salts, acids, and bases.
C-6.6 Distinguish between strong and weak common acids and bases.
C-6.7 Represent common acids and bases by their names and formulas.

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-6.8 Use the hydronium or hydroxide ion concentration to determine the pH and pOH of aqueous solutions.
C-6.9 Explain how the use of a titration can determine the concentration of acid and base solutions
C-6.10 Interpret solubility curves to determine saturation at different temperatures.
C-6.11 Use a variety of procedures for separating mixtures (including distillation, crystallization filtration, paper chromatography, and centrifuge).
C-6.12 Use solubility rules to write net ionic equations for precipitation reactions in aqueous solution.
C-6.13 Use the calculated molality of a solution to calculate the freezing point depression and the boiling point elevation of a solution.
C-6.14 Represent neutralization reactions and reactions between common acids and metals by using chemical equations.
C-6.15 Analyze the composition of a chemical sample by using gas chromatography.

Physics

Overview

The standards for physics establish the scientific inquiry skills and core content for all physics courses in South Carolina schools. In these courses, students acquire a fundamental knowledge of motion, matter, and energy that should not only serve them as the foundation for their study of science in institutions of higher education but should also provide them with the science skills that are necessary in physics-oriented technical careers. A total of *seven* high school core area standards for physics must be taught: the *required* standards for physics are standards 1 through 5; any *two* of standards 6 through 10 are required in addition. The decision about which two of standards 6 through 10 to address in any particular physics course should be based on the objectives for that course.

In order for students to achieve these goals, physics courses must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. Teachers, schools, and districts should therefore use these standards to make decisions concerning the structure and content of all their courses in physics and to make choices regarding additional content, activities, and learning strategies that will be determined by the objectives of the particular courses.

All physics courses are laboratory courses (minimum of 30 percent hands-on investigation). Physics laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations.

The skills and tools listed in the scientific inquiry sections have been assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators have been assessed *cumulatively*. Therefore, as students progress through this course, they are expected to know the content of the scientific inquiry indicators—including the use of tools—from all their previous grades and science courses. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

PHYSICS

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard P-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

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Indicators

P-1.1 Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.

P-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

P-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

P-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

P-1.5 Organize and interpret the data from a controlled scientific investigation by using (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.

P-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

P-1.7 Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.

P-1.8 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

P-1.9 Communicate and defend a scientific argument or conclusion.

P-1.10 Use appropriate safety procedures when conducting investigations.

PHYSICS

Standard P-2: The student will demonstrate an understanding of the principles of force and motion and relationships between them.

Indicators

P-2.1 Represent vector quantities (including displacement, velocity, acceleration, and force) and use vector addition.

P-2.2 Apply formulas for velocity or speed and acceleration to one and two-dimensional problems.

P-2.3 Interpret the velocity or speed and acceleration of one and two-dimensional motion on distance-time, velocity-time or speed-time, and acceleration-time graphs.

P-2.4 Interpret the resulting motion of objects by applying Newton's three laws of motion: inertia; the relationship among net force, mass, and acceleration (using $F = ma$); and action and reaction forces.

P-2.5 Explain the factors that influence the dynamics of falling objects and projectiles.

P-2.6 Apply formulas for velocity and acceleration to solve problems related to projectile motion.

P-2.7 Use a free-body diagram to determine the net force and component forces acting upon an object.

P-2.8 Distinguish between static and kinetic friction and the factors that affect the motion of objects.

P-2.9 Explain how torque is affected by the magnitude, direction, and point of application of force.

P-2.10 Explain the relationships among speed, velocity, acceleration, and force in rotational systems.

PHYSICS

Standard P-3: The student will demonstrate an understanding of the conservation, transfer, and transformation of mechanical energy.

Indicators

P-3.1 Apply energy formulas to determine potential and kinetic energy and explain the transformation from one to the other.
P-3.2 Apply the law of conservation of energy to the transfer of mechanical energy through work.
P-3.3 Explain, both conceptually and quantitatively, how energy can transfer from one system to another (including work, power, and efficiency).
P-3.4 Explain, both conceptually and quantitatively, the factors that influence periodic motion.
P-3.5 Explain the factors involved in producing a change in momentum (including impulse and the law of conservation of momentum in both linear and rotary systems).
P-3.6 Compare elastic and inelastic collisions in terms of conservation laws.

PHYSICS

Standard P-4: The student will demonstrate an understanding of the properties of electricity and magnetism and the relationships between them.

Indicators

P-4.1 Recognize the characteristics of static charge and explain how a static charge is generated.
P-4.2 Use diagrams to illustrate an electric field (including point charges and electric field lines).
P-4.3 Summarize current, potential difference, and resistance in terms of electrons.
P-4.4 Compare how current, voltage, and resistance are measured in a series and in a parallel electric circuit and identify the appropriate units of measurement.
P-4.5 Analyze the relationships among voltage, resistance, and current in a complex circuit by using Ohm's law to calculate voltage, resistance, and current at each resistor, any branch, and the overall circuit.
P-4.6 Differentiate between alternating current (AC) and direct current (DC) in electrical circuits.
P-4.7 Carry out calculations for electric power and electric energy for circuits.
P-4.8 Summarize the function of electrical safety components (including fuses, surge protectors, and breakers).
P-4.9 Explain the effects of magnetic forces on the production of electrical currents and on current carrying wires and moving charges.
P-4.10 Distinguish between the function of motors and generators on the basis of the use of electricity and magnetism by each.
P-4.11 Predict the cost of operating an electrical device by determining the amount of electrical power and electrical energy in the circuit.

PHYSICS

Standard P-5: The student will demonstrate an understanding of the properties and behaviors of mechanical and electromagnetic waves.

Indicators

P-5.1 Analyze the relationships among the properties of waves (including energy, frequency, amplitude, wavelength, period, phase, and speed).
P-5.2 Compare the properties of electromagnetic and mechanical waves.
P-5.3 Analyze wave behaviors (including reflection, refraction, diffraction, and constructive and destructive interference).
P-5.4 Distinguish the different properties of waves across the range of the electromagnetic spectrum.
P-5.5 Illustrate the interaction of light waves with optical lenses and mirrors by using Snell's law and ray diagrams.
P-5.6 Summarize the operation of lasers and compare them to incandescent light.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-6: The student will demonstrate an understanding of the properties and behaviors of sound.

Indicators

P-6.1 Summarize the production of sound and its speed and transmission through various media.
P-6.2 Explain how frequency and intensity affect the parts of the sonic spectrum.
P-6.3 Explain pitch, loudness, and tonal quality in terms of wave characteristics that determine what is heard.
P-6.4 Compare intensity and loudness.
P-6.5 Apply formulas to determine the relative intensity of sound.
P-6.6 Apply formulas in order to solve for resonant wavelengths in problems involving open and closed tubes.
P-6.7 Explain the relationship among frequency, fundamental tones, and harmonics in producing music.
P-6.8 Explain how musical instruments produce resonance and standing waves.
P-6.9 Explain how the variables of length, width, tension, and density affect the resonant frequency, harmonics, and pitch of a vibrating string.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-7: The student will demonstrate an understanding of the properties and behaviors of light and optics.

Indicators

P-7.1 Explain the particulate nature of light as evidenced in the photoelectric effect.
P-7.2 Use the inverse square law to determine the change in intensity of light with distance.
P-7.3 Illustrate the polarization of light.
P-7.4 Summarize the operation of fiber optics in terms of total internal reflection.
P-7.5 Summarize image formation in microscopes and telescopes (including reflecting and refracting).
P-7.6 Summarize the production of continuous, emission, or absorption spectra.
P-7.7 Compare color by transmission to color by reflection.
P-7.8 Compare color mixing in pigments to color mixing in light.
P-7.9 Illustrate the diffraction and interference of light.
P-7.10 Identify the parts of the eye and explain their function in image formation.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-8: The student will demonstrate an understanding of nuclear physics and modern physics.

Indicators

P-8.1 Compare the strong and weak nuclear forces in terms of their roles in radioactivity.
P-8.2 Compare the nuclear binding energy to the energy released during a nuclear reaction, given the atomic masses of the constituent particles.
P-8.3 Predict the resulting isotope of a given alpha, beta, or gamma emission.
P-8.4 Apply appropriate procedures to balance nuclear equations (including fusion, fission, alpha decay, beta decay, and electron capture).
P-8.5 Interpret a representative nuclear decay series.
P-8.6 Explain the relationship between mass and energy that is represented in the equation $E = mc^2$ according to Einstein's special theory of relativity.
P-8.7 Compare the value of time, length, and momentum in the reference frame of an object moving at relativistic velocity to those values measured in the reference frame of an observer by applying Einstein's special theory of relativity.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-9: The student will demonstrate an understanding of the principles of fluid mechanics.

Indicators

P-9.1 Predict the behavior of fluids (including changing forces) in pneumatic and hydraulic systems.
P-9.2 Apply appropriate procedures to solve problems involving pressure, force, volume, and area.
P-9.3 Explain the factors that affect buoyancy.
P-9.4 Explain how the rate of flow of a fluid is affected by the size of the pipe, friction, and the viscosity of the fluid.
P-9.5 Explain how depth and fluid density affect pressure.
P-9.6 Apply fluid formulas to solve problems involving work and power.
P-9.7 Exemplify the relationship between velocity and pressure by using Bernoulli's principle.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-10: The student will demonstrate an understanding of the principles of thermodynamics.

Indicators

P-10.1 Summarize the first and second laws of thermodynamics.
P-10.2 Explain the relationship among internal energy, heat, and work.
P-10.3 Exemplify the concept of entropy.
P-10.4 Explain thermal expansion in solids, liquids, and gases in terms of kinetic theory and the unique behavior of water.
P-10.5 Differentiate heat and temperature in terms of molecular motion.
P-10.6 Summarize the concepts involved in phase change.
P-10.7 Apply the concepts of heat capacity, specific heat, and heat exchange to solve calorimetry problems.
P-10.8 Summarize the functioning of heat transfer mechanisms (including engines and refrigeration systems).

Earth Science Overview

The standards for earth science establish the scientific inquiry skills and core content for all earth science courses in South Carolina schools. Earth science courses should provide students with a basic knowledge of the natural world that will serve as the foundation for more advanced secondary and postsecondary courses and will also give them the science skills necessary for earth-science oriented technical careers.

In order for students to achieve these goals, earth science courses must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. Teachers, schools, and districts should use the academic standards for earth science to make decisions concerning the structure and content of all their earth science courses and to determine how these courses may go beyond the standards. These decisions will involve choices regarding additional content, activities, and learning strategies and will depend on the objectives of the individual courses.

All earth science courses are laboratory courses (minimum of 30 percent hands-on investigation). Earth science laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations.

The skills and tools listed in the scientific inquiry sections have been assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators have been assessed *cumulatively*. Therefore, as students progress through this course, they are expected to know the content of the scientific inquiry indicators—including the use of tools—from all their previous grades and science courses. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

EARTH SCIENCE

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard ES-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

ES-1.1 Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.

ES-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

ES-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

ES-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

ES-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.

ES-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

ES-1.7 Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.

ES-1.8 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

ES-1.9 Communicate and defend a scientific argument or conclusion.

ES-1.10 Use appropriate safety procedures when conducting investigations.

EARTH SCIENCE

Astronomy

Standard ES-2: Students will demonstrate an understanding of the structure and properties of the universe.

Indicators

ES-2.1 Summarize the properties of the solar system that support the theory of its formation along with the planets.

ES-2.2 Identify properties and features of the Moon that make it unique among other moons in the solar system.

ES-2.3 Summarize the evidence that supports the big bang theory and the expansion of the universe (including the red shift of light from distant galaxies and the cosmic background radiation).

ES-2.4 Explain the formation of elements that results from nuclear fusion occurring within stars or supernova explosions.

ES-2.5 Classify stars by using the Hertzsprung-Russell diagram.

ES-2.6 Compare the information obtained through the use of x-ray, radio, and visual (reflecting and refracting) telescopes.

ES-2.7 Summarize the life cycles of stars.

ES-2.8 Explain how gravity and motion affect the formation and shapes of galaxies (including the Milky Way).

ES-2.9 Explain how technology and computer modeling have increased our understanding of the universe.

EARTH SCIENCE

Solid Earth

Standard ES-3: Students will demonstrate an understanding of the internal and external dynamics of solid Earth.

Indicators

ES-3.1 Summarize theories and evidence of the origin and formation of Earth's systems by using the concepts of gravitational force and heat production.

ES-3.2 Explain the differentiation of the structure of Earth's layers into a core, mantle, and crust based on the production of internal heat from the decay of isotopes and the role of gravitational energy.

ES-3.3 Summarize theory of plate tectonics (including the role of convection currents, the action at plate boundaries, and the scientific evidence for the theory).

ES-3.4 Explain how forces due to plate tectonics cause crustal changes as evidenced in earthquake activity, volcanic eruptions, and mountain building.

ES-3.5 Analyze surface features of Earth in order to identify geologic processes (including weathering, erosion, deposition, and glaciation) that are likely to have been responsible for their formation.

ES-3.6 Explain how the dynamic nature of the rock cycle accounts for the interrelationships among igneous, sedimentary, and metamorphic rocks.

ES-3.7 Classify minerals and rocks on the basis of their physical and chemical properties and the environment in which they were formed.

ES-3.8 Summarize the formation of ores and fossil fuels and the impact on the environment that the use of these fuels has had.

EARTH SCIENCE

Earth's Atmosphere

Standard ES-4: The student will demonstrate an understanding of the dynamics of Earth's atmosphere.

Indicators

ES-4.1 Summarize the thermal structures, the gaseous composition, and the location of the layers of Earth's atmosphere.
ES-4.2 Summarize the changes in Earth's atmosphere over geologic time (including the importance of photosynthesizing organisms to the atmosphere).
ES-4.3 Summarize the cause and effects of convection within Earth's atmosphere.
ES-4.4 Attribute global climate patterns to geographic influences (including latitude, topography, elevation, and proximity to water).
ES-4.5 Explain the relationship between the rotation of Earth and the pattern of wind belts.
ES-4.6 Summarize possible causes of and evidence for past and present global climate changes.
ES-4.7 Summarize the evidence for the likely impact of human activities on the atmosphere (including ozone holes, greenhouse gases, acid rain, and photochemical smog).
ES-4.8 Predict weather conditions and storms (including thunderstorms, hurricanes, and tornados) on the basis of the relationship among the movement of air masses, high and low pressure systems, and frontal boundaries.

EARTH SCIENCE

Earth's Hydrosphere

Standard ES-5: The student will demonstrate an understanding of Earth's freshwater and ocean systems.

Indicators

ES-5.1 Summarize the location, movement, and energy transfers involved in the movement of water on Earth's surface (including lakes, surface-water drainage basins [watersheds], freshwater wetlands, and groundwater zones).

ES-5.2 Illustrate the characteristics of the succession of river systems.

ES-5.3 Explain how karst topography develops as a result of groundwater processes.

ES-5.4 Compare the physical and chemical properties of seawater and freshwater.

ES-5.5 Explain the results of the interaction of the shore with waves and currents.

ES-5.6 Summarize the advantages and disadvantages of devices used to control and prevent coastal erosion and flooding.

ES-5.7 Explain the effects of the transfer of solar energy and geothermal energy on the oceans of Earth (including the circulation of ocean currents and chemosynthesis).

ES-5.8 Analyze environments to determine possible sources of water pollution (including industrial waste, agriculture, domestic waste, and transportation devices).

EARTH SCIENCE

The Paleobiosphere

Standard ES-6: Students will demonstrate an understanding of the dynamic relationship between Earth's conditions over geologic time and the diversity of its organisms.

Indicators

ES-6.1 Summarize the conditions of Earth that enable the planet to support life.
ES-6.2 Recall the divisions of the geologic time scale and illustrate the changes (in complexity and/or diversity) of organisms that have existed across these time units.
ES-6.3 Summarize how fossil evidence reflects the changes in environmental conditions on Earth over time.
ES-6.4 Match dating methods (including index fossils, ordering of rock layers, and radiometric dating) with the most appropriate application for estimating geologic time.
ES-6.5 Infer explanations concerning the age of the universe and the age of Earth on the basis of scientific evidence.

APPENDIX A

Scientific Inquiry Standards and Indicators
Kindergarten through Grade Twelve

Scientific inquiry standards and indicators will be assessed cumulatively on statewide tests. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—from all their earlier grades. In accordance with that fact, only those tools that have not been identified in the earlier grades are listed at each successive grade level.

K–12 Scientific Inquiry Standards and Indicators
Kindergarten **Standard K-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.** **Indicators** K-1.1 Identify observed objects or events by using the senses. K-1.2 Use tools (including magnifiers and eyedroppers) safely, accurately, and appropriately when gathering specific data. K-1.3 Predict and explain information or events based on observation or previous experience. K-1.4 Compare objects by using nonstandard units of measurement. K-1.5 Use appropriate safety procedures when conducting investigations.
Grade 1 **Standard 1-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.** **Indicators** 1-1.1 Compare, classify, and sequence objects by number, shape, texture, size, color, and motion, using standard English units of measurement where appropriate 1-1.2 Use tools (including rulers) safely, accurately, and appropriately when gathering specific data. 1-1.3 Carry out simple scientific investigations when given clear directions. 1-1.4 Use appropriate safety procedures when conducting investigations.
Grade 2 **Standard 2-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.** **Indicators** 2-1.1 Carry out simple scientific investigations to answer questions about familiar objects and events. 2-1.2 Use tools (including thermometers, rain gauges, balances, and measuring cups) safely, accurately, and appropriately when gathering specific data. 2-1.3 Represent and communicate simple data and explanations through drawings, tables, pictographs, bar graphs, and oral and written language. 2-1.4 Infer explanations regarding scientific observations and experiences. 2-1.5 Use appropriate safety procedures when conducting investigations.
Grade 3 **Standard 3-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific**

investigation.

Indicators

3-1.1 Classify objects by two of their properties (attributes).
3-1.2 Classify objects or events in sequential order.
3-1.3 Generate questions such as "what if?" or "how?" about objects, organisms, and events in the environment and use those questions to conduct a simple scientific investigation.
3-1.4 Predict the outcome of a simple investigation and compare the result with the prediction.
3-1.5 Use tools (including beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes) safely, accurately, and appropriately when gathering specific data.
3-1.6 Infer meaning from data communicated in graphs, tables, and diagrams.
3-1.7 Explain why similar investigations might produce different results.
3-1.8 Use appropriate safety procedures when conducting investigations.

Grade 4

Standard 4-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

4-1.1 Classify observations as either quantitative or qualitative.
4-1.2 Use appropriate instruments and tools (including a compass, an anemometer, mirrors, and a prism) safely and accurately when conducting simple investigations.
4-1.3 Summarize the characteristics of a simple scientific investigation that represent a fair test (including a question that identifies the problem, a prediction that indicates a possible outcome, a process that tests one manipulated variable at a time, and results that are communicated and explained).
4-1.4 Distinguish among observations, predictions, and inferences.
4-1.5 Recognize the correct placement of variables on a line graph.
4-1.6 Construct and interpret diagrams, tables, and graphs made from recorded measurements and observations.
4-1.7 Use appropriate safety procedures when conducting investigations.

Grade 5

Standard 5-1: The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

Indicators

5-1.1 Identify questions suitable for generating a hypothesis.
5-1.2 Identify independent (manipulated), dependent (responding), and controlled variables in an experiment.
5-1.3 Plan and conduct controlled scientific investigations, manipulating one variable at a time.
5-1.4 Use appropriate tools and instruments (including a timing device and a 10x magnifier) safely and accurately when conducting a controlled scientific investigation.
5-1.5 Construct a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables.
5-1.6 Evaluate results of an investigation to formulate a valid conclusion based on evidence and communicate the findings of the evaluation in oral or written form.
5-1.7 Use a simple technological design process to develop a solution or a product, communicating the design by using descriptions, models, and drawings.
5-1.8 Use appropriate safety procedures when conducting investigations.

K–12 Scientific Inquiry Standards and Indicators

Grade 6

Standard 6-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

6-1.1 Use appropriate tools and instruments (including a spring scale, beam balance, barometer, and sling psychrometer) safely and accurately when conducting a controlled scientific investigation.

6-1.2 Differentiate between observation and inference during the analysis and interpretation of data.

6-1.3 Use a technological design process to plan and produce a solution to a problem or a product (including identifying a problem, designing a solution or a product, implementing the design, and evaluating the solution or the product).

6-1.4 Use appropriate safety procedures when conducting investigations.

Grade 7

Standard 7-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

7-1.1 Use appropriate tools and instruments (including a microscope) safely and accurately when conducting a controlled scientific investigation.

7-1.2 Generate questions that can be answered through scientific investigation.

7-1.3 Explain the reasons for testing one independent variable at a time in a controlled scientific investigation.

7-1.4 Explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation.

scientific

Grade 3

Standard 3-1: The student will demonstrate an understanding of scientific inquiry (including the processes, skills, and mathematical thinking necessary to conduct a simple investigation. (Inquiry)

Indicators

3-1.1 Classify objects by two properties (attributes).

3-1.2 Classify objects or events in sequential order.

3-1.3 Generate questions ("what if" or "how") about objects, organisms, and events in the environment that will be used to conduct a simple investigation.

3-1.4 Predict the outcome of a simple investigation and compare the result with the prediction.

3-1.5 Use tools including beakers, meter tapes and sticks, forceps/tweezers, tuning forks, and graduated cylinders/syringes safely, accurately, and as appropriate for gathering specific data.

3-1.6 Infer from data communicated in graphs, tables, and diagrams.

3-1.7 Explain why similar investigations might produce different results

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stigations.

8-1.3 Construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation.

8-1.4 Generate questions for further study on the basis of prior investigations.

8-1.5 Explain the importance of and requirements for replication of scientific investigations.

8-1.6 Use appropriate tools and instruments (including convex lenses, plane mirrors, color filters, prisms, and slinky springs) safely and accurately when conducting a controlled scientific investigation.

8-1.7 Use appropriate safety procedures when conducting investigations.

Physical Science

Standard PS-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

PS-1.1 Generate hypotheses on the basis of credible, accurate, and relevant sources of scientific information.

K–12 Scientific Inquiry Standards and Indicators

PS-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
PS-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
PS-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
PS-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas and dimensional analysis), graphs, models, and/or technology.
PS-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
PS-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
PS-1.8 Compare the processes of scientific investigation and technological design.
PS-1.9 Use appropriate safety procedures when conducting investigations.

Biology

Standard B-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

B-1.1 Generate hypotheses based on credible, accurate, and relevant sources of scientific information.
B-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
B-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
B-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
B-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics, graphs, models, and/or technology.
B-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
B-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
B-1.8 Compare the processes of scientific investigation and technological design.
B-1.9 Use appropriate safety procedures when conducting investigations.

K–12 Scientific Inquiry Standards and Indicators

Chemistry

Standard C-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

C-1.1 Apply established rules for significant digits, both in reading a scientific instrument and in calculating a derived quantity from measurement.

C-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

C-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

C-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

C-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas, scientific notation, and dimensional analysis), graphs, models, and/or technology.

C-1.6 Evaluate the results of a scientific investigation in terms of whether they verify or refute the hypothesis and what the possible sources of error are.

C-1.7 Evaluate a technological design or product on the basis of designated criteria.

C-1.8 Use appropriate safety procedures when conducting investigations.

Physics

Standard P-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

P-1.1 Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.

P-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

P-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

P-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

P-1.5 Organize and interpret the data from a controlled scientific investigation by using (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.

P-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

P-1.7 Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.

P-1.8 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

P-1.9 Communicate and defend a scientific argument or conclusion.

P-1.10 Use appropriate safety procedures when conducting investigations.

Earth Science

Standard ES-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

K–12 Scientific Inquiry Standards and Indicators	
ES-1.1	Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.
ES-1.2	Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
ES-1.3	Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
ES-1.4	Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
ES-1.5	Organize and interpret the data from a controlled scientific investigation by using mathematics (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.
ES-1.6	Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
ES-1.7	Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.
ES-1.8	Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
ES-1.9	Communicate and defend a scientific argument or conclusion.
ES-1.10	Use appropriate safety procedures when conducting investigations.

APPENDIX B

Revised Bloom's Taxonomy

In 1956, Benjamin Bloom and his colleagues published the *Taxonomy of Educational Objectives: The Classification of Educational Goals*, a groundbreaking book that classified educational goals according to the cognitive processes that learners must use in order to attain those goals. The work, which was enthusiastically received, was utilized by teachers to analyze learning in the classroom for nearly fifty years.

However, research during that time span generated new ideas and information about how learners learn and how teachers teach. Education practice is very different today. Even the measurement of achievement has changed; teachers now live in a standards-based world defined by state accountability systems.

In order to reflect the new data and insights about teaching and learning that the past forty-five years of research have yielded—and to refocus educators' attention on the value of the original Bloom's taxonomy—Lorin Anderson and David Krathwohl led a team of colleagues in revising and enhancing that system to make it more usable for aligning standards, instruction, and assessment in today's schools. The results of their work were published in 2001 as *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (New York: Allyn and Bacon)—a book that is important to educators because it provides the common understanding of expectations that is critical for improving student achievement in all subjects.

The revised taxonomy is two-dimensional, identifying both the kind of knowledge to be learned (knowledge dimension) and the kind of learning expected from students (cognitive processes) to help teachers and administrators improve alignment and rigor in the classroom. This taxonomy will assist educators to improve instruction, to ensure that their lessons and assessments are aligned with one another and with the state standards, that their lessons are cognitively rich, and that instructional opportunities are not missed.

Science goes well beyond simple recognition and the memorization of facts that many people mistake for scientific literacy. Therefore, many of the main verbs in the indicators of the South Carolina science standards reflect the cognitive processes described in the revised Bloom's taxonomy under the category *understand*. This category requires *interpreting, exemplifying, classifying, summarizing, inferring, comparing,* and *explaining* from students—understanding rather than rote memorization of materials. Students might have to *compare* two organisms or *explain* how variations in habitats affect the survival of an organism. Several indicators require students to demonstrate two even higher categories of cognitive processes—*analyze* and *evaluate*—by *organizing* and *critiquing* data and/or the results of scientific investigation, for example.

Tables 1 and 2 on the following pages are reproduced from Anderson and Krathwohl's *Taxonomy for Learning, Teaching, and Assessing,* pages 46 and 67, respectively. Table 3, "A Taxonomy for Teaching, Learning, and Assessing," describes both dimensions of the taxonomy: types and subtypes of knowledge described in table 1 and the cognitive categories and processes described in table 2. This matrix is provided as a template for teachers to use in analyzing their instruction as they seek to align standards, units/lessons/activities, and assessments. Examples and more information about specific uses of the matrix can be found in the *Taxonomy for Learning.*

Table 1: The Knowledge Dimension		
MAJOR TYPES AND SUBTYPES		**EXAMPLES**
A. FACTUAL KNOWLEDGE—The basic elements students must know to be acquainted with a discipline or solve problems in it		
AA.	Knowledge of terminology	Technical vocabulary, musical symbols
AB.	Knowledge of specific details and elements	Major natural resources, reliable sources of information
B. CONCEPTUAL KNOWLEDGE—The interrelationships among the basic elements within a larger structure that enable them to function together		
BA.	Knowledge of classifications and categories	Periods of geological time, forms of business ownership
BB.	Knowledge of principles and generalizations	Pythagorean theorem, law of supply and demand
BC.	Knowledge of theories, models, and structures	Theory of evolution, structure of Congress
C. PROCEDURAL KNOWLEDGE—How to do something, methods and inquiry, and criteria for using skills, algorithms, techniques, and methods		
CA.	Knowledge of subject-specific skills and algorithms	Skills used in painting with watercolors, whole-number division algorithm
CB.	Knowledge of subject-specific techniques and methods	Interviewing techniques, scientific method
CC.	Knowledge of criteria for determining when to use appropriate procedures	Criteria used to determine when to apply a procedure involving Newton's second law, criteria used to judge the feasibility of using a particular method to estimate business costs
D. METACOGNITIVE KNOWLEDGE—Knowledge of cognition in general as well as awareness and knowledge of one's own cognition		
DA.	Strategic knowledge	Knowledge of outlining as a means of capturing the structure of a unit of subject matter in a textbook, knowledge of the use of heuristics
DB.	Knowledge about cognitive tasks including appropriate contextual and conditional knowledge	Knowledge of the types of tests particular teachers administer, knowledge of the cognitive demands of different tasks
DC.	Self-knowledge	Knowledge that critiquing essays is a personal strength, whereas writing essays is a personal weakness; awareness of one's own knowledge level

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Table 2: The Cognitive Process Dimension		
CATEGORIES & COGNITIVE PROCESSES	**ALTERNATIVE NAMES**	**DEFINITIONS AND EXAMPLES**
1. REMEMBER—Retrieve relevant knowledge from long-term memory		
1.1 RECOGNIZING	Identifying	Locating knowledge in long-term memory that is consistent with presented material (e.g., Recognize the dates of important events in United States history)
1.2 RECALLING	Retrieving	Retrieving relevant knowledge from long-term memory (e.g., Recall the dates of important events in United States history)
2. UNDERSTAND—Construct meaning from instructional messages including oral, written, and graphic communication		
2.1 INTERPRETING	Clarifying, paraphrasing, representing, translating	Changing from one form of representation (e.g., numerical) to another (e.g., verbal) (e.g., Paraphrase important speeches and documents)
2.2 EXEMPLIFYING	Illustrating, instantiating	Finding a specific example or illustration of a concept or principle (e.g., Give examples of various artistic painting styles)
2.3 CLASSIFYING	Categorizing, subsuming	Determining that something belongs to a category (e.g., Classify observed or described cases of mental disorders)
2.4 SUMMARIZING	Abstracting, generalizing	Abstracting a general theme or major point(s) (e.g., Write a short summary of events portrayed on a videotape)
2.5 INFERRING	Concluding, extrapolating, interpolating, predicting	Drawing a logical conclusion from presented information (e.g., In learning a foreign language, infer grammatical principles from examples)
2.6 COMPARING	Contrasting, mapping, matching	Detecting correspondences between two ideas, objects, and the like (e.g., Compare historical events to contemporary situations)
2.7 EXPLAINING	Constructing models	Constructing a cause-and-effect model of a system (e.g., Explain the causes of important 18th Century events in France)
3. APPLY—Carry out or use a procedure in a given situation		
3.1 EXECUTING	Carrying out	Applying a procedure to a familiar task (e.g., Divide one whole number by another whole number, both with multiple digits)
3.2 IMPLEMENTING	Using	Applying a procedure to an unfamiliar task (e.g., Use Newton's Second Law in situations in which it is appropriate)

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Table 2: The Cognitive Process Dimension		
CATEGORIES & COGNITIVE PROCESSES	**ALTERNATIVE NAMES**	**DEFINITIONS AND EXAMPLES**
4. ANALYZE—Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose		
4.1 DIFFERENTIATING	Discriminating, distinguishing, focusing, selecting	Distinguishing relevant from irrelevant parts or important from unimportant parts of presented material (e.g., Distinguish between relevant and irrelevant numbers in a mathematical word problem)
4.2 ORGANIZING	Finding coherence, integrating, outlining, parsing, structuring	Determining how elements fit or function within a structure (e.g., Structure evidence in a historical description into evidence for and against a particular historical explanation)
4.3 ATTRIBUTING	Deconstructing	Determine a point of view, bias, values, or intent underlying presented material (e.g., Determine the point of view of the author of an essay in terms of his or her political perspective)
5. EVALUATE—Make judgments based on criteria and standards		
5.1 CHECKING	Coordinating, detecting, monitoring, testing	Detecting inconsistencies or fallacies within a process or product; determining whether a process or product has internal consistency; detecting the effectiveness of a procedure as it is being implemented (e.g., Determine if a scientist's conclusions follow from observed data)
5.2 CRITIQUING	Judging	Detecting inconsistencies between a product and external criteria, determining whether a product has external consistency; detecting the appropriateness of a procedure for a given problem (e.g., Judge which of two methods is the best way to solve a given problem)
6. CREATE—Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure		
6.1 GENERATING	Hypothesizing	Coming up with alternative hypotheses based on criteria (e.g., Generate hypotheses to account for an observed phenomenon)
6.2 PLANNING	Designing	Devising a procedure for accomplishing some task (e.g., Plan a research paper on a given historical topic)
6.3 PRODUCING	Constructing	Inventing a product (e.g., Build habitats for a specific purpose)

Table 3: A Taxonomy for Teaching, Learning, and Assessing

THE KNOWLEDGE DIMENSION	THE COGNITIVE PROCESS DIMENSION					
	1. Remember—Retrieve relevant knowledge from long-term memory 1.1 Recognizing 1.2 Recalling	**2. Understand**—Construct meaning from instructional messages including oral, written, and graphic communication 2.1 Interpreting 2.2 Exemplifying 2.3 Classifying 2.4 Summarizing 2.5 Inferring 2.6 Comparing 2.7 Explaining	**3. Apply**—Carry out or use a procedure in a given situation 3.1 Executing 3.2 Implementing	**4. Analyze**—Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose 4.1 Differentiating 4.2 Organizing 4.3 Attributing	**5. Evaluate**—Make judgments based on criteria and standards 5.1 Checking 5.2 Critiquing	**6. Create**—Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure 6.1 Generating 6.2 Planning 6.3 Producing
A. Factual Knowledge—The basic elements that students must know to be acquainted with a discipline or solve problems in it AA. Knowledge of terminology AB. Knowledge of specific details and elements						
B. Conceptual Knowledge—The interrelationships among the basic elements within a larger structure that enable them to function together BA. Knowledge of classifications and categories BB. Knowledge of principles and generalizations BC. Knowledge of theories, models, and structures						
C. Procedural Knowledge—How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods CA. Knowledge of subject-specific skills and algorithms CB. Knowledge of subject-specific techniques and methods CC. Knowledge of criteria for determining when to use appropriate procedures						
D. Metacognitive Knowledge—Knowledge of cognition in general as well as awareness of one's own cognition DA. Strategic knowledge DB. Knowledge about cognitive tasks (including appropriate contextual and conditional knowledge DC. Self-knowledge						

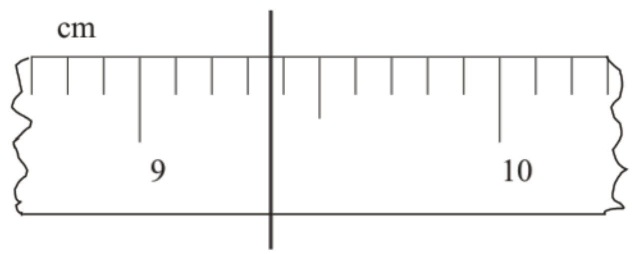
APPENDIX C

Science Standards Glossary

Some of the terms and phrases that are used in the science standards have multiple definitions or interpretations. In any case, the definition of scientific terms should be refined as students become more cognitively adept. In the classroom, teachers should use the definition most appropriate for the immediate context—particular students, grade level, and subject area.

The following definitions explain certain key terms that are not specifically defined within the text of the standards or the indicators:

Glossary	
abiotic	A term that refers to nonliving factors in the environment such as light and temperature.
accuracy	The degree to which the reading from a scientific instrument agrees with an accepted value. The accuracy of a scientific measuring tool can be checked by ensuring that the instrument reads *zero* when it should and by comparing the reading of the instrument to an established standard.
biotic	A term that refers to living organisms or to something that is produced or caused by living organisms. Antonym *abiotic*.
conceptual	A term that places the emphasis on scientific concepts rather than on mathematical relationships.
controlled scientific investigation	An experiment in which the variables are managed so that the results of the experiment will be reliable.
dependent variable	The respondent or outcome variable in an investigation; the variable that the experimenter hypothesizes will be affected by manipulations in the independent variable.
derived quantity	A quantity that has a unit that is a combination of base units. Grams and milliliters are base units (for mass and volume respectively). Density is a derived quantity because the units for density are grams per milliliter (g/ml).
dimensional analysis	A method for converting a given result from one unit of measure to another unit of measure (e.g., if one wishes to convert the length of a line from centimeters to meters).
fair test	An experiment in which only one variable is manipulated.
hypothesis	A prediction based on observations and inferences that may be tested by one or more experiments.

Glossary	
independent variable	The manipulated variable in an investigation; the variable the experimenter hypothesizes will affect the dependent variable.
precision	The degree to which an instrument can be read with certainty plus one final digit, which is uncertain (estimate). All measurements in science should be recorded to include all digits including the estimated digit. On the metric ruler below, the distance between the markings is 0.1 cm. In order to correctly represent this measurement, to the precision of the instrument, one might write 9.37 cm or 9.38 cm (or whatever is judged to be closest); thus the 0.01 cm place is uncertain. 
qualitative	A term that refers to the nature—the characteristics and attributes—of a substance, object, or event rather than the amount.
quantitative	A term that refers to measurement or amount rather than to characteristics or attributes.
representative elements	The elements in groups 1–2 and 13–18 on the periodic table. These elements are also known as the “main group” elements because they represent the entire range of chemical properties and a wide range of physical properties.
simple investigation	An experiment with a single independent and dependent variable.

SOUTH CAROLINA ACADEMIC STANDARDS AND PERFORMANCE INDICATORS FOR SCIENCE

Mick Zais, Ph.D.
State Superintendent of Education

South Carolina Department of Education
Columbia, South Carolina

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Contents

Academic Standards and Performance Indicators for Science

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SOUTH CAROLINA DEPARTMENT OF EDUCATION

The academic standards and performance indicators included in this document were revised under the direction of Charmeka Bosket Childs, Deputy Superintendent, Division of School Effectiveness, Dr. Briana Timmerman, Director, Office of Instructional Practices and Evaluations, and Cathy Jones Stork, Team Leader, Office of Instructional Practices and Evaluations.

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INTRODUCTION

Science is a way of understanding the physical universe using observation and experimentation to explain natural phenomena. Science also refers to an organized body of knowledge that includes core ideas to the disciplines and common themes that bridge the disciplines. This document, *South Carolina Academic Standards and Performance Indicators for Science*, contains the academic standards in science for the state's students in kindergarten through grade twelve.

ACADEMIC STANDARDS

In accordance with the South Carolina Education Accountability Act of 1998 (S.C. Code Ann. § 59-18-110), the purpose of academic standards is to provide the basis for the development of local curricula and statewide assessment. Consensually developed academic standards describe for each grade and high school core area the specific areas of student learning that are considered the most important for proficiency in the discipline at the particular level.

Operating procedures for the review and revision of all South Carolina academic standards were jointly developed by staff at the State Department of Education (SCDE) and the Education Oversight Committee (EOC). According to these procedures, a field review of the first draft of the revised South Carolina science standards was conducted from March through May 2013. Feedback from that review and input from the SCDE and EOC review panels was considered and used to develop these standards.

The academic standards in this document are not sequenced for instruction and do not prescribe classroom activities; materials; or instructional strategies, approaches, or practices. The *South Carolina Academic Standards and Performance Indicators for Science* is not a curriculum.

STATEWIDE ASSESSMENT

The science standards and performance indicators for grades three through eight will be used as the basis for the development and/or refinement of questions on the South Carolina Palmetto Assessment of State Standards (SC-PASS) in science. The SC-PASS is based on the broad standards that address the life, earth, and physical science core content at each grade level. Test questions will measure the practice and/or the core content of the performance indicator. In addition, most performance indicators may be assessed with items that utilize any of the science and engineering practices. For example, an assessment item for a performance indicator that requires students to *construct explanations* may also ask students to use other practices such as *asking questions, using models*, or *analyzing data* around the core content in the original indicator. Items may also assess students' understanding of the core content without a science and engineering practice.

The high school course standards and performance indicators for Biology 1 will be used as the basis for the state-required End-of-Course Examination Program (EOCEP) for Biology 1.

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Science Curriculum Support Document

The SCDE will develop a support document after these standards have been adopted by the State Board of Education. Local districts, schools and teachers may use that document to construct standards-based science curriculum, allowing them to add or expand topics they feel are important and to organize content to fit their students' needs and match available instructional materials. The support document will include suggested resources, instructional strategies, essential knowledge, and assessment recommendations.

Crosscutting Concepts

Seven common threads or themes are presented in *A Framework for K-12 Science Education* (2012). These concepts connect knowledge across the science disciplines (biology, chemistry, physics, earth and space science) and have value to both scientists and engineers because they identify universal properties and processes found in all disciplines. These crosscutting concepts are:

1. Patterns
2. Cause and Effect: Mechanism and Explanation
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter: Flows, Cycles, and Conservation
6. Structure and Function
7. Stability and Change

These concepts should not to be taught in isolation but reinforced in the context of instruction within the core science content for each grade level or course.

Science and Engineering Practices

In addition to the academic standards, each grade level or high school course explicitly identifies *Science and Engineering Practice* standards, with indicators that are differentiated across grade levels and core areas. The term "practice" is used instead of the term "skill," to emphasize that scientists and engineers use skill and knowledge simultaneously, not in isolation. These eight science and engineering practices are:

1. Ask questions and define problems
2. Develop and use models
3. Plan and conduct investigations
4. Analyze and interpret data
5. Use mathematical and computational thinking
6. Construct explanations and design solutions
7. Engage in scientific argument from evidence
8. Obtain, evaluate, and communicate information

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade levels and courses. It is critical that educators understand that the Science and Engineering Practices are <u>*not*</u> to be taught in isolation. There should <u>*not*</u> be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed <u>*within the content*</u> for each grade level or course.

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Additionally, an important component of all scientists and engineers' work is communicating their results both by informal and formal speaking and listening, and formal reading and writing. Speaking, listening, reading and writing is important not only for the purpose of sharing results, but because during the processes of reading, speaking, listening and writing, scientists and engineers continue to construct their own knowledge and understanding of meaning and implications of their research. Knowing how one's results connect to previous results and what those connections reveal about the underlying principles is an important part of the scientific discovery process. Therefore, students should similarly be reading, writing, speaking and listening throughout the scientific processes in which they engage.

STRUCTURE OF THE STANDARDS DOCUMENT

The organization and structure of this standards document includes:

- **Grade Level Overview**: An overview that describes the specific content and themes for each grade level and/or high school course.

- **Academic Standard**: Statements of the most important, consensually determined expectations for student learning in a particular discipline. In South Carolina, academic standards are specified for kindergarten through grade eight and for the following high school courses: biology, chemistry, physics, and earth science.

- **Conceptual Understanding**: Statements of the core ideas for which students should demonstrate an understanding. Some grade level topics include more than one conceptual understanding with each building upon the intent of the standard.

- **Performance Indicator**: Statements of what students can do to demonstrate knowledge of the conceptual understanding. Each performance indicator includes a specific science and engineering practice paired with the content knowledge and skills that students should demonstrate to meet the grade level or high school course standards.

- The term *including* appears in parenthetical statements in the performance indicators. It is used to introduce a list of specified components for an indicator that are critical for a specific grade level or course with regard to the state assessments and the management of instructional time. Teachers should focus instruction on the entire indicator including the instructional components specified in the parenthetical statements. The phrase *such as* also appears in parenthetical statements in the performance indicators and provides potential examples to help frame, but not limit, the learning.

RESOURCES

The SCDE, in partnership with SEDL, developed the *Academic Standards and Performance Indicators for Science* utilizing a number of resources. Central among these resources were the *South Carolina Science Academic Standards 2005*. Other resources include:

American Association for the Advancement of Science, 2001. *Atlas of Science Literacy*. Washington, D.C.: Project 2061 and the National Science Teachers Association.

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American Association for the Advancement of Science. 2009. *Benchmarks for Science Literacy.* Project 2061. Available at http://www.project2061.org/publications/bsl/online/index.php.

College Board. 2009. *Science College Board Standards for College Success*. Available at http://professionals.collegeboard.com/profdownload/cbscs-science-standards-2009.pdf.

Duschl, Richard A., Heidi A. Schweingruber, and Andrew W. Shouse. *Taking Science to School: Learning and Teaching Science in Grades K-8*. Washington, D.C.: National Academies, 2007.

Lerner, L.S., Goodenough, U., Lynch, J. Schwartz, M. and Schwartz, R. 2012. *The State of State Science Standards 2012*. Available at: http://www.edexcellence.net/publications/the-state-of-state-science-standards-2012.html.

Michaels, Sarah, Andrew W. Shouse, and Heidi A. Schweingruber. *Ready, Set, Science! Putting Research to Work in K-8 Science Classrooms*. Washington, D.C.: National Academies, 2008.

National Research Council. 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, D.C.: National Academies Press.

National Assessment Governing Board. 2010. *Science Framework for the 2011 National Assessment of Educational Progress.* Washington, D.C.: U.S. Dept. of Education.

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KINDERGARTEN OVERVIEW

In kindergarten through grade two, the standards and performance indicators for the science and engineering practices and core science content emphasize students making observations and explanations about phenomena they can directly explore and investigate. Student experiences should be structured as they begin to learn the features of a scientific investigation and engage in the practices of science and engineering. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

These academic standards and performance indicators establish the practices and core content that South Carolina's students should know and be able to do by the end of kindergarten.

The three core areas of the kindergarten standards include:

- Exploring Organisms and the Environment
- Exploring Weather Patterns
- Exploring Properties of Objects and Materials

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed *within the content* for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety of learning experiences, materials, and instructional strategies that accommodate a broad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with materials and equipment necessary to complete scientific investigations.

The academic standards and performance indicators for kindergarten should be the basis for the development of classroom and grade-level assessments. Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future learning in science.

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KINDERGARTEN
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard K.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

K.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

K.P.1A.1 Ask and answer questions about the natural world using explorations, observations, or structured investigations.

K.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.

K.P.1A.3 With teacher guidance, conduct structured investigations to answer scientific questions, test predictions and develop explanations: (1) predict possible outcomes, (2) identify materials and follow procedures, (3) use appropriate tools or instruments to make qualitative observations and take nonstandard measurements, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

K.P.1A.4 Analyze and interpret data from observations, measurements, or investigations to understand patterns and meanings.

K.P.1A.5 Use mathematical thinking to (1) recognize and express quantitative observations, (2) collect and analyze data, or (3) understand patterns and relationships.

K.P.1A.6 Construct explanations of phenomena using (1) student-generated observations and measurements, (2) results of investigations, or (3) data communicated in graphs, tables, or diagrams.

K.P.1A.7 Construct scientific arguments to support explanations using evidence from observations or data collected.

K.P.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions about the natural world, (2) understand phenomena, (3) develop models, or (4) support explanations. Communicate observations and explanations using oral and written language.

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K.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

K.P.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem, and (6) communicate the results.

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KINDERGARTEN
LIFE SCIENCE: EXPLORING ORGANISMS AND THE ENVIRONMENT

Standard K.L.2: The student will demonstrate an understanding of organisms found in the environment and how these organisms depend on the environment to meet those needs.

K.L.2A. Conceptual Understanding: The environment consists of many types of organisms including plants, animals, and fungi. Organisms depend on the land, water, and air to live and grow. Plants need water and light to make their own food. Fungi and animals cannot make their own food and get energy from other sources. Animals (including humans) use different body parts to obtain food and other resources needed to grow and survive. Organisms live in areas where their needs for air, water, nutrients, and shelter are met.

Performance Indicators: Students who demonstrate this understanding can:

K.L.2A.1 Obtain information to answer questions about different organisms found in the environment (such as plants, animals, or fungi).

K.L.2A.2 Conduct structured investigations to determine what plants need to live and grow (including water and light).

K.L.2A.3 Develop and use models to exemplify how animals use their body parts to (1) obtain food and other resources, (2) protect themselves, and (3) move from place to place.

K.L.2A.4 Analyze and interpret data to describe how humans use their senses to learn about the world around them.

K.L.2A.5 Construct explanations from observations of what animals need to survive and grow (including air, water, nutrients, and shelter).

K.L.2A.6 Obtain and communicate information about the needs of organisms to explain why they live in particular areas.

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KINDERGARTEN
EARTH SCIENCE: EXPLORING WEATHER PATTERNS

Standard K.E.3: The student will demonstrate an understanding of daily and seasonal weather patterns.

K.E.3A. Conceptual Understanding: Weather is a combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. Scientists measure weather conditions to describe and record the weather and to notice patterns over time. Plants and animals (including humans) respond to different weather conditions in different ways.

Performance Indicators: Students who demonstrate this understanding can:

K.E.3A.1 Analyze and interpret local weather condition data (including precipitation, wind, temperature, and cloud cover) to describe weather patterns that occur from day to day, using simple graphs and pictorial weather symbols.

K.E.3A.2 Develop and use models to predict seasonal weather patterns and changes.

K.E.3A.3 Obtain and communicate information to support claims about how changes in seasons affect plants and animals.

K.E.3A.4 Define problems caused by the effects of weather on human activities and design solutions or devices to solve the problem.

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KINDERGARTEN
PHYSICAL SCIENCE: EXPLORING PROPERTIES OF OBJECTS AND MATERIALS

Standard K.P.4: The student will demonstrate an understanding of the observable properties of matter.

K.P.4A. Conceptual Understanding: Objects can be described and classified by their observable properties, by their uses, and by whether they occur naturally or are manufactured (human-made). Different properties of objects are suited for different purposes.

Performance Indicators: Students who demonstrate this understanding can:

K.P.4A.1 Analyze and interpret data to compare the qualitative properties of objects (such as size, shape, color, texture, weight, flexibility, attraction to magnets, or ability to sink or float) and classify objects based on similar properties.

K.P.4A.2 Develop and use models to describe and compare the properties of different materials (including wood, plastic, metal, cloth, and paper) and classify materials by their observable properties, by their uses, and by whether they are natural or human-made.

K.P.4A.3 Conduct structured investigations to answer questions about which materials have the properties that are best suited to solve a problem or need.

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GRADE 1 OVERVIEW

In kindergarten through grade two, the standards and performance indicators for the science and engineering practices and core science content emphasize students making observations and explanations about phenomena they can directly explore and investigate. Student experiences should be structured as they begin to learn the features of a scientific investigation and engage in the practices of science and engineering. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

These academic standards and performance indicators establish the practices and core content that South Carolina's students should know and be able to do by the end of grade one.

The four core areas of the grade one standards include:

- Exploring Light and Shadows
- Exploring the Sun and Moon
- Earth's Natural Resources
- Plants and Their Environments

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are ***not*** to be taught in isolation. There should ***not*** be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety experiences, materials, and instructional strategies that accommodate a broad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with the materials and equipment necessary to complete scientific investigations.

The academic standards and performance indicators for grade one should be the basis for the development of classroom and grade-level assessments. Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future science learning.

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GRADE ONE
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard 1.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

1.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

1.P.1A.1 Ask and answer questions about the natural world using explorations, observations, or structured investigations.

1.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.

1.P.1A.3 With teacher guidance, conduct structured investigations to answer scientific questions, test predictions and develop explanations: (1) predict possible outcomes, (2) identify materials and follow procedures, (3) use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

1.P.1A.4 Analyze and interpret data from observations, measurements, or investigations to understand patterns and meanings.

1.P.1A.5 Use mathematical and computational thinking to (1) recognize and express quantitative observations, (2) collect and analyze data, or (3) understand patterns and relationships.

1.P.1A.6 Construct explanations of phenomena using (1) student-generated observations and measurements, (2) results of scientific investigations, or (3) data communicated in graphs, tables, or diagrams.

1.P.1A.7 Construct scientific arguments to support claims or explanations using evidence from observations or data collected.

1.P.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions about the natural world, (2) understand phenomena, (3) develop models, or (4) support explanations. Communicate observations and explanations clearly through oral and written language.

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1.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

1.P.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem, and (6) communicate the results.

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Grade One

Physical Science: Exploring Light and Shadows

Standard 1.P.2: The student will demonstrate an understanding of the properties of light and how shadows are formed.

1.P.2A. Conceptual Understanding: Objects can only be seen when light shines on them. Some materials allow light to pass through them; others allow only some light to pass through; and some do not allow any light to pass through and will create a shadow of the object. Technology such as mirrors can change the direction of a beam of light.

Performance Indicators: Students who demonstrate this understanding can:

1.P.2A.1 Obtain and communicate information to describe how light is required to make objects visible.

1.P.2A.2 Analyze and interpret data from observations to compare how light behaves when it shines on different materials.

1.P.2A.3 Conduct structured investigations to answer questions about how shadows change when the position of the light source changes.

1.P.2A.4 Develop and use models to describe what happens when light shines on mirrors based on observations and data collected.

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Grade One

Earth Science: Exploring the Sun and Moon

Standard 1.E.3: The student will demonstrate an understanding of the patterns of the Sun and the Moon and the Sun's effect on Earth.

1.E.3A. Conceptual Understanding: Objects in the sky move in predictable patterns. Some objects are better seen in the day sky and some are better seen in the night sky. The Sun is a star that provides heat and light energy for Earth.

Performance Indicators: Students who demonstrate this understanding can:

1.E.3A.1 Analyze and interpret data from observations to describe and predict seasonal patterns of sunrise and sunset.

1.E.3A.2 Develop and use models to exemplify how the appearance of the Moon changes over time in a predictable pattern.

1.E.3A.3 Obtain and communicate information to describe how technology has enabled the study of the Sun, the Moon, planets, and stars.

1.E.3A.4 Conduct structured investigations to answer questions about the effect of sunlight on Earth's surface.

1.E.3A.5 Define problems related to the warming effect of sunlight and design possible solutions to reduce its impact on a particular area.

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Grade One
Earth Science: Earth's Natural Resources

Standard 1.E.4: The student will demonstrate an understanding of the properties and uses of Earth's natural resources.

1.E.4A. Conceptual Understanding: Earth is made of different materials, including rocks, sand, soil, and water. An Earth material is a resource that comes from Earth. Earth materials can be classified by their observable properties.

Performance Indicators: Students who demonstrate this understanding can:

1.E.4A.1 Analyze and interpret data from observations and measurements to compare the properties of Earth materials (including rocks, soils, sand, and water).

1.E.4A.2 Develop and use models (such as drawings or maps) to describe patterns in the distribution of land and water on Earth and classify bodies of water (including oceans, rivers and streams, lakes, and ponds).

1.E.4A.3 Conduct structured investigations to answer questions about how the movement of water can change the shape of the land.

1.E.4B. Conceptual Understanding: Natural resources are things that people use that come from Earth (such as land, water, air, and trees). Natural resources can be conserved.

Performance Indicators: Students who demonstrate this understanding can:

1.E.4B.1 Obtain and communicate information to summarize how natural resources are used in different ways (such as soil and water to grow plants; rocks to make roads, walls, or buildings; or sand to make glass).

1.E.4B.2 Obtain and communicate information to explain ways natural resources can be conserved (such as reducing trash through reuse, recycling, or replanting trees).

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Grade One

Life Science: Plants and Their Environments

Standard 1.L.5: The student will demonstrate an understanding of how the structures of plants help them survive and grow in their environments.

1.L.5A. Conceptual Understanding: Plants have specific structures that help them survive, grow, and produce more plants. Plants have predictable characteristics at different stages of development.

Performance Indicators: Students who demonstrate this understanding can:

1.L.5A.1 Obtain and communicate information to construct explanations for how different plant structures (including roots, stems, leaves, flowers, fruits, and seeds) help plants survive, grow, and produce more plants.

1.L.5A.2 Construct explanations of the stages of development of a flowering plant as it grow from a seed using observations and measurements.

1.L.5B. Conceptual Understanding: Plants have basic needs that provide energy in order to grow and be healthy. Each plant has a specific environment where it can thrive. There are distinct environments in the world that support different types of plants. These environments can change slowly or quickly. Plants respond to these changes in different ways.

Performance Indicators: Students who demonstrate this understanding can:

1.L.5B.1 Conduct structured investigations to answer questions about what plants need to live and grow (including air, water, sunlight, minerals, and space).

1.L.5B.2 Develop and use models to compare how the different characteristics of plants help them survive in distinct environments (including deserts, forests, and grasslands).

1.L.5B.3 Analyze and interpret data from observations to describe how changes in the environment cause plants to respond in different ways (such as turning leaves toward the Sun, leaves changing color, leaves wilting, or trees shedding leaves).

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GRADE 2 OVERVIEW

In kindergarten through grade two, the standards and performance indicators for the science and engineering practices and core science content emphasize students making observations and explanations about phenomena they can directly explore and investigate. Student experiences should be structured as they begin to learn the features of a scientific investigation and engage in the practices of science and engineering. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

These academic standards and performance indicators establish the practices and core content that South Carolina's students should know and be able to do by the end of grade two.

The four core areas of the grade two standards include:

- Weather
- Properties of Solids and Liquids
- Exploring Pushes and Pulls
- Animals and Their Environments

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed *within the content* for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety experiences, materials, and instructional strategies that accommodate abroad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with the materials and equipment necessary to complete scientific investigations.

The academic standards and performance indicators for grade two should be the basis for the development of classroom and grade-level assessments. Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future science learning when students will be formally assessed at the state-level.

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Grade Two
Science and Engineering Practices

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

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Standard 2.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

2.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

2.P.1A.1 Ask and answer questions about the natural world using explorations, observations, or structured investigations.

2.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.

2.P.1A.3 With teacher guidance, conduct structured investigations to answer scientific questions, test predictions and develop explanations: (1) predict possible outcomes, (2) identify materials and follow procedures, (3) use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

2.P.1A.4 Analyze and interpret data from observations, measurements, or investigations to understand patterns and meanings.

2.P.1A.5 Use mathematical and computational thinking to (1) express quantitative observations using appropriate English or metric units, (2) collect and analyze data, or (3) understand patterns, trends and relationships.

2.P.1A.6 Construct explanations of phenomena using (1) student-generated observations and measurements, (2) results of scientific investigations, or (3) data communicated in graphs, tables, or diagrams.

2.P.1A.7 Construct scientific arguments to support claims or explanations using evidence from observations or data collected.

2.P.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions about the natural world, (2) understand phenomena, (3) develop models, or (4) support explanations. Communicate observations and explanations using oral and written language.

2.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

2.P.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem, and (6) communicate the results.

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GRADE TWO
EARTH SCIENCE: WEATHER

Standard 2.E.2: The student will demonstrate an understanding of the daily and seasonal weather patterns.

2.E.2A. Conceptual Understanding: Weather is the combination of sunlight, wind, precipitation (rain, sleet, snow, and hail), and temperature in a particular region at a particular time. Scientists measure and record these conditions to describe the weather and to identify patterns over time. Weather scientists (meteorologists) forecast severe weather so that communities can prepare for and respond to these events.

Performance Indicators: Students who demonstrate this understanding can:

2.E.2A.1 Analyze and interpret data from observations and measurements to describe local weather conditions (including temperature, wind, and forms of precipitation).

2.E.2A.2 Analyze local weather data to predict daily and seasonal patterns over time.

2.E.2A.3 Develop and use models to describe and compare the effects of wind (moving air) on objects.

2.E.2A.4 Obtain and communicate information about severe weather conditions to explain why certain safety precautions are necessary.

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Grade Two
Physical Science: Properties of Solids and Liquids

Standard 2.P.3: The student will demonstrate an understanding of the observable properties of solids and liquids and the special properties of magnets.

2.P.3A. Conceptual Understanding: Solids and liquids are two forms of matter that have distinct observable properties. Some matter can be mixed together and then separated again. Solids and liquids can be changed from one form to another when heat is added or removed.

Performance Indicators: Students who demonstrate this understanding can:

2.P.3A.1 Analyze and interpret data from observations and measurements to describe the properties used to classify matter as a solid or a liquid.

2.P.3A.2 Develop and use models to exemplify how matter can be mixed together and separated again based on the properties of the mixture.

2.P.3A.3 Conduct structured investigations to test how adding or removing heat can cause changes in solids and liquids.

2.P.3A.4 Construct scientific arguments using evidence from investigations to support claims that some changes in solids or liquids are reversible and some are not when heat is added or removed.

2.P.3B. Conceptual Understanding: Magnets are a specific type of solid that can attract and repel certain other kinds of materials, including other magnets. There are some materials that are neither attracted to nor repelled by magnets. Because of their special properties, magnets are used in various ways.

Performance Indicators: Students who demonstrate this understanding can:

2.P.3B.1 Conduct structured investigations to answer questions about how the poles of magnets attract and repel each other.

2.P.3B.2 Analyze and interpret data from observations to compare the effects of magnets on various materials.

2.P.3B.3 Obtain and communicate information to exemplify the uses of magnets in everyday life.

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Grade Two
Physical Science: Exploring Pushes and Pulls

Standard 2.P.4: The student will demonstrate an understanding of the effects of pushes, pulls, and friction on the motion of objects.

2.P.4A. Conceptual Understanding: An object that is not moving will only move if it is pushed or pulled. Pushes and pulls can vary in strength and direction and can affect the motion of an object. Gravity is a pull that makes objects fall to the ground. Friction is produced when two objects come in contact with each other and can be reduced if needed.

Performance Indicators: Students who demonstrate this understanding can:

2.P.4A.1 Analyze and interpret data from observations and measurements to compare the effects of different strengths and directions of pushing and pulling on the motion of an object.

2.P.4A.2 Develop and use models to exemplify the effects of pushing and pulling on an object.

2.P.4A.3 Construct explanations of the relationship between the motion of an object and the pull of gravity using observations and data collected.

2.P.4A.4 Conduct structured investigations to answer questions about the relationship between friction and the motion of objects.

2.P.4A.5 Define problems related to the effects of friction and design possible solutions to reduce the effects on the motion of an object.

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GRADE TWO

LIFE SCIENCE: ANIMALS AND THEIR ENVIRONMENTS

Standard 2.L.5: The student will demonstrate an understanding of how the structures of animals help them survive and grow in their environments.

2.L.5A. Conceptual Understanding: There are many different groups of animals. One way to group animals is by using their physical characteristics. Animals have basic needs that provide for energy, growth, reproduction, and protection. Animals have predictable characteristics at different stages of development.

Performance Indicators: Students who demonstrate this understanding can:

2.L.5A.1 Obtain and communicate information to classify animals (such as mammals, birds, amphibians, reptiles, fish, or insects) based on their physical characteristics.

2.L.5A.2 Construct explanations for how structures (including structures for seeing, hearing, grasping, protection, locomotion, and obtaining and using resources) of different animals help them survive.

2.L.5A.3 Construct explanations using observations and measurements of an animal as it grows and changes to describe the stages of development of the animal.

2.L.5B. Conceptual Understanding: Animals (including humans) require air, water, food, and shelter to survive in environments where these needs can be met. There are distinct environments in the world that support different types of animals. Environments can change slowly or quickly. Animals respond to these changes in different ways.

Performance Indicators: Students who demonstrate this understanding can:

2.L.5B.1 Obtain and communicate information to describe and compare how animals interact with other animals and plants in the environment.

2.L.5B.2 Develop and use models to exemplify characteristics of animals that help them survive in distinct environments (such as salt and freshwater, deserts, forests, wetlands, or polar lands).

2.L.5B.3 Analyze and interpret data from observations to describe how animals respond to changes in their environment (such as changes in food availability, water, or air).

2.L.5B.4 Construct scientific arguments to explain how animals can change their environments (such as the shape of the land or the flow of water).

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GRADE 3 OVERVIEW

In grades three through five, the standards and performance indicators for the science and engineering practices and core science content emphasize students becoming more sophisticated in describing, representing or explaining concepts or ideas. Students use their experiences from structured investigations in kindergarten through grade two to begin planning their own investigations to answer scientific questions. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

These academic standards and performance indicators establish the practices and core content that South Carolina’s students should know and be able to do by the end of grade three.

The four core areas of the grade three standards include:

- Properties and Changes in Matter
- Energy Transfer – Electricity and Magnetism
- Earth’s Materials and Resources
- Environments and Habitats

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are ***not*** to be taught in isolation. There should ***not*** be a distinct “Inquiry” unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety of experiences, materials, and instructional strategies that accommodate a broad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with the materials and equipment necessary to complete scientific investigations.

The academic standards and performance indicators for grade three should be the basis for the development of classroom and grade-level assessments. In addition, these standards and performance indicators will be the basis for the development of items on the state-required South Carolina Palmetto Assessment of State Standards (SC-PASS). Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future science learning.

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GRADE THREE
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard 3.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

3.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

3.P.1A.1 Ask questions that can be (1) answered using scientific investigations or (2) used to refine models, explanations, or designs.

3.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.

3.P.1A.3 Plan and conduct scientific investigations to answer questions, test predictions and develop explanations: (1) formulate scientific questions and predict possible outcomes, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

3.P.1A.4 Analyze and interpret data from observations, measurements, or investigations to understand patterns and meanings.

3.P.1A.5 Use mathematical and computational thinking to (1) express quantitative observations using appropriate English or metric units, (2) collect and analyze data, or (3) understand patterns, trends and relationships.

3.P.1A.6 Construct explanations of phenomena using (1) 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.

3.P.1A.7 Construct scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

3.P.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language.

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3.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

3.P.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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Grade Three
Physical Science: Properties and Changes in Matter

Standard 3.P.2: The student will demonstrate an understanding of the properties used to classify matter and how heat energy can change matter from one state to another.

3.P.2A. Conceptual Understanding: Matter exists in several different states and is classified based on observable and measurable properties. Matter can be changed from one state to another when heat (thermal energy) is added or removed.

Performance Indicators: Students who demonstrate this understanding can:

3.P.2A.1 Analyze and interpret data from observations and measurements to describe and compare the physical properties of matter (including length, mass, temperature, and volume of liquids).

3.P.2A.2 Construct explanations using observations and measurements to describe how matter can be classified as a solid, liquid or gas.

3.P.2A.3 Plan and conduct scientific investigations to determine how changes in heat (increase or decrease) change matter from one state to another (including melting, freezing, condensing, boiling, and evaporating).

3.P.2A.4 Obtain and communicate information to compare how different processes (including burning, friction, and electricity) serve as sources of heat energy.

3.P.2A.5 Define problems related to heat transfer and design devices or solutions that facilitate (conductor) or inhibit (insulator) the transfer of heat.

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GRADE THREE

PHYSICAL SCIENCE: ENERGY TRANSFER – ELECTRICITY AND MAGNETISM

Standard 3.P.3: The student will demonstrate an understanding of how electricity transfers energy and how magnetism can result from electricity.

3.P.3A. Conceptual Understanding: Energy can be transferred from place to place by electric currents. Electric currents flowing through a simple circuit can be used to produce motion, sound, heat, or light. Some materials allow electricity to flow through a circuit and some do not.

Performance Indicators: Students who demonstrate this understanding can:

3.P.3A.1 Obtain and communicate information to develop models showing how electrical energy can be transformed into other forms of energy (including motion, sound, heat, or light).

3.P.3A.2 Develop and use models to describe the path of an electric current in a complete simple circuit as it accomplishes a task (such as lighting a bulb or making a sound).

3.P.3A.3 Analyze and interpret data from observations and investigations to classify different materials as either an insulator or conductor of electricity.

3.P.3B. Conceptual Understanding: Magnets can exert forces on other magnets or magnetizable materials causing energy transfer between them, even when the objects are not touching. An electromagnet is produced when an electric current passes through a coil of wire wrapped around an iron core. Magnets and electromagnets have unique properties.

Performance Indicators: Students who demonstrate this understanding can:

3.P.3B.1 Develop and use models to describe and compare the properties of magnets and electromagnets (including polarity, attraction, repulsion, and strength).

3.P.3B.2 Plan and conduct scientific investigations to determine the factors that affect the strength of an electromagnet.

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GRADE THREE
EARTH SCIENCE: EARTH'S MATERIALS AND PROCESSES

Standard 3.E.4: The student will demonstrate an understanding of the composition of Earth and the processes that shape features of Earth's surface.

3.E.4A. Conceptual Understanding: Earth is made of materials (including rocks, minerals, soil, and water) that have distinct properties. These materials provide resources for human activities.

Performance Indicators: Students who demonstrate this understanding can:

3.E.4A.1 Analyze and interpret data from observations and measurements to describe and compare different Earth materials (including rocks, minerals, and soil) and classify each type of material based on its distinct physical properties.

3.E.4A.2 Develop and use models to describe and classify the pattern distribution of land and water features on Earth.

3.E.4A.3 Obtain and communicate information to exemplify how humans obtain, use, and protect renewable and nonrenewable Earth resources.

3.E.4B. Conceptual Understanding: Earth's surface has changed over time by natural processes and by human activities. Humans can take steps to reduce the impact of these changes.

Performance Indicators: Students who demonstrate this understanding can:

3.E.4B.1 Develop and use models to describe the characteristics of Earth's continental landforms and classify landforms as volcanoes, mountains, valleys, canyons, plains, and islands.

3.E.4B.2 Plan and conduct scientific investigations to determine how natural processes (including weathering, erosion, and gravity) shape Earth's surface.

3.E.4B.3 Obtain and communicate information to explain how natural events (such as fires, landslides, earthquakes, volcanic eruptions, or floods) and human activities (such as farming, mining, or building) impact the environment.

3.E.4B.4 Define problems caused by a natural event or human activity and design devices or solutions to reduce the impact on the environment.

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GRADE THREE
LIFE SCIENCE: ENVIRONMENTS AND HABITATS

Standard 3.L.5: The student will demonstrate an understanding of how the characteristics and changes in environments and habitats affect the diversity of organisms.

3.L.5A. Conceptual Understanding: The characteristics of an environment (including physical characteristics, temperature, availability of resources, or the kinds and numbers of organisms present) influence the diversity of organisms that live there. Organisms can survive only in environments where their basic needs are met. All organisms need energy to live and grow. This energy is obtained from food. The role an organism serves in an ecosystem can be described by the way in which it gets its energy.

Performance Indicators: Students who demonstrate this understanding can:

3.L.5A.1 Analyze and interpret data about the characteristics of environments (including salt and fresh water, deserts, grasslands, forests, rain forests, and polar lands) to describe how the environment supports a variety of organisms.

3.L.5A.2 Develop and use a food chain model to classify organisms as producers, consumers, and decomposers and to describe how organisms obtain energy.

3.L.5B. Conceptual Understanding: When the environment or habitat changes, some plants and animals survive and reproduce, some move to new locations, and some die. Fossils can be used to infer characteristics of environments from long ago.

Performance Indicators: Students who demonstrate this understanding can:

3.L.5B.1 Obtain and communicate information to explain how changes in habitats (such as those that occur naturally or those caused by organisms) can be beneficial or harmful to the organisms that live there.

3.L.5B.2 Develop and use models to explain how changes in a habitat cause plants and animals to respond in different ways (such as hibernating, migrating, responding to light, death, or extinction).

3.L.5B.3 Construct scientific arguments using evidence from fossils of plants and animals that lived long ago to infer the characteristics of early environments.

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GRADE 4 OVERVIEW

In grades three through five, the standards and performance indicators for the science and engineering practices and core science content emphasize students becoming more sophisticated in describing, representing or explaining concepts or ideas. Students use their experiences from structured investigations in kindergarten through grade two to begin planning their own investigations to answer scientific questions. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

These academic standards and performance indicators establish the practices and core content for that South Carolina's students should know and be able to do by the end of grade four.

The four core areas of the grade four standards include:

- Weather and Climate
- Stars and the Solar System
- Forms of Energy – Light and Sound
- Characteristics and Growth of Organisms

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are ***not*** to be taught in isolation. There should ***not*** be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety of experiences, materials, and instructional strategies that accommodate a broad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with the materials and equipment necessary to complete scientific investigations.

The academic standards and performance indicators for grade four should be the basis for the development of classroom and grade-level assessments. In addition, these standards and performance indicators will be the basis for the development of items on the state-required South Carolina Palmetto Assessment of State Standards (SC-PASS). Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future science learning.

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GRADE FOUR
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard 4.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

4.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

4.P.1A.1 Ask questions that can be (1) answered using scientific investigations or (2) used to refine models, explanations, or designs.

4.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.

4.P.1A.3 Plan and conduct scientific investigations to answer questions, test predictions and develop explanations: (1) formulate scientific questions and predict possible outcomes, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

4.P.1A.4 Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation or graphing) to (1) reveal patterns and construct meaning or (2) support explanations, claims, or designs.

4.P.1A.5 Use mathematical and computational thinking to (1) express quantitative observations using appropriate English or metric units, (2) collect and analyze data, or (3) understand patterns, trends and relationships between variables.

4.P.1A.6 Construct explanations of phenomena using (1) 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.

4.P.1A.7 Construct scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

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4.P.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language.

4.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

4.P.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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GRADE FOUR
EARTH SCIENCE: WEATHER AND CLIMATE

Standard 4.E.2: The student will demonstrate an understanding of the water cycle and weather and climate patterns.

4.E.2A. Conceptual Understanding: Earth's atmosphere is a mixture of gases, including water vapor and oxygen. The movement of water, which is found almost everywhere on Earth including the atmosphere, changes form and cycles between Earth's surface and the air and back again. This cycling of water is driven by energy from the Sun. The movement of water in the water cycle is a major pattern that influences weather conditions. Clouds form during this cycle and various types of precipitation result.

Performance Indicators: Students who demonstrate this understanding can:

4.E.2A.1 Obtain and communicate information about some of the gases in the atmosphere (including oxygen, nitrogen, and water vapor) to develop models that exemplify the composition of Earth's atmosphere where weather takes place.

4.E.2A.2 Develop and use models to explain how water changes as it moves between the atmosphere and Earth's surface during each phase of the water cycle (including evaporation, condensation, precipitation, and runoff).

4.E.2B. Conceptual Understanding: Scientists record patterns in weather conditions across time and place to make predictions about what kind of weather might occur next. Climate describes the range of an area's typical weather conditions and the extent to which those conditions vary over long periods of time. Some weather conditions lead to severe weather phenomena that have different effects and safety concerns.

Performance Indicators: Students who demonstrate this understanding can:

4.E.2B.1 Analyze and interpret data from observations, measurements, and weather maps to describe patterns in local weather conditions (including temperature, precipitation, wind speed/direction, relative humidity, and cloud types) and predict changes in weather over time.

4.E.2B.2 Obtain and communicate information about severe weather phenomena (including thunderstorms, hurricanes, and tornadoes) to explain steps humans can take to reduce the impact of severe weather phenomena.

4.E.2B.3 Construct explanations about regional climate differences using data from the long term weather conditions of the region.

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GRADE FOUR

EARTH SCIENCE: STARS AND THE SOLAR SYSTEM

Standard 4.E.3: The student will demonstrate an understanding of the locations, movements, and patterns of stars and objects in the solar system.

4.E.3A. Conceptual Understanding: Astronomy is the study of objects in our solar system and beyond. A solar system includes a sun, (star), and all other objects that orbit that sun. Planets in our night sky change positions and are not always visible from Earth as they orbit our Sun. Stars that are beyond the solar system can be seen in the night sky in patterns called constellations. Constellations can be used for navigation and appear to move together across the sky because of Earth's rotation.

Performance Indicators: Students who demonstrate this understanding can:

4.E.3A.1 Develop and use models of Earth's solar system to exemplify the location and order of the planets as they orbit the Sun and the main composition (rock or gas) of the planets.

4.E.3A.2 Obtain and communicate information to describe how constellations (including Ursa Major, Ursa Minor, and Orion) appear to move from Earth's perspective throughout the seasons.

4.E.3A.3 Construct scientific arguments to support claims about the importance of astronomy in navigation and exploration (including the use of telescopes, astrolabes, compasses, and sextants).

4.E.3B. Conceptual Understanding: Earth orbits around the Sun and the Moon orbits around Earth. These movements together with the rotation of Earth on a tilted axis result in patterns that can be observed and predicted.

Performance Indicators: Students who demonstrate this understanding can:

4.E.3B.1 Analyze and interpret data from observations to describe patterns in the (1) location, (2) movement, and (3) appearance of the Moon throughout the year.

4.E.3B.2 Construct explanations of how day and night result from Earth's rotation on its axis.

4.E.3B.3 Construct explanations of how the Sun appears to move throughout the day using observations of shadows.

4.E.3B.4 Develop and use models to describe the factors (including tilt, revolution, and angle of sunlight) that result in Earth's seasonal changes.

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GRADE FOUR
PHYSICAL SCIENCE: FORMS OF ENERGY – LIGHT AND SOUND

Standard 4.P.4: The student will demonstrate an understanding of the properties of light and sound as forms of energy.

4.P.4A. Conceptual Understanding: Light, as a form of energy, has specific properties including color and brightness. Light travels in a straight line until it strikes an object. The way light reacts when it strikes an object depends on the object's properties.

Performance Indicators: Students who demonstrate this understanding can:

4.P.4A.1 Construct scientific arguments to support the claim that white light is made up of different colors.

4.P.4A.2 Analyze and interpret data from observations and measurements to describe how the apparent brightness of light can vary as a result of the distance and intensity of the light source.

4.P.4A.3 Obtain and communicate information to explain how the visibility of an object is related to light.

4.P.4A.4 Develop and use models to describe how light travels and interacts when it strikes an object (including reflection, refraction, and absorption) using evidence from observations.

4.P.4A.5 Plan and conduct scientific investigations to explain how light behaves when it strikes transparent, translucent, and opaque materials.

4.P.4B. Conceptual Understanding: Sound, as a form of energy, is produced by vibrating objects and has specific properties including pitch and volume. Sound travels through air and other materials and is used to communicate information in various forms of technology.

Performance Indicators: Students who demonstrate this understanding can:

4.P.4B.1 Plan and conduct scientific investigations to test how different variables affect the properties of sound (including pitch and volume).

4.P.4B.2 Analyze and interpret data from observations and measurements to describe how changes in vibration affects the pitch and volume of sound.

4.P.4B.3 Define problems related to the communication of information over a distance and design devices or solutions that use sound to solve the problem.

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GRADE FOUR

LIFE SCIENCE: CHARACTERISTICS AND GROWTH OF ORGANISMS

Standard 4.L.5: The student will demonstrate an understanding of how the structural characteristics and traits of plants and animals allow them to survive, grow, and reproduce.

4.L.5A. Conceptual Understanding: Scientists have identified and classified many types of plants and animals. Each plant or animal has a unique pattern of growth and development called a life cycle. Some characteristics (traits) that organisms have are inherited and some result from interactions with the environment.

Performance Indicators: Students who demonstrate this understanding can:

4.L.5A.1 Obtain and communicate information about the characteristics of plants and animals to develop models which classify plants as flowering or nonflowering and animals as vertebrate or invertebrate.

4.L.5A.2 Analyze and interpret data from observations and measurements to compare the stages of development of different seed plants.

4.L.5A.3 Develop and use models to compare the stages of growth and development in various animals.

4.L.5A.4 Construct scientific arguments to support claims that some characteristics of organisms are inherited from parents and some are influenced by the environment.

4.L.5B. Conceptual Understanding: Plants and animals have physical characteristics that allow them to receive information from the environment. Structural adaptations within groups of plants and animals allow them to better survive and reproduce.

Performance Indicators: Students who demonstrate this understanding can:

4.L.5B.1 Develop and use models to compare how humans and other animals use their senses and sensory organs to detect and respond to signals from the environment.

4.L.5B.2 Construct explanations for how structural adaptations (such as the types of roots, stems, or leaves; color of flowers; or seed dispersal) allow plants to survive and reproduce.

4.L.5B.3 Construct explanations for how structural adaptations (such as methods for defense, locomotion, obtaining resources, or camouflage) allow animals to survive in the environment.

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GRADE 5 OVERVIEW

In grades three through five, the standards and performance indicators for the science and engineering practices and core science content emphasize students becoming more sophisticated in describing, representing or explaining concepts or ideas. Students use their experiences from structured investigations in kindergarten through grade two to begin planning their own investigations to answer scientific questions. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

These academic standards and performance indicators establish the practices and core content that South Carolina's students should know and be able to do by the end of grade five.

The four core areas of the grade five standards include:

- Matter and Mixtures
- Changes in Landforms and Oceans
- Forces and Motion
- Interdependent Relationships in Ecosystems

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are ***not*** to be taught in isolation. There should ***not*** be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety of experiences, materials, and instructional strategies that accommodate a broad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with the materials and equipment necessary to complete scientific investigations

The academic standards and performance indicators for grade five should be the basis for the development of classroom and grade-level assessments. In addition, these standards and performance indicators will be the basis for the development of items on the state-required South Carolina Palmetto Assessment of State Standards (SC-PASS). Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future science learning.

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GRADE FIVE
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard 5.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

5.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

5.P.1A.1 Ask questions used to (1) generate hypotheses for scientific investigations or (2) refine models, explanations, or designs.

5.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.

5.P.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses and predictions, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

5.P.1A.4 Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation or graphing) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs.

5.P.1A.5 Use mathematical and computational thinking to (1) express quantitative observations using appropriate metric units, (2) collect and analyze data, or (3) understand patterns, trends and relationships between variables.

5.P.1A.6 Construct explanations of phenomena using (1) 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.

5.P.1A.7 Construct scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

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5.P.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support hypotheses, explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language.

5.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

5.P.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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Grade Five
Physical Science: Matter and Mixtures

Standard 5.P.2: The student will demonstrate an understanding of the physical properties of matter and mixtures.

5.P.2A. Conceptual Understanding: Matter is made up of particles that are too small to be seen. Even though the particles are very small, the movement and spacing of these particles determines the basic properties of matter.

Performance Indicators: Students who demonstrate this understanding can:

5.P.2A.1 Analyze and interpret data from observations and measurements of the physical properties of matter (including volume, shape, movement, and spacing of particles) to explain why matter can be classified as a solid, liquid or gas.

5.P.2B. Conceptual Understanding: A mixture is formed when two or more kinds of matter are put together. Sometimes when two or more different substances are mixed together, a new substance with different properties may be formed but the total amount (mass) of the substances is conserved. Solutions are a special type of mixture in which one substance is dissolved evenly into another substance. When the physical properties of the components in a mixture are not changed, they can be separated in different physical ways.

Performance Indicators: Students who demonstrate this understanding can:

5.P.2B.1 Obtain and communicate information to describe what happens to the properties of substances when two or more substances are mixed together.

5.P.2B.2 Analyze and interpret data to support claims that when two substances are mixed the total amount (mass) of the substances does not change.

5.P.2B.3 Develop models using observations to describe mixtures, including solutions, based on their characteristics.

5.P.2B.4 Construct explanations for how the amount of solute and the solvent determine the concentration of a solution.

5.P.2B.5 Conduct controlled scientific investigations to test how different variables (including temperature change, particle size, and stirring) affect the rate of dissolving.

5.P.2B.6 Design and test the appropriate method(s) (such as filtration, sifting, attraction to magnets, evaporation, chromatography, or floatation) for separating various mixtures.

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Grade Five

Earth Science: Changes in Landforms and Oceans

Standard 5.E.3: The student will demonstrate an understanding of how natural processes and human activities affect the features of Earth's landforms and oceans.

5.E.3A. Conceptual Understanding: Some of the land on Earth is located above water and some is located below the oceans. The downhill movement of water as it flows to the ocean shapes the appearance of the land. There are patterns in the location and structure of landforms found on the continents and those found on the ocean floor.

Performance Indicators: Students who demonstrate this understanding can:

5.E.3A.1 Construct explanations of how different landforms and surface features result from the location and movement of water on Earth's surface through watersheds (drainage basins) and rivers.

5.E.3A.2 Develop and use models to describe and compare the characteristics and locations of the landforms on continents with those on the ocean floor (including the continental shelf and slope, the mid-ocean ridge, the rift zone, the trench, and the abyssal plain).

5.E.3B. Conceptual Understanding: Earth's oceans and landforms can be affected by natural processes in various ways. Humans cannot eliminate natural hazards caused by these processes but can take steps to reduce their impacts. Human activities can affect the land and oceans in positive and negative ways.

Performance Indicators: Students who demonstrate this understanding can:

5.E.3B.1 Analyze and interpret data to describe and predict how natural processes (such as weathering, erosion, deposition, earthquakes, tsunamis, hurricanes, or storms) affect Earth's surface.

5.E.3B.2 Develop and use models to explain the effect of the movement of ocean water (including waves, currents, and tides) on the ocean shore zone (including beaches, barrier islands, estuaries, and inlets).

5.E.3B.3 Construct scientific arguments to support claims that human activities (such as conservation efforts or pollution) affect the land and oceans of Earth.

5.E.3B.4 Define problems caused by natural processes or human activities and test possible solutions to reduce the impact on landforms and the ocean shore zone.

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GRADE FIVE
LIFE SCIENCE: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

Standard 5.L.4: The student will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems.

5.L.4A. Conceptual Understanding: Ecosystems are complex, interactive systems that include both the living components (biotic factors) and physical components (abiotic factors) of the environment. Ecosystems can be classified as either terrestrial (such as forests, wetlands, and grasslands) or aquatic (such as oceans, estuaries, lakes, and ponds).

Performance Indicators: Students who demonstrate this understanding can:

5.L.4A.1 Analyze and interpret data to summarize the abiotic factors (including quantity of light and water, range of temperature, salinity, and soil composition) of different terrestrial ecosystems and aquatic ecosystems.

5.L.4A.2 Obtain and communicate information to describe and compare the biotic factors (including individual organisms, populations, and communities) of different terrestrial and aquatic ecosystems.

5.L.4B. Conceptual Understanding: All organisms need energy to live and grow. Energy is obtained from food. The role an organism serves in an ecosystem can be described by the way in which it gets its energy. Energy is transferred within an ecosystem as organisms produce, consume, or decompose food. A healthy ecosystem is one in which a diversity of life forms are able to meet their needs in a relatively stable web of life.

Performance Indicators: Students who demonstrate this understanding can:

5.L.4B.1 Analyze and interpret data to explain how organisms obtain their energy and classify an organisms as producers, consumers (including herbivore, carnivore, and omnivore), or decomposers (such as fungi and bacteria).

5.L.4B.2 Develop and use models of food chains and food webs to describe the flow of energy in an ecosystem.

5.L.4B.3 Construct explanations for how organisms interact with each other in an ecosystem (including predators and prey, and parasites and hosts).

5.L.4B.4 Construct scientific arguments to explain how limiting factors (including food, water, space, and shelter) or a newly introduced organism can affect an ecosystem.

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GRADE FIVE
PHYSICAL SCIENCE: FORCES AND MOTION

Standard 5.P.5: The student will demonstrate an understanding of the factors that affect the motion of an object.

5.P.5A. Conceptual Understanding: The motion of an object can be described in terms of its position, direction, and speed. The rate and motion of an object is determined by multiple factors.

Performance Indicators: Students who demonstrate this understanding can:

5.P.5A.1 Use mathematical and computational thinking to describe and predict the motion of an object (including position, direction, and speed).

5.P.5A.2 Develop and use models to explain how the amount or type of force (contact and non-contact) affects the motion of an object.

5.P.5A.3 Plan and conduct controlled scientific investigations to test the effects of balanced and unbalanced forces on the rate and direction of motion of objects.

5.P.5A.4 Analyze and interpret data to describe how a change of force, a change in mass, or friction affects the motion of an object.

5.P.5A.5 Design and test possible devices or solutions that reduce the effects of friction on the motion of an object.

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GRADE 6 OVERVIEW

In grades six through eight, the standards and performance indicators for the science and engineering practices and core science content, transition students to developing and planning controlled investigations to create more explicit and detailed models and explanations. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom. Science in the middle school provides students with the foundation to be successful in high school science courses, by providing a range of content in the life, earth, and physical sciences.

These academic standards and performance indicators establish the practices and core content that South Carolina's students should know and be able to do by the end of grade six.

The four core areas of the grade six standards include:

- Earth's Weather and Climate
- Energy Transfer and Conservation
- Diversity of Life – Classification and Animals
- Diversity of Life – Protists, Fungi, and Plants

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are ***not*** to be taught in isolation. There should ***not*** be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety of experiences, materials, and instructional strategies that accommodate a broad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with the materials and equipment necessary to complete scientific investigations

The academic standards and performance indicators for grade six should be the basis for the development of classroom and grade-level assessments. In addition, these standards and performance indicators will be the basis for the development of items on the state-required South Carolina Palmetto Assessment of State Standards (SC-PASS). Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future science courses.

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GRADE SIX

SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard 6.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

6.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

6.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 claims.

6.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.

6.P.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

6.P.1A.4 Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs.

6.P.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) collect and analyze data, (3) express relationships between variables for models and investigations, or (4) use grade-level appropriate statistics to analyze data.

6.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.

6.P.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

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6.P.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.

6.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

6.P.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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GRADE SIX
EARTH SCIENCE: EARTH'S WEATHER AND CLIMATE

Standard 6.E.2: The student will demonstrate an understanding of the interactions within Earth's systems (flow of energy) that regulate weather and climate.

6.E.2A. Conceptual Understanding: Earth's atmosphere, an envelope of gases that surround the planet, makes conditions on Earth suitable for living things and influences weather. Water is always moving between the atmosphere (troposphere) and the surface of Earth as a result of the force of gravity and energy from the Sun. The Sun is the driving energy source for heating Earth and for the circulation of Earth's atmosphere.

Performance Indicators: Students who demonstrate this understanding can:

6.E.2A.1 Develop and use models to exemplify the properties of the atmosphere (including the gases, temperature and pressure differences, and altitude changes) and the relative scale in relation to the size of Earth.

6.E.2A.2 Critically analyze scientific arguments based on evidence for and against how different phenomena (natural and human induced) may contribute to the composition of Earth's atmosphere.

6.E.2A.3 Construct explanations of the processes involved in the cycling of water through Earth's systems (including transpiration, evaporation, condensation and crystallization, precipitation, and downhill flow of water on land).

6.E.2B. Conceptual Understanding: The complex patterns of changes and movement of water in the atmosphere determined by winds, landforms, ocean temperatures and currents, and convection are major determinants of local weather patterns and climate. Technology has enhanced our ability to measure and predict weather patterns.

Performance Indicators: Students who demonstrate this understanding can:

6.E.2B.1 Analyze and interpret data from weather conditions (including wind speed and direction, air temperature, humidity, cloud types, and air pressure), weather maps, satellites, and radar to predict local weather patterns and conditions.

6.E.2B.2 Develop and use models to explain how relationships between the movement and interactions of air masses, high and low pressure systems, and frontal boundaries result in weather conditions and storms (including thunderstorms, hurricanes and tornadoes).

6.E.2B.3 Develop and use models to represent how solar energy and convection impact Earth's weather patterns and climate conditions (including global winds, the jet stream, and ocean currents).

6.E.2B.4 Construct explanations for how climate is determined in an area (including latitude, elevation, shape of the land, distance from water, global winds, and ocean currents).

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GRADE SIX

PHYSICAL SCIENCE: ENERGY TRANSFER AND CONSERVATION

Standard 6.P.3: The student will demonstrate an understanding of the properties of energy, the transfer and conservation of energy, and the relationship between energy and forces.

6.P.3A. Conceptual Understanding: Energy manifests itself in multiple forms, such as mechanical (kinetic energy and potential energy), electrical, chemical, radiant (solar), and thermal energy. According to the principle of conservation of energy, energy cannot be created nor destroyed, but it can be transferred from one place to another and transformed between systems.

Performance Indicators: Students who demonstrate this understanding can:

6.P.3A.1 Analyze and interpret data to describe the properties and compare sources of different forms of energy (including mechanical, electrical, chemical, radiant, and thermal).

6.E.3A.2 Develop and use models to exemplify the conservation of energy as it is transformed from kinetic to potential (gravitational and elastic) and vice versa.

6.P.3A.3 Construct explanations for how energy is conserved as it is transferred and transformed in electrical circuits.

6.P.3A.4 Develop and use models to exemplify how energy stored in electric and magnetic fields is interrelated in electromagnets, generators, and simple electrical motors.

6.P.3A.5 Develop and use models to describe and compare the directional transfer of heat through convection, radiation, and conduction.

6.P.3A.6 Design and test devices that minimize or maximize heat transfer by conduction, convection, or radiation.

6.P.3B. Conceptual Understanding: Energy transfer occurs when two objects interact thereby exerting force on each other. It is the property of an object or a system that enables it to do work (force moving an object over a distance). Machines are governed by this application of energy, work, and conservation of energy.

Performance Indicators: Students who demonstrate this understanding can:

6.P.3B.1 Plan and conduct controlled scientific investigations to provide evidence for how the design of simple machines (including levers, pulleys, inclined planes) helps transfer mechanical energy by reducing the amount of force required to do work.

6.P.3B.2 Design and test solutions that improve the efficiency of a machine by reducing the input energy (effort) or the amount of energy transferred to the surrounding environment as it moves an object.

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GRADE SIX

LIFE SCIENCE: DIVERSITY OF LIFE – CLASSIFICATION AND ANIMALS

Standard 6.L.4: The student will demonstrate an understanding of how scientists classify organisms and how the structures, processes, behaviors, and adaptations of animals allow them to survive.

6.L.4A. Conceptual Understanding: Life is the quality that differentiates living things (organisms) from nonliving objects or those that were once living. All organisms are made up of cells, need food and water, a way to dispose of waste, and an environment in which they can live. Because of the diversity of life on Earth, scientists have developed a way to organize groups of organisms according to their characteristic traits, making it easier to identify and study them.

Performance Indicators: Students who demonstrate this understanding can:

6.L.4A.1 Obtain and communicate information to support claims that living organisms (1) obtain and use resources for energy, (2) respond to stimuli, (3) reproduce, and (4) grow and develop.

6.L.4A.2 Develop and use models to classify organisms based on the current hierarchical taxonomic structure (including the kingdoms of protists, plants, fungi, and animals).

6.L.4B. Conceptual Understanding: The Animal Kingdom includes a diversity of organisms that have many characteristics in common. Classification of animals is based on structures that function in growth, reproduction, and survival. Animals have both structural and behavioral adaptations that increase the chances of reproduction and survival in changing environments.

Performance Indicators: Students who demonstrate this understanding can:

6.L.4B.1 Analyze and interpret data related to the diversity of animals to support claims that all animals (vertebrates and invertebrates) share common characteristics.

6.L.4B.2 Obtain and communicate information to explain how the structural adaptations and processes of animals allow for defense, movement, or resource obtainment.

6.L.4B.3 Construct explanations of how animal responses (including hibernation, migration, grouping, and courtship) to environmental stimuli allow them to survive and reproduce.

6.L.4B.4 Obtain and communicate information to compare and classify innate and learned behaviors in animals.

6.L.4B.5 Analyze and interpret data to compare how endothermic and ectothermic animals respond to changes in environmental temperature.

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GRADE SIX

LIFE SCIENCE: DIVERSITY OF LIFE – PROTISTS, FUNGI AND PLANTS

Standard 6.L.5: The student will demonstrate an understanding of the structures, processes, and responses that allow protists, fungi, and plants to survive and reproduce.

6.L.5A. Conceptual Understanding: The Protist Kingdom is one of the most diverse groups and includes organisms that have characteristics similar to but are not classified as plants, animals, or fungi. These microorganisms live in moist environments and vary in how they obtain energy and move.

Performance Indicators: Students who demonstrate this understanding can:

6.L.5A.1 Analyze and interpret data from observations to compare how the structures of protists (including euglena, paramecium, and amoeba) allow them to obtain energy and move.

6.L.5B. Conceptual Understanding: The Fungi Kingdom consists of organisms that do not make their own food (heterotrophs) but obtain their nutrition through external absorption. Fungi can be grouped by their growth habit or fruiting structure and respond to changes in the environmental stimuli similar to plants.

Performance Indicators: Students who demonstrate this understanding can:

6.L.5B.1 Develop and use models to describe commonly found fungi by growth habit (yeast or filamentous) or fruiting structure (such as mushroom or puffball).

6.L.5B.2 Analyze and interpret data to describe how fungi respond to external stimuli (including temperature, light, touch, water, and gravity).

6.L.5C. Conceptual Understanding: The Plant Kingdom consists of organisms that primarily make their own food (autotrophs) and are commonly classified based on internal structures that function in the transport of food and water. Plants have structural and behavioral adaptations that increase the chances of reproduction and survival in changing environments.

Performance Indicators: Students who demonstrate this understanding can:

6.L.5C.1 Construct explanations of how the internal structures of vascular and nonvascular plants transport food and water.

6.L.5C.2 Analyze and interpret data to explain how the processes of photosynthesis, respiration, and transpiration work together to meet the needs of plants.

6.L.5C.3 Develop and use models to compare structural adaptations and processes that flowering plants use for defense, survival and reproduction.

6.L.5C.4 Plan and conduct controlled scientific investigations to determine how changes in environmental factors (such as air, water, light, minerals, or space) affect the growth and development of a flowering plant.

6.L.5C.5 Analyze and interpret data to describe how plants respond to external stimuli (including temperature, light, touch, water, and gravity).

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GRADE 7 OVERVIEW

In grades six through eight, the standards and performance indicators for the science and engineering practices and core science content, transition students to developing and planning controlled investigations to create more explicit and detailed models and explanations. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom. Science in the middle school provides students with the foundation to be successful in high school science courses, by providing a range of content in the life, earth, and physical sciences.

These academic standards and performance indicators establish the practices and core content that South Carolina's students should know and be able to do by the end of grade seven.

The four core areas of the grade seven standards include:

- Classification and Conservation of Matter
- Organization in Living Systems
- Heredity – Inheritance and Variation of Traits
- Interactions of Living Systems and the Environment

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed *within the content* for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety of experiences, materials, and instructional strategies that accommodate a broad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with the materials and equipment necessary to complete scientific investigations

The academic standards and performance indicators for grade seven should be the basis for the development of classroom and grade-level assessments. In addition, these standards and performance indicators will be the basis for the development of items on the state-required South Carolina Palmetto Assessment of State Standards (SC-PASS). Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future science courses.

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Grade Seven
Science and Engineering Practices

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard 7.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

7.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

7.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 claims.

7.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.

7.P.1A.3 Plan and conduct controlled scientific investigation to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

7.P.1A.4. Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs.

7.P.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) collect and analyze data, (3) express relationships between variables for models and investigations, or (4) use grade-level appropriate statistics to analyze data.

7.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.

7.P.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

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7.P.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.

7.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

7.P.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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GRADE SEVEN

PHYSICAL SCIENCE: CLASSIFICATION AND CONSERVATION OF MATTER

Standard 7.P.2: The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

7.P.2A. Conceptual Understanding: All substances are composed of one or more elements. Elements are pure substances which contain only one kind of atom. The periodic table organizes these elements based on similar properties. Compounds are substances composed of two or more elements. Chemical formulas can be used to describe compounds.

Performance Indicators: Students who demonstrate this understanding can:

7.P.2A.1 Develop and use simple atomic models to illustrate the components of elements (including the relative position and charge of protons, neutrons, and electrons).

7.P.2A.2 Obtain and use information about elements (including chemical symbol, atomic number, atomic mass, and group or family) to describe the organization of the periodic table.

7.P.2A.3 Analyze and interpret data to describe and classify matter as pure substances (elements or compounds) or mixtures (heterogeneous or homogeneous) based on composition.

7.P.2A.4 Construct explanations for how compounds are classified as ionic (metal bonded to nonmetal) or covalent (nonmetals bonded together) using chemical formulas.

7.P.2B. Conceptual Understanding: Substances (such as metals or acids) are identified according to their physical or chemical properties. Changes to substances can either be physical or chemical. Many substances react chemically with other substances to form new substances with different properties. According to the law of conservation of matter, total mass does not change in a chemical reaction.

7.P.2B.1 Analyze and interpret data to describe substances using physical properties (including state, boiling/melting point, density, conductivity, color, hardness, and magnetic properties) and chemical properties (the ability to burn or rust).

7.P.2B.2 Use mathematical and computational thinking to describe the relationship between the mass, volume, and density of a given substance.

7.P.2B.3 Analyze and interpret data to compare the physical properties, chemical properties (neutralization to form a salt, reaction with metals), and pH of various solutions and classify solutions as acids or bases.

7.P.2B.4 Plan and conduct controlled scientific investigations to answer questions about how physical and chemical changes affect the properties of different substances.

7.P.2B.5 Develop and use models to explain how chemical reactions are supported by the law of conservation of matter.

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GRADE SEVEN

LIFE SCIENCE: ORGANIZATION IN LIVING SYSTEMS

Standard 7.L.3: The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.

7.L.3A. Conceptual Understanding: Cells are the most basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular) and require food and water, a way to dispose of waste, and an environment in which they can live in order to survive. Through the use of technology, scientists have discovered special structures within individual cells that have specific functions that allow the cell to grow, survive, and reproduce. Bacteria are one-celled organisms found almost everywhere and can be both helpful and harmful. They can be simply classified by their size, shape and whether or not they can move.

Performance Indicators: Students who demonstrate this understanding can:

7.L.3A.1 Obtain and communicate information to support claims that (1) organisms are made of one or more cells, (2) cells are the basic unit of structure and function of organisms, and (3) cells come only from existing cells.

7.L.3A.2 Analyze and interpret data from observations to describe different types of cells and classify cells as plant, animal, protist, or bacteria.

7.L.3A.3 Develop and use models to explain how the relevant structures within cells (including cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplasts, lysosomes, and vacuoles) function to support the life of plant, animal, and bacterial cells.

7.L.3A.4 Construct scientific arguments to support claims that bacteria are both helpful and harmful to other organisms and the environment.

7.L.3B. Conceptual Understanding: Multicellular organisms (including humans) are complex systems with specialized cells that perform specific functions. Organs and organ systems are composed of cells that function to serve the needs of cells which in turn serve the needs of the organism.

Performance Indicators: Students who demonstrate this understanding can:

7.L.3B.1 Develop and use models to explain how the structural organizations within multicellular organisms function to serve the needs of the organism.

7.L.3B.2 Construct explanations for how systems in the human body (including circulatory, respiratory, digestive, excretory, nervous, and musculoskeletal systems) work together to support the essential life functions of the body.

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GRADE SEVEN

LIFE SCIENCE: HEREDITY – INHERITANCE AND VARIATION OF TRAITS

Standard 7.L.4: The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

7.L.4A. Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicators: Students who demonstrate this understanding can:

7.L.4A.1 Obtain and communicate information about the relationship between genes and chromosomes to construct explanations of their relationship to inherited characteristics.

7.L.4A.2 Construct explanations for how genetic information is transferred from parent to offspring in organisms that reproduce sexually.

7.L.4A.3 Develop and use models (Punnett squares) to describe and predict patterns of the inheritance of single genetic traits from parent to offspring (including dominant and recessive traits, incomplete dominance, and codominance).

7.L.4A.4 Use mathematical and computational thinking to predict the probability of phenotypes and genotypes based on patterns of inheritance.

7.L.4A.5 Construct scientific arguments using evidence to support claims for how changes in genes (mutations) may have beneficial, harmful, or neutral effects on organisms.

7.L.4A.6 Construct scientific arguments using evidence to support claims concerning the advantages and disadvantages of the use of technology (such as selective breeding, genetic engineering, or biomedical research) in influencing the transfer of genetic information.

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Grade Seven

Ecology: Interactions of Living Systems and the Environment

Standard 7.E.5: The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

7.E.5A. Conceptual Understanding: In all ecosystems, organisms and populations of organisms depend on their environmental interactions with other living things (biotic factors) and with physical (abiotic) factors (such as light, temperature, water, or soil quality). Disruptions to any component of an ecosystem can lead to shifts in its diversity and abundance of populations.

Performance Indicators: Students who demonstrate this understanding can:

7.E.5A.1 Develop and use models to describe the characteristics of the levels of organization within ecosystems (including species, populations, communities, ecosystems, and biomes).

7.E.5A.2 Construct explanations of how soil quality (including composition, texture, particle size, permeability, and pH) affects the characteristics of an ecosystem using evidence from soil profiles.

7.E.5A.3 Analyze and interpret data to predict changes in the number of organisms within a population when certain changes occur to the physical environment (such as changes due to natural hazards or limiting factors).

7.E.5B. Conceptual Understanding: Organisms in all ecosystems interact with and depend upon each other. Organisms with similar needs compete for limited resources. Food webs and energy pyramids are models that demonstrate how energy is transferred within an ecosystem.

Performance Indicators: Students who demonstrate this understanding can:

7.E.5B.1 Develop and use models to explain how organisms interact in a competitive or mutually beneficial relationship for food, shelter, or space (including competition, mutualism, commensalism, parasitism, and predator-prey relationships).

7.E.5B.2 Develop and use models (food webs and energy pyramids) to exemplify how the transfer of energy in an ecosystem supports the concept that energy is conserved.

7.E.5B.3 Analyze and interpret data to predict how changes in the number of organisms of one species affects the balance of an ecosystem.

7.E.5B.4 Define problems caused by the introduction of a new species in an environment and design devices or solutions to minimize the impact(s) to the balance of an ecosystem.

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GRADE 8 OVERVIEW

In grades six through eight, the standards and performance indicators for the science and engineering practices and core science content, transition students to developing and planning controlled investigations to create more explicit and detailed models and explanations. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom. Science in the middle school provides students with the foundation to be successful in high school science courses, by providing a range of content in the life, earth, and physical sciences.

These academic standards and performance indicators establish the practices and core content that South Carolina's students should know and be able to do by the end of grade eight.

The five core areas of the grade eight standards include:

- Forces and Motion
- Waves
- Earth's Place in the Universe
- Earth Systems and Resources
- Earth's History and Diversity of Life

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade level. It is critical that educators understand the Science and Engineering Practices are ***not*** to be taught in isolation. There should ***not*** be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to provide a wide variety of experiences, materials, and instructional strategies that accommodate a broad range of individual differences. These standards support active engagement in learning. Classrooms will need to be supplied with the materials and equipment necessary to complete scientific investigations

The academic standards and performance indicators for grade eight should be the basis for the development of classroom and grade-level assessments. In addition, these standards and performance indicators will be the basis for the development of items on the state-required South Carolina Palmetto Assessment of State Standards (SC-PASS). Students must demonstrate knowledge of the science and engineering practices and core content ideas in preparation for future science courses.

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GRADE EIGHT
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected at this grade level. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard 8.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

8.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

8.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 claims.

8.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.

8.P.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

8.P.1A.4 Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs.

8.P.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) collect and analyze data, (3) express relationships between variables for models and investigations, or (4) use grade-level appropriate statistics to analyze data.

8.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.

8.P.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

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8.P.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.

8.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

8.P.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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GRADE EIGHT

PHYSICAL SCIENCE: FORCES AND MOTION

Standard 8.P.2: The student will demonstrate an understanding of the effects of forces on the motion and stability of an object.

8.P.2A. Conceptual Understanding: Motion occurs when there is a change in position of an object with respect to a reference point. The final position of an object is determined by measuring the change in position and direction of the segments along a trip. While the speed of the object may vary during the total time it is moving, the average speed is the result of the total distance divided by the total time taken. Forces acting on an object can be balanced or unbalanced. Varying the amount of force or mass will affect the motion of an object. Inertia is the tendency of objects to resist any change in motion.

Performance Indicators: Students who demonstrate this understanding can:

8.P.2A.1 Plan and conduct controlled scientific investigations to test how varying the amount of force or mass of an object affects the motion (speed and direction), shape, or orientation of an object.

8.P.2A.2 Develop and use models to compare and predict the resulting effect of balanced and unbalanced forces on an object's motion in terms of magnitude and direction.

8.P.2A.3 Construct explanations for the relationship between the mass of an object and the concept of inertia (Newton's First Law of Motion).

8.P.2A.4 Analyze and interpret data to support claims that for every force exerted on an object there is an equal force exerted in the opposite direction (Newton's Third Law of Motion).

8.P.2A.5 Analyze and interpret data to describe and predict the effects of forces (including gravitational and friction) on the speed and direction of an object.

8.P.2A.6 Use mathematical and computational thinking to generate graphs that represent the motion of an object's position and speed as a function of time.

8.P.2A.7 Use mathematical and computational thinking to describe the relationship between the speed and velocity (including positive and negative expression of direction) of an object in determining average speed (v=d/t).

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GRADE EIGHT
PHYSICAL SCIENCE: WAVES

Standard 8.P.3: The student will demonstrate an understanding of the properties and behaviors of waves.

8.P.3A. Conceptual Understanding: Waves (including sound and seismic waves, waves on water, and light waves) have energy and transfer energy when they interact with matter. Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter. All types of waves have some features in common. When waves interact, they superimpose upon or interfere with each other resulting in changes to the amplitude. Major modern technologies are based on waves and their interactions with matter.

Performance Indicators: Students who demonstrate this understanding can:

8.P.3A.1 Construct explanations of the relationship between matter and energy based on the characteristics of mechanical and light waves.

8.P.3A.2 Develop and use models to exemplify the basic properties of waves (including frequency, amplitude, wavelength, and speed).

8.P.3A.3 Analyze and interpret data to describe the behavior of waves (including refraction, reflection, transmission, and absorption) as they interact with various materials.

8.P.3A.4 Analyze and interpret data to describe the behavior of mechanical waves as they intersect.

8.P.3A.5 Construct explanations for how humans see color as a result of the transmission, absorption, and reflection of light waves by various materials.

8.P.3A.6 Obtain and communicate information about how various instruments are used to extend human senses by transmitting and detecting waves (such as radio, television, cell phones, and wireless computer networks) to exemplify how technological advancements and designs meet human needs.

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GRADE EIGHT
EARTH SCIENCE: EARTH'S PLACE IN THE UNIVERSE

Standard 8.E.4: The student will demonstrate an understanding of the universe and the predictable patterns caused by Earth's movement in the solar system.

8.E.4A. Conceptual Understanding: Earth's solar system is part of the Milky Way Galaxy, which is one of many galaxies in the universe. The planet Earth is a tiny part of a vast universe that has developed over a span of time beginning with a period of extreme and rapid expansion.

Performance Indicators: Students who demonstrate this understanding can:

8.E.4A.1 Obtain and communicate information to model the position of the Sun in the universe, the shapes and composition of galaxies, and the measurement unit needed to identify star and galaxy locations.

8.E.4A.2 Construct and analyze scientific arguments to support claims that the universe began with a period of extreme and rapid expansion using evidence from the composition of stars and gases and the motion of galaxies in the universe.

8.E.4B. Conceptual Understanding: Earth's solar system consists of the Sun and other objects that are held in orbit around the Sun by its gravitational pull on them. Motions within the Earth-Moon-Sun system have effects that can be observed on Earth.

Performance Indicators: Students who demonstrate this understanding can:

8.E.4B.1 Obtain and communicate information to model and compare the characteristics and movements of objects in the solar system (including planets, moons, asteroids, comets, and meteors).

8.E.4B.2 Construct explanations for how gravity affects the motion of objects in the solar system and tides on Earth.

8.E.4B.3 Develop and use models to explain how seasons, caused by the tilt of Earth's axis as it orbits the Sun, affects the length of the day and the amount of heating on Earth's surface.

8.E.4B.4 Develop and use models to explain how motions within the Sun-Earth-Moon system cause Earth phenomena (including day and year, moon phases, solar and lunar eclipses, and tides).

8.E.4B.5 Obtain and communicate information to describe how data from technologies (including telescopes, spectroscopes, satellites, space probes) provide information about objects in the solar system and the universe.

8.E.4B.6 Analyze and interpret data from the surface features of the Sun (including photosphere, corona, sunspots, prominences, and solar flares) to predict how these features may affect Earth.

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Grade Eight

Earth Science: Earth Systems and Resources

Standard 8.E.5: The student will demonstrate an understanding of the processes that alter the structure of Earth and provide resources for life on the planet.

8.E.5A. Conceptual Understanding: All Earth processes are the result of energy flowing and matter cycling within and among Earth's systems. Because Earth's processes are dynamic and interactive in nature, the surface of Earth is constantly changing. Earth's hot interior is a main source of energy that drives the cycling and moving of materials. Plate tectonics is the unifying theory that explains the past and current crustal movements at the Earth's surface. This theory provides a framework for understanding geological history.

Performance Indicators: Students who demonstrate this understanding can:

8.E.5A.1 Develop and use models to explain how the processes of weathering, erosion, and deposition change surface features in the environment.

8.E.5A.2 Use the rock cycle model to describe the relationship between the processes and forces that create igneous, sedimentary, and metamorphic rocks.

8.E.5A.3 Obtain and communicate information about the relative position, density, and composition of Earth's layers to describe the crust, mantle, and core.

8.E.5A.4 Construct explanations for how the theory of plate tectonics accounts for (1) the motion of lithospheric plates, (2) the geologic activities at plate boundaries, and (3) the changes in landform areas over geologic time.

8.E.5A.5 Construct and analyze scientific arguments to support claims that plate tectonics accounts for (1) the distribution of fossils on different continents, (2) the occurrence of earthquakes, and (3) continental and ocean floor features (including mountains, volcanoes, faults and trenches).

8.E.5B. Conceptual Understanding: Natural processes can cause sudden or gradual changes to Earth's systems. Some may adversely affect humans such as volcanic eruptions or earthquakes. Mapping the history of natural hazards in a region, combined with an understanding of related geological forces can help forecast the locations and likelihoods of future events.

Performance Indicators: Students who demonstrate this understanding can:

8.E.5B.1 Analyze and interpret data to describe patterns in the location of volcanoes and earthquakes related to tectonic plate boundaries, interactions, and hot spots.

8.E.5B.2 Construct explanations of how forces inside Earth result in earthquakes and volcanoes.

8.E.5B.3 Define problems that may be caused by a catastrophic event resulting from plate movements and design possible devices or solutions to minimize the effects of that event on Earth's surface and/or human structures.

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8.E.5C. Conceptual Understanding: Humans depend upon many Earth resources – some renewable over human lifetimes and some nonrenewable or irreplaceable. Resources are distributed unevenly around the planet as a result of past geological processes.

Performance Indicators: Students who demonstrate this understanding can:

8.E.5C.1 Obtain and communicate information regarding the physical and chemical properties of minerals, ores, and fossil fuels to describe their importance as Earth resources.

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GRADE EIGHT
EARTH SCIENCE: EARTH'S HISTORY AND DIVERSITY OF LIFE

Standard 8.E.6: The student will demonstrate an understanding of Earth's geologic history and its diversity of life over time.

8.E.6A. Conceptual Understanding: The geologic time scale interpreted from rock strata provides a way to organize major historical events in Earth's history. Analysis of rock strata and the fossil record, which documents the existence, diversity, extinction, and change of many life forms throughout history, provide only relative dates, not an absolute scale. Changes in life forms are shaped by Earth's varying geological conditions.

Performance Indicators: Students who demonstrate this understanding can:

8.E.6A.1 Develop and use models to organize Earth's history (including era, period, and epoch) according to the geologic time scale using evidence from rock layers.

8.E.6A.2 Analyze and interpret data from index fossil records and the ordering of rock layers to infer the relative age of rocks and fossils.

8.E.6A.3 Construct explanations from evidence for how catastrophic events (including volcanic activities, earthquakes, climatic changes, and the impact of an asteroid/comet) may have affected the conditions on Earth and the diversity of its life forms.

8.E.6A.4 Construct and analyze scientific arguments to support claims that different types of fossils provide evidence of (1) the diversity of life that has been present on Earth, (2) relationships between past and existing life forms, and (3) environmental changes that have occurred during Earth's history.

8.E.6A.5 Construct explanations for why most individual organisms, as well as some entire taxonomic groups of organisms, that lived in the past were never fossilized.

8.E.6B. Conceptual Understanding: Adaptation by natural selection acting over generations is one important process by which species change in response to changes in environmental conditions. The resources of biological communities can be used within sustainable limits, but if the ecosystem becomes unbalanced in ways that prevent the sustainable use of resources, then ecosystem degradation and species extinction can occur.

Performance Indicators: Students who demonstrate this understanding can:

8.E.6B.1 Construct explanations for how biological adaptations and genetic variations of traits in a population enhance the probability of survival in a particular environment.

8.E.6B.2 Obtain and communicate information to support claims that natural and human-made factors can contribute to the extinction of species.

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Academic Standards and Performance Indicators for Science

High School Course Standards

In grades nine through twelve, the standards and performance indicators for the science and engineering practices and core science content for the high school courses transition students to developing more abstract models and explanations to understand concepts in greater detail and sophistication as they build from experiences in kindergarten through grade eight. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

These courses should not only serve as the foundation for advanced studies at the secondary level and in institutions of higher education but should also provide students with the science skills that are necessary for informed decision making regarding scientific societal questions and to lay the foundation for skills necessary for science related technical careers.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for the course. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed *within the content* for each grade level.

In South Carolina, students are required to have a minimum of three (3) science units for high school graduation. Students must also pass a high school course in science in which an end-of-course examination is administered. At the time this document was written, the required course was Biology.

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BIOLOGY 1 OVERVIEW

The academic standards and performance indicators establish the practices and core content for all Biology courses in South Carolina high schools. The core ideas within the standards are not meant to represent an equal division of material and concepts. Therefore, the number of indicators per core idea should not be expected to be equal, nor should equal numbers of performance indicators within each standard be expected.

The five core areas of the Biology 1 course standards include:

- Cells as a System
- Energy Transfer
- Heredity – Inheritance and Variation of Traits
- Biological Evolution – Unity and Diversity
- Ecosystem Dynamics

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for the course. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to make decisions concerning the structure and content of Biology 1 courses. All biology courses must include instruction in the practices of science and engineering, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. All biology courses are laboratory courses requiring a minimum of 30% hands-on investigation. Biology laboratories will need to be stocked with the materials and equipment necessary to complete investigations.

The academic standards and performance indicators for Biology 1 should be the basis for the development of classroom and course-level assessments. In addition, the academic standards and performance indicators for Biology 1 will be the basis for the development of the items on the state-required End-of-Course Examination Program (EOCEP) for Biology 1.

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BIOLOGY 1
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected in this course. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard H.B.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

H.B.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

H.B.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.B.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.B.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.B.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.

H.B.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.B.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.

H.B.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence and valid reasoning from observations, data, or informational texts.

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H.B.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.

H.B.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

H.B.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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BIOLOGY 1
CELLS AS A SYSTEM

Standard H.B.2: The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells.

H.B.2A. Conceptual Understanding: The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) that are catalyzed by enzymes.

Performance Indicators: Students who demonstrate this understanding can:

H.B.2A.1 Construct explanations of how the structures of carbohydrates, lipids, proteins, and nucleic acids (including DNA and RNA) are related to their functions in organisms.

H.B.2A.2 Plan and conduct investigations to determine how various environmental factors (including temperature and pH) affect enzyme activity and the rate of biochemical reactions.

H.B.2B. Conceptual Understanding: Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life.

Performance Indicators: Students who demonstrate this understanding can:

H.B.2B.1 Develop and use models to explain how specialized structures within cells (including the nucleus, chromosomes, cytoskeleton, endoplasmic reticulum, ribosomes and Golgi complex) interact to produce, modify, and transport proteins. Models should compare and contrast how prokaryotic cells meet the same life needs as eukaryotic cells without similar structures.

H.B.2B.2 Collect and interpret descriptive data on cell structure to compare and contrast different types of cells (including prokaryotic versus eukaryotic, and animal versus plant versus fungal).

H.B.2B.3 Obtain information to contrast the structure of viruses from that of cells and to explain, in general, why viruses must use living cells to reproduce.

H.B.2C. Conceptual Understanding: Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell.

Performance Indicators: Students who demonstrate this understanding can:

H.B.2C.1 Develop and use models to exemplify how the cell membrane serves to maintain homeostasis of the cell through both active and passive transport processes.

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H.B.2C.2 Ask scientific questions to define the problems that organisms face in maintaining homeostasis within different environments (including water of varying solute concentrations).

H.B.2C.3 Analyze and interpret data to explain the movement of molecules (including water) across a membrane.

H.B.2D. Conceptual Understanding: The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation.

Performance Indicators: Students who demonstrate this understanding can:

H.B.2D.1 Construct models to explain how the processes of cell division and cell differentiation produce and maintain complex multicellular organisms.

H.B.2D.2 Develop and use models to exemplify the changes that occur in a cell during the cell cycle (including changes in cell size, chromosomes, cell membrane/cell wall, and the number of cells produced) and predict, based on the models, what might happen to a cell that does not progress through the cycle correctly.

H.B.2D.3 Construct explanations for how the cell cycle is monitored by check point systems and communicate possible consequences of the continued cycling of abnormal cells.

H.B.2D.4 Construct scientific arguments to support the pros and cons of biotechnological applications of stem cells using examples from both plants and animals.

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BIOLOGY 1
ENERGY TRANSFER

Standard H.B.3: The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem.

H.B.3A. Conceptual Understanding: Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another.

Performance Indicators: Students who demonstrate this understanding can:

H.B.3A.1 Develop and use models to explain how chemical reactions among ATP, ADP, and inorganic phosphate act to transfer chemical energy within cells.

H.B.3A.2 Develop and revise models to describe how photosynthesis transforms light energy into stored chemical energy.

H.B.3A.3 Construct scientific arguments to support claims that chemical elements in the sugar molecules produced by photosynthesis may interact with other elements to form amino acids, lipids, nucleic acids or other large organic molecules.

H.B.3A.4 Develop models of the major inputs and outputs of cellular respiration (aerobic and anaerobic) to exemplify the chemical process in which the bonds of food molecules are broken, the bonds of new compounds are formed and a net transfer of energy results. Use the models to explain common exercise phenomena (such as lactic acid buildup, changes in breathing during and after exercise, cool down after exercise).

H.B.3A.5 Plan and conduct scientific investigations or computer simulations to determine the relationship between variables that affect the processes of fermentation and/or cellular respiration in living organisms and interpret the data in terms of real-world phenomena.

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BIOLOGY 1
HEREDITY – INHERITANCE AND VARIATION OF TRAITS

Standard H.B.4: The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes.

H.B.4A. Conceptual Understanding: Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations.

Performance Indicators: Students who demonstrate this understanding can:

H.B.4A.1 Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.

H.B.4A.2 Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).

H.B.4B. Conceptual Understanding: In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems.

Performance Indicators: Students who demonstrate this understanding can:

H.B.4B.1 Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.

H.B.4B.2 Obtain, evaluate and communicate information on how biotechnology (including gel electrophoresis, plasmid-based transformation and DNA fingerprinting) may be used in the fields of medicine, agriculture, and forensic science.

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Biology 1

Heredity: Inheritance and Variation of Traits *(continued)*

H.B.4C. Conceptual Understanding: Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent.

Performance Indicators: Students who demonstrate this understanding can:

H.B.4C.1 Develop and use models of sex cell formation (meiosis) to explain why the DNA of the daughter cells is different from the DNA of the parent cell.

H.B.4C.2 Analyze data on the variation of traits among individual organisms within a population to explain patterns in the data in the context of transmission of genetic information.

H.B.4C.3 Construct explanations for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.

H.B.4D. Conceptual Understanding: Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation.

Performance Indicators: Students who demonstrate this understanding can:

H.B.4D.1 Develop and use models to explain how mutations in DNA that occur during replication (1) can affect the proteins that are produced or the traits that result and (2) may or may not be inherited.

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BIOLOGY 1
BIOLOGICAL EVOLUTION – UNITY AND DIVERSITY

Standard H.B.5: The student will demonstrate an understanding of biological evolution and the unity and diversity of life on Earth.

H.B.5A. Conceptual Understanding: Scientific evidence from the fields of anatomy, embryology, biochemistry, and paleontology underlie the theory of biological evolution. The similarities and differences in DNA sequences, amino acid sequences, anatomical features and fossils all provide information about patterns of descent with modification. Organisms resemble their ancestors because genetic information is transferred from ancestor to offspring during reproduction.

Performance Indicators: Students who demonstrate this understanding can:

H.B.5A.1 Analyze scientific data to explain how multiple lines of evidence (including DNA or amino acid sequences, anatomical and embryological features, fossils, and artificial selection) are used to investigate common ancestry and descent with modification.

H.B.5A.2 Construct explanations of ways scientists use data from a variety of sources to investigate and critically analyze aspects of the theory of biological evolution.

H.B.5A.3 Construct and interpret a phylogenetic tree, based on anatomical evidence, of the degree of relatedness among various organisms and revise the model based on the inclusion of molecular (such as DNA and/or amino acid sequence) evidence.

H.B.5B. Conceptual Understanding: Biological evolution occurs primarily when natural selection acts on the genetic variation in a population and changes the distribution of traits in that population over multiple generations.

Performance Indicators: Students who demonstrate this understanding can:

H.B.5B.1 Critically analyze and interpret data to explain that natural selection results from four factors: (1) the potential for a population to increase in number, (2) the genetic variation among individuals in a species due to sexual reproduction and mutation (3) competition for a limited supply of resources, and (4) the ensuing proliferation of those individuals that are better able to survive and reproduce in that environment.

H.B.5B.2 Conduct investigations by simulating several generations of natural selection to investigate how changes in environmental conditions may lead to changes in selective pressure on a population of organisms.

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H.B.5C. Conceptual Understanding: According to the theory of biological evolution, natural selection results in populations that are adapted to a particular environment at a particular time. Changes in the physical environment have contributed to the expansion, emergence, or extinction of the Earth's species. Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Modern classification of Earth's biodiversity is based on the relationships of organisms to one another.

Performance Indicators: Students who demonstrate this understanding can:

H.B.5C.1 Analyze and interpret data, using the principles of natural selection, to make predictions about the long term biological changes that may occur within two populations of the same species that become geographically isolated from one another.

H.B.5C.2 Construct scientific arguments using data on how changes in environmental conditions could result in (1) the expansion of some species, (2) the emergence of new species over time, or (3) the extinction of other species.

H.B.5C.3 Use models of the current three-domain, six-kingdom tree of life to explain how scientists classify organisms and how classification systems are revised over time as discoveries provide new evidence.

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BIOLOGY 1
ECOSYSTEM DYNAMICS

Standard H.B.6: The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment.

H.B.6A. Conceptual Understanding: Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Limiting factors include the availability of biotic and abiotic resources and challenges such as predation, competition, and disease.

Performance Indicators: Students who demonstrate this understanding can:

H.B.6A.1 Analyze and interpret data that depict changes in the abiotic and biotic components of an ecosystem over time or space (such as percent change, average change, correlation and proportionality) and propose hypotheses about possible relationships between the changes in the abiotic components and the biotic components of the environment.

H.B.6A.2 Use mathematical and computational thinking to support claims that limiting factors affect the number of individuals that an ecosystem can support.

H.B.6B. Conceptual Understanding: Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

Performance Indicators: Students who demonstrate this understanding can:

H.B.6B.1 Develop and use models of the carbon cycle, which include the interactions between photosynthesis, cellular respiration and other processes that release carbon dioxide, to evaluate the effects of increasing atmospheric carbon dioxide on natural and agricultural ecosystems.

H.B.6B.1 Analyze and interpret quantitative data to construct an explanation for the effects of greenhouse gases (such as carbon dioxide and methane) on the carbon cycle and global climate.

H.B.6C. Conceptual Understanding: A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively stable over long periods of time. Fluctuations in conditions can challenge the functioning of ecosystems in terms of resource and habitat availability.

Performance Indicators: Students who demonstrate this understanding can:

H.B.6C.1 Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.

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H.B.6D. Conceptual Understanding: Sustaining biodiversity maintains ecosystem functioning and productivity which are essential to supporting and enhancing life on Earth. Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity can impact biodiversity.

Performance Indicators: Students who demonstrate this understanding can:

H.B.6D.1 Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.

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CHEMISTRY 1 OVERVIEW

The academic standards and performance indicators establish the practices and core content for all Chemistry 1 courses in South Carolina high schools. The core ideas within the standards are not meant to represent an equal division of material and concepts. Therefore the number of indicators per core idea should not be expected to be equal, nor should equal numbers of performance indicators within each standard be expected.

The six core areas of the Chemistry 1 standards include:

- Atomic Structure and Nuclear Processes
- Bonding and Chemical Formulas
- States of Matter
- Solutions, Acids, and Bases
- Chemical Reactions
- Thermochemistry and Chemical Kinetics

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for the course. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed *within the content* for each grade level.

Teachers, schools, and districts should use these standards and indicators to make decisions concerning the structure and content of Chemistry 1. All chemistry courses must include instruction in the practices of science and engineering, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. All chemistry courses are laboratory courses requiring a minimum of 30 % hands-on investigation. Chemistry laboratories will need to be stocked with the materials and equipment necessary to complete scientific investigations.

The academic standards and performance indicators for Chemistry 1 should be the basis for the development of classroom and course-level assessments.

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CHEMISTRY 1
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected in this course. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard H.C.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

H.C.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

H.C.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.C.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.C.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.C.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.

H.C.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.C.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.

H.C.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence and valid reasoning from observations, data, or informational texts.

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H.C.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.

H.C.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

H.C.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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CHEMISTRY 1
ATOMIC STRUCTURE AND NUCLEAR PROCESSES

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

H.C.2A. Conceptual Understanding: 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.

Performance Indicators: Students who demonstrate this understanding can:

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.

H.C.2B. Conceptual Understanding: 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.

Performance Indicators: Students who demonstrate this understanding can:

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 ($E=mc^2$).

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CHEMISTRY 1
BONDING AND CHEMICAL FORMULAS

Standard H.C.3: The student will demonstrate an understanding of the structures and classification of chemical compounds.

H.C.3A. Conceptual Understanding: Elements are made up of only one kind of atom. With increasing atomic number, a predictable pattern for the addition of electrons exists. This pattern is the basis for the arrangement of elements in the periodic table. The chemical properties of an element are determined by an element's electron configuration. Elements can react to form chemical compounds/molecules that have unique properties determined by the kinds of atoms combined to make up the compound/molecule. Essentially, the ways in which electrons are involved in bonds determines whether ionic or covalent bonds are formed. Compounds have characteristic shapes that are determined by the type and number of bonds formed.

Performance Indicators: Students who demonstrate this understanding can:

H.C.3A.1 Construct explanations for the formation of molecular compounds via sharing of electrons and for the formation of ionic compounds via transfer of electrons.

H.C.3A.2 Use the periodic table to write and interpret the formulas and names of chemical compounds (including binary ionic compounds, binary covalent compounds, and straight-chain alkanes up to six carbons).

H.C.3A.3 Analyze and interpret data to predict the type of bonding (ionic or covalent) and the shape of simple compounds by using the Lewis dot structures and oxidation numbers.

H.C.3A.4 Plan and conduct controlled scientific investigations to generate data on the properties of substances and analyze the data to infer the types of bonds (including ionic, polar covalent, and nonpolar covalent) in simple compounds.

H.C.3A.5 Develop and use models (such as Lewis dot structures, structural formulas, or ball-and-stick models) of simple hydrocarbons to exemplify structural isomerism.

H.C.3A.6 Construct explanations of how the basic structure of common natural and synthetic polymers is related to their bulk properties.

H.C.3A.7 Analyze and interpret data to determine the empirical formula of a compound and the percent composition of a compound.

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CHEMISTRY 1
STATES OF MATTER

Standard H.C.4: The student will demonstrate an understanding of the structure and behavior of the different states of matter.

H.C.4A. Conceptual Understanding: Matter can exist as a solid, liquid, or gas, and in very high-energy states, as plasma. In general terms, for a given chemical, the particles making up the solid are at a lower energy state than the liquid phase, which is at a lower energy state than the gaseous phase. The changes from one state of matter into another are energy dependent. The behaviors of gases are dependent on the factors of pressure, volume, and temperature.

Performance Indicators: Students who demonstrate this understanding can:

H.C.4A.1 Develop and use models to explain the arrangement and movement of the particles in solids, liquids, gases, and plasma as well as the relative strengths of their intermolecular forces.

H.C.4A.2 Analyze and interpret heating curve graphs to explain that changes from one state of matter to another are energy dependent.

H.C.4A.3 Conduct controlled scientific investigations and use models to explain the behaviors of gases (including the proportional relationships among pressure, volume, and temperature).

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CHEMISTRY 1
SOLUTIONS, ACIDS, AND BASES

Standard H.C.5: The student will demonstrate an understanding of the nature and properties of various types of chemical solutions.

H.C.5A. Conceptual Understanding: Solutions can exist in any of three physical states: gas, liquid, or solid. Solution concentrations can be expressed by specifying the relative amounts of solute and solvent. The nature of the solute, the solvent, the temperature, and the pressure can affect solubility. Solutes can affect such solvent properties as freezing point, boiling point, and vapor pressure. Acids, bases, and salts have characteristic properties. Several definitions of acids and bases are used in chemistry.

Performance Indicators: Students who demonstrate this understanding can:

H.C.5A.1 Obtain and communicate information to describe how a substance can dissolve in water by dissociation, dispersion, or ionization and how intermolecular forces affect solvation.

H.C.5A.2 Analyze and interpret data to explain the effects of temperature and pressure on the solubility of solutes in a given amount of solvent.

H.C.5A.3 Use mathematical representations to analyze the concentrations of unknown solutions in terms of molarity and percent by mass.

H.C.5A.4 Analyze and interpret data to describe the properties of acids, bases, and salts.

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CHEMISTRY 1
CHEMICAL REACTIONS

Standard H.C.6: The student will demonstrate an understanding of the types, the causes, and the effects of chemical reactions.

H.C.6A. Conceptual Understanding: A chemical reaction occurs when elements and/or compounds interact, resulting in a rearrangement of the atoms of these elements and/or compounds to produce substances with unique properties. Mass is conserved in chemical reactions. Reactions tend to proceed in a direction that favors lower energies. Chemical reactions can be categorized using knowledge about the reactants to predict products. Chemical reactions are quantifiable. When stress is applied to a chemical system that is in equilibrium, the system will shift in a direction that reduces that stress.

Performance Indicators: Students who demonstrate this understanding can:

H.C.6A.1 Develop and use models to predict the products of chemical reactions (1) based upon movements of ions; (2) based upon movements of protons; and (3) based upon movements of electrons.

H.C.6A.2 Use Le Châtelier's principle to predict shifts in chemical equilibria resulting from changes in concentration, pressure, and temperature.

H.C.6A.3 Plan and conduct controlled scientific investigations to produce mathematical evidence that mass is conserved in chemical reactions.

H.C.6A.4 Use mathematical and computational thinking to predict the amounts of reactants required and products produced in specific chemical reactions.

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CHEMISTRY 1
THERMOCHEMISTRY AND CHEMICAL KINETICS

Standard H.C.7: The student will demonstrate an understanding of the conservation of energy and energy transfer.

H.C.7A. Conceptual Understanding: The first law of thermodynamics states that the amount of energy in the universe is constant. An energy diagram is used to represent changes in the energy of the reactants and products in a chemical reaction. Enthalpy refers to the heat content that is present in an atom, ion, or compound. While some chemical reactions occur spontaneously, other reactions may require that activation energy be lowered in order for the reaction to occur.

Performance Indicators: Students who demonstrate this understanding can:

H.C.7A.1 Analyze and interpret data from energy diagrams and investigations to support claims that the amount of energy released or absorbed during a chemical reaction depends on changes in total bond energy.

H.C.7A.2 Use mathematical and computational thinking to write thermochemical equations and draw energy diagrams for the combustion of common hydrocarbon fuels and carbohydrates, given molar enthalpies of combustion.

H.C.7A.3 Plan and conduct controlled scientific investigations to determine the effects of temperature, surface area, stirring, concentration of reactants, and the presence of various catalysts on the rate of chemical reactions.

H.C.7A.4 Develop and use models to explain the relationships between collision frequency, the energy of collisions, the orientation of molecules, activation energy, and the rates of chemical reactions.

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PHYSICS 1 OVERVIEW

The academic standards and performance indicators establish the practices and core content for all Physics 1 courses in South Carolina schools. The two core ideas are subdivided and are not meant to represent an equal division of material and concepts. Therefore the number of indicators per core idea should not be expected to be equal, nor should equal numbers of performance indicators within each standard be expected.

The two core areas of the Physics 1 standards include:

- Interactions and Forces: Patterns of Linear Motion; Forces and Changes in Motion; Interactions and Contact Forces; Interactions and Noncontact Forces and Fields
- Interactions and Energy: Conservation and Energy Transfer and Work; Mechanical Energy; Thermal Energy; Sound, Electricity and Magnetism; Radiation; Nuclear Energy

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for the course. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to make decisions concerning the structure and content of Physics 1. All Physics courses must include instruction in the practices of science and engineering, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. All Physics courses are laboratory courses requiring a minimum of 30 % hands-on investigation. Physics laboratories will need to be stocked with the materials and equipment necessary to complete investigations.

The academic standards and performance indicators for Physics 1 should be the basis for the development of classroom and course-level assessments.

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PHYSICS 1
SCIENCE AND ENGINEERING PRACTICES

> **NOTE**: Scientific investigations should always be done in the context of content knowledge expected in this course. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard H.P.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

H.P.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

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.

H.P.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate English and metric units, (2) express relationships between variables for models and investigations, or (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.

H.P.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence and valid reasoning from observations, data, or informational texts.

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H.P.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.

H.P.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

H.P.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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PHYSICS 1
INTERACTIONS AND FORCES

Standard H.P.2: The student will demonstrate an understanding of how the interactions among objects and their subsequent motion can be explained and predicted using the concept of forces.

H.P.2A. Conceptual Understanding: The linear motion of an object can be described by its displacement, velocity, and acceleration.

Performance Indicators: Students who demonstrate this understanding can:

H.P.2A.1 Plan and conduct controlled scientific investigations on the straight-line motion of an object to include an interpretation of the object's displacement, time of motion, constant velocity, average velocity, and constant acceleration.

H.P.2A.2 Construct explanations for an object's change in motion using one-dimensional vector addition.

H.P.2A.3 Use mathematical and computational thinking to apply formulas related to an object's displacement, constant velocity, average velocity and constant acceleration. Interpret the meaning of the sign of displacement, velocity, and acceleration.

H.P.2A.4 Develop and use models to represent an object's displacement, velocity, and acceleration (including vector diagrams, data tables, motion graphs, dot motion diagrams, and mathematical formulas).

H.P.2A.5 Construct explanations for what is meant by "constant" velocity and "constant" acceleration (including writing descriptions of the object's motion and calculating the sign and magnitude of the slope of the line on a position-time and velocity-time graph).

H.P.2A.6 Obtain information to communicate the similarities and differences between distance and displacement; speed and velocity; constant velocity and instantaneous velocity; constant velocity and average velocity; and velocity and acceleration.

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H.P.2B. Conceptual Understanding: The interactions among objects and their subsequent motion can be explained and predicted by analyzing the forces acting on the objects and applying Newton's laws of motion.

Performance Indicators: Students who demonstrate this understanding can:

H.P.2B.1 Plan and conduct controlled scientific investigations involving the motion of an object to determine the relationships among the net force on the object, its mass, and its acceleration (Newton's second law of motion, $F_{net} = ma$) and analyze collected data to construct an explanation of the object's motion using Newton's second law of motion.

H.P.2B.2 Use a free-body diagram to represent the forces on an object.

H.P.2B.3 Use Newton's Third Law of Motion to construct explanations of everyday phenomena (such as a hammer hitting a nail, the thrust of a rocket engine, the lift of an airplane wing, or a book at rest on a table) and identify the force pairs in each given situation involving two objects and compare the size and direction of each force.

H.P.2B.4 Use mathematical and computational thinking to derive the relationship between impulse and Newton's Second Law of Motion.

H.P.2B.5 Plan and conduct controlled scientific investigations to support the Law of Conservation of Momentum in the context of two objects moving linearly (p=mv).

H.P.2B.6 Construct scientific arguments to defend the use of the conservation of linear momentum in the investigation of traffic accidents in which the initial motions of the objects are used to determine the final motions of the objects.

H.P.2B.7 Apply physics principles to design a device that minimizes the force on an object during a collision and construct an explanation for the design.

H.P.2B.8 Develop and use models (such as a computer simulation, drawing, or demonstration) and Newton's Second Law of Motion to construct explanations for why an object moving at a constant speed in a circle is accelerating.

H.P.2B.9 Construct explanations for the practical applications of torque (such as a see-saw, bolt, wrench, and hinged door).

H.P.2B.10 Obtain information to communicate physical situations in which Newton's Second Law of Motion does not apply.

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PHYSICS 1
INTERACTIONS AND FORCES *(CONTINUED)*

H.P.2C. Conceptual Understanding: The contact interactions among objects and their subsequent motion can be explained and predicted by analyzing the normal, tension, applied, and frictional forces acting on the objects and by applying Newton's Laws of Motion.

Performance Indicators: Students who demonstrate this understanding can:

H.P.2C.1 Use a free-body diagram to represent the normal, tension (or elastic), applied, and frictional forces on an object.

H.P.2C.2 Plan and conduct controlled scientific investigations to determine the variables that could affect the kinetic frictional force on an object.

H.P.2C.3 Obtain and evaluate information to compare kinetic and static friction.

H.P.2C.4 Analyze and interpret data on force and displacement to determine the spring (or elastic) constant of an elastic material (Hooke's Law, F=-kx), including constructing an appropriate graph in order to draw a line-of-best-fit whose calculated slope will yield the spring constant, *k*.

H.P.2C.5 Use mathematical and computational thinking to apply F_{net} = ma to analyze problems involving contact interactions and gravity.

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PHYSICS 1
INTERACTIONS AND FORCES *(CONTINUED)*

H.P.2D. Conceptual Understanding: The non-contact (at a distance) interactions among objects and their subsequent motion can be explained and predicted by analyzing the gravitational, electric, and magnetic forces acting on the objects and applying Newton's laws of motion. These non-contact forces can be represented as fields.

Performance Indicators: Students who demonstrate this understanding can:

H.P.2D.1 Develop and use models (such as computer simulations, demonstrations, diagrams, and drawings) to explain how neutral objects can become charged and how objects mutually repel or attract each other and include the concept of conservation of charge in the explanation.

H.P.2D.2 Use mathematical and computational thinking to predict the relationships among the masses of two objects, the attractive gravitational force between them, and the distance between them (Newton's Law of Universal Gravitation, $F=Gm_1m_2/r^2$).

H.P.2D.3 Obtain information to communicate how long-term gravitational interactions govern the evolution and maintenance of large-scale structures in the universe (such as the solar system and galaxies) and the patterns of motion within them.

H.P.2D.4 Use mathematical and computational thinking to predict the relationships among the charges of two particles, the attractive or repulsive electrical force between them, and the distance between them (Coulomb's Law. $F=kq_1q_2/r^2$).

H.P.2D.5 Construct explanations for how the non-contact forces of gravity, electricity, and magnetism can be modeled as fields by sketching field diagrams for two given charges, two massive objects, or a bar magnet and use these diagrams to qualitatively interpret the direction and magnitude of the force at a particular location in the field.

H.P.2D.6 Use a free-body diagram to represent the gravitational force on an object.

H.P.2D.7 Use a free-body diagram to represent the electrical force on a charge.

H.P.2D.8 Develop and use models (such as computer simulations, drawings, or demonstrations) to explain the relationship between moving charged particles (current) and magnetic forces and fields.

H.P.2D.9 Use Newton's Law of Universal Gravitation and Newton's second law of motion to explain why all objects near Earth's surface have the same acceleration.

H.P.2D.10 Use mathematical and computational thinking to apply $F_{net} = ma$ to analyze problems involving non-contact interactions, including objects in free fall.

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PHYSICS 1
INTERACTIONS AND ENERGY

Standard 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.

H.P.3A. Conceptual Understanding: Work and energy are equivalent to each other. Work is defined as the product of displacement and the force causing that displacement; this results in the transfer of mechanical energy. Therefore, in the case of mechanical energy, energy is seen as the ability to do work. This is called the work-energy principle. The rate at which work is done (or energy is transformed) is called power. For machines that do useful work for humans, the ratio of useful power output is the efficiency of the machine. For all energies and in all instances, energy in a closed system remains constant.

Performance Indicators: Students who demonstrate this understanding can:

H.P.3A.1 Use mathematical and computational thinking to determine the work done by a constant force (W=Fd).

H.P.3A.2 Use mathematical and computational thinking to analyze problems dealing with the work done on or by an object and its change in energy.

H.P.3A.3 Obtain information to communicate how energy is conserved in elastic and inelastic collisions.

H.P.3A.4 Plan and conduct controlled scientific investigations to determine the power output of the human body.

H.P.3A.5 Obtain and communicate information to describe the efficiency of everyday machines (such as automobiles, hair dryers, refrigerators, and washing machines).

H.P.3B. Conceptual Understanding: Mechanical energy refers to a combination of motion (kinetic energy) and stored energy (potential energy). When only non-conservative forces act on an object and when no mass is converted to energy, mechanical energy is conserved. Gravitational and electrical potential energy can be modeled as energy stored in the fields created by massive objects or charged particles.

Performance Indicators: Students who demonstrate this understanding can:

H.P.3B.1 Develop and use models (such as computer simulations, drawings, bar graphs, and diagrams) to exemplify the transformation of mechanical energy in simple systems and those with periodic motion and on which only non-conservative forces act.

H.P.3B.2 Use mathematical and computational thinking to argue the validity of the conservation of mechanical energy in simple systems and those with periodic motion and on which only non-conservative forces act ($KE = ½ mv^2$, $PE_g = mgh$, $PE_e = ½ kx^2$).

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H.P.3B.3 Use drawings or diagrams to identify positions of relative high and low potential energy in a gravitational and electrical field (with the source of the field being positive as well as negative and the charge experiencing the field being positive as well as negative).

H.P.3C. Conceptual Understanding: 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.

Performance Indicators: Students who demonstrate this understanding can:

H.P.3C.1 Plan and conduct controlled scientific investigations to determine the variables that affect the rate of heat transfer between two objects.

H.P.3C.2 Analyze and interpret data to describe the thermal conductivity of different materials.

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).

H.P.3D. Conceptual Understanding: Sound is a mechanical, longitudinal wave that is the result of vibrations (kinetic energy) that transfer energy through a medium.

Performance Indicators: Students who demonstrate this understanding can:

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.

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H.P.3E. Conceptual Understanding: During electric circuit interactions, electrical energy (energy stored in a battery or energy transmitted by a current) is transformed into other forms of energy and transferred to circuit devices and the surroundings. Charged particles and magnets create fields that store energy. Magnetic fields exert forces on moving charged particles. Changing magnetic fields cause electrons in wires to move, creating current.

Performance Indicators: Students who demonstrate this understanding can:

H.P.3E.1 Plan and conduct controlled scientific investigations to determine the relationship between the current and potential drop (voltage) across an Ohmic resistor. Analyze and interpret data to verify Ohm's law, including constructing an appropriate graph in order to draw a line-of-best-fit whose calculated slope will yield *R*, the resistance of the resistor.

H.P.3E.2 Develop and use models (such as circuit drawings and mathematical representations) to explain how an electric circuit works by tracing the path of the electrons and including concepts of energy transformation, transfer, and the conservation of energy and electric charge.

H.P.3E.3 Use mathematical and computational thinking to analyze problems dealing with current, electric potential, resistance, and electric charge.

H.P.3E.4 Use mathematical and computational thinking to analyze problems dealing with the power output of electric devices.

H.P.3E.5 Plan and conduct controlled scientific investigations to determine how connecting resistors in series and in parallel affects the power (brightness) of light bulbs.

H.P.3E.6 Obtain and communicate information about the relationship between magnetism and electric currents to explain the role of magnets and coils of wire in microphones, speakers, generators, and motors.

H.P.3E.7 Design a simple motor and construct an explanation of how this motor transforms electrical energy into mechanical energy and work.

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H.P.3F. Conceptual Understanding: During radiant energy interactions, energy can be transferred over long distances without a medium. Radiation can be modeled as an electromagnetic wave or as a stream of discrete packets of energy (photons); all radiation travels at the same speed in a vacuum (speed of light). This electromagnetic radiation is a major source of energy for life on Earth.

Performance Indicators: Students who demonstrate this understanding can:

H.P.3F.1 Construct scientific arguments that support the wave model of light and the particle model of light.

H.P.3F.2 Plan and conduct controlled scientific investigations to determine the interaction between the visible light portion of the electromagnetic spectrum and various objects (including mirrors, lenses, barriers with two slits, and diffraction gratings) and to construct explanations of the behavior of light (reflection, refraction, transmission, interference) in these instances using models (including ray diagrams).

H.P.3F.3 Use drawings to exemplify the behavior of light passing from one transparent medium to another and construct explanations for this behavior.

H.P.3F.4 Use mathematical and computational thinking to analyze problems that relate the frequency, period, amplitude, wavelength, velocity, and energy of light.

H.P.3F.5 Obtain information to communicate the similarities and differences among the different bands of the electromagnetic spectrum (including radio waves, microwaves, infrared, visible light, ultraviolet, and gamma rays) and give examples of devices or phenomena from each band.

H.P.3F.6 Obtain information to construct explanations on how waves are used to produce, transmit, and capture signals and store and interpret information (including ultrasound imaging, telescopes, cell phones, and bar code scanners).

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PHYSICS 1
INTERACTIONS AND ENERGY *(CONTINUED)*

H.P.3G. Conceptual Understanding: Nuclear energy is energy stored in an atom's nucleus; this energy holds the atom together and is called binding energy. Binding energy is a reflection of the equivalence of mass and energy; the mass of any nucleus is always less than the sum of the masses of the individual constituent nucleons that comprise it. Binding energy is also a measure of the strong nuclear force that exists in the nucleus and is responsible for overcoming the repulsive forces among protons. The strong and weak nuclear forces, gravity, and the electromagnetic force are the fundamental forces in nature. Strong and weak nuclear forces determine nuclear sizes, stability, and rates of radioactive decay. At the subatomic scale, the conservation of energy becomes the conservation of mass-energy.

Performance Indicators: Students who demonstrate this understanding can:

H.P.3G.1 Develop and use models to represent the basic structure of an atom (including protons, neutrons, electrons, and the nucleus).

H.P.3G.2 Develop and use models (such as drawings, diagrams, computer simulations, and demonstrations) to communicate the similarities and differences between fusion and fission. Give examples of fusion and fission reactions and include the concept of conservation of mass-energy.

H.P.3G.3 Construct scientific arguments to support claims for or against the viability of fusion and fission as sources of usable energy.

H.P.3G.4 Use mathematical and computational thinking to predict the products of radioactive decay (including alpha, beta, and gamma decay).

H.P.3G.5 Obtain information to communicate how radioactive decay processes have practical applications (such as food preservation, cancer treatments, fossil and rock dating, and as radioisotopic medical tracers).

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EARTH SCIENCE OVERVIEW

The academic standards and performance indicators establish the practices and core content for all Earth Science courses in South Carolina schools. The core ideas within the standards are not meant to represent an equal division of material and concepts. Therefore the number of indicators per core idea should not be expected to be equal, nor should equal numbers of performance indicators within each standard be expected.

The five core areas of the Earth Science standards include:

- Astronomy
- Earth's Geosphere
- Earth's Paleobiosphere
- Earth's Atmosphere – Weather and Climate
- Earth's Hydrosphere

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for the course. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed ***within the content*** for each grade level.

Teachers, schools, and districts should use these standards and indicators to make decisions concerning the structure and content of an Earth Science course. All Earth Science courses must include instruction in the practices of science and engineering, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. All Earth Science courses are laboratory courses requiring a minimum of 30% hands-on investigation. Earth Science laboratories will need to be stocked with the materials and equipment necessary to complete investigations.

The academic standards and performance indicators for Earth Science should be the basis for the development of classroom and course-level assessments.

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Earth Science
Science and Engineering Practices

NOTE: Scientific investigations should always be done in the context of content knowledge expected in this course. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard H.E.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

H.E.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

H.E.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.E.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.E.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.E.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.

H.E.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) express relationships between variables for models and investigations, or (3) use grade-level appropriate statistics to analyze data.

H.E.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.

H.E.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence and valid reasoning from observations, data, or informational texts.

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H.E.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.

H.E.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

H.E.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

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EARTH SCIENCE
ASTRONOMY

Standard H.E.2: The student will demonstrate an understanding of the structure, properties, and history of the observable universe.

H.E.2A. Conceptual Understanding: Earth is a tiny part of a vast universe that has developed over a huge expanse of time. At the center of Earth's solar system is one local star, the Sun. It is just one of a vast number of stars in the Milky Way Galaxy, which is just one of a vast number of galaxies in the observable universe. The study of the light spectra and brightness of stars is used to identify compositional elements of stars, their movements, and their distances from Earth. Nearly all observable matter in the universe formed and continues to form within the cores of stars. The universe began with a period of extreme and rapid expansion and has been expanding ever since.

Performance Indicators: Students who demonstrate this understanding can:

H.E.2A.1 Construct explanations for how gravity and motion affect the formation and shapes of galaxies (including the Milky Way Galaxy).

H.E.2A.2 Use the Hertzsprung-Russell diagram to classify stars and explain the life cycles of stars (including the Sun).

H.E.2A.3 Construct explanations for how elements are formed using evidence from nuclear fusion occurring within stars and/or supernova explosions.

H.E.2A.4 Construct and analyze scientific arguments to support claims about the origin of the universe (including the red shift of light from distant galaxies, the measured composition of stars and nonstellar gases, and the cosmic background radiation).

H.E.2A.5 Obtain and evaluate information to describe how the use of x-ray, gamma-ray, radio, and visual (reflecting, refracting, and catadioptric) telescopes and computer modeling have increased the understanding of the universe.

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EARTH SCIENCE

ASTRONOMY *(CONTINUED)*

H.E.2B. Conceptual Understanding: The solar system consists of the Sun and a collection of objects of varying sizes and conditions – including planets and their moons – that have predictable patterns of movement. These patterns can be explained by gravitational forces and conservation laws, and in turn explains many large-scale phenomena observed on Earth. Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the Sun. The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

Performance Indicators: Students who demonstrate this understanding can:

H.E.2B.1 Analyze and interpret data to compare the properties of Earth and other planets (including composition, density, surface expression of tectonics, climate, and conditions necessary for life).

H.E.2B.2 Obtain, evaluate, and communicate information about the properties and features of the moon to support claims that it is unique among other moons in the solar system in its effects on the planet it orbits.

H.E.2B.3 Use mathematical and computational thinking to explain the motion of an orbiting object in the solar system.

H.E.2B.4 Construct explanations for how the solar system was formed.

Draft submitted September 2013 for State Board of Education Approval

EARTH SCIENCE
EARTH'S GEOSPHERE

Standard H.E.3: The student will demonstrate an understanding of the internal and external dynamics of Earth's geosphere.

H.E.3A. Conceptual Understanding: Evidence indicates Earth's interior is divided into a solid inner core, a liquid outer core, a solid (but flowing) mantle and solid crust. Although the crust is solid, it is in constant motion and is recycled through time. Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a coherent account of its geological history. Weathering (physical and chemical) and soil formation are a result of the interactions of Earth's geosphere, hydrosphere, and atmosphere. All forms of resource extraction and land use have associated economic, social, environmental, and geopolitical costs, risks, and benefits. Natural hazards and other geological events have shaped the course of human history.

Performance Indicators: Students who demonstrate this understanding can:

H.E.3A.1 Analyze and interpret data to explain the differentiation of Earth's internal structure using (1) the production of internal heat from the radioactive decay of unstable isotopes, (2) gravitational energy, (3) data from seismic waves, and (4) Earth's magnetic field.

H.E.3A.2 Analyze and interpret data from ocean topography, correlation of rock assemblages, the fossil record, the role of convection current, and the action at plate boundaries to explain the theory of plate tectonics.

H.E.3A.3 Construct explanations of how forces cause crustal changes as evidenced in sea floor spreading, earthquake activity, volcanic eruptions, and mountain building using evidence of tectonic environments (such as mid-ocean ridges and subduction zones).

H.E.3A.4 Use mathematical and computational thinking to analyze seismic graphs to (1) triangulate the location of an earthquake's epicenter and magnitude, and (2) describe the correlation between frequency and magnitude of an earthquake.

H.E.3A.5 Analyze and interpret data to describe the physical and chemical properties of minerals and rocks and classify each based on the properties and environment in which they were formed.

H.E.3A.6 Develop and use models to explain how various rock formations on the surface of Earth result from geologic processes (including weathering, erosion, deposition, and glaciation).

H.E.3A.7 Plan and conduct controlled scientific investigations to determine the factors that affect the rate of weathering.

H.E.3A.8 Analyze and interpret data of soil from different locations to compare the major physical components of soil (such as the amounts of sand, silt, clay, and humus) as evidence of Earth processes in that region producing each type of soil.

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H.E.3B. Conceptual Understanding: The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Human transformation of the natural environment can contribute to the frequency and intensity of some natural hazards.

Performance Indicators: Students who demonstrate this understanding can:

H.E.3B.1 Obtain and communicate information to explain how the formation, availability, and use of ores and fossil fuels impact the environment.

H.E.3B.2 Construct scientific arguments to support claims that responsible management of natural resources is necessary for the sustainability of human societies and the biodiversity that supports them.

H.E.3B.3 Analyze and interpret data to explain how natural hazards and other geologic events have shaped the course of human history.

H.E.3B.4 Obtain and evaluate available data on a current controversy regarding human activities which may affect the frequency, intensity, or consequences of natural hazards.

H.E.3B.5 Define problems caused by the impacts of locally significant natural hazards and design possible devices or solutions to reduce the impacts of such natural hazards on human activities.

Draft submitted September 2013 for State Board of Education Approval

EARTH SCIENCE
EARTH'S PALEOBIOSPHERE

Standard H.E.4: The student will demonstrate an understanding of the dynamic relationship between Earth's conditions over geologic time and the diversity of organisms.

H.E.4A. Conceptual Understanding: Living things have changed the makeup of Earth's geosphere, hydrosphere, and atmosphere over geological time. Organisms ranging from bacteria to human beings may contribute to the global carbon cycle. They may influence the global climate by modifying the chemical makeup of the atmosphere. As Earth changes, life on Earth adapts and evolves to those changes. Just as life influences components of the Earth System, changes in the Earth System influences life.

Performance Indicators: Students who demonstrate this understanding can:

H.E.4A.1 Construct scientific arguments to support claims that the physical conditions of Earth enable the planet to support carbon-based life.

H.E.4A.2 Construct explanations for how various life forms have altered the geosphere, hydrosphere and atmosphere over geological time.

H.E.4A.3 Construct explanations of how changes to Earth's surface are related to changes in the complexity and diversity of life using evidence from the geologic time scale.

H.E.4A.4 Obtain and evaluate evidence from rock and fossil records and ice core samples to support claims that Earth's environmental conditions have changed over time.

H.E.4A.5 Develop and use models of various dating methods (including index fossils, ordering of rock layers, and radiometric dating) to estimate geologic time.

H.E.4A.6 Use mathematical and computational thinking to calculate the age of Earth materials using isotope ratios (actual or simulated).

H.E.4A.7 Develop and use models to predict the effects of an environmental change (such as the changing life forms, tectonic change, or human activity) on global carbon cycling.

Draft submitted September 2013 for State Board of Education Approval

EARTH SCIENCE
EARTH'S ATMOSPHERE – WEATHER AND CLIMATE

Standard H.E.5: The student will demonstrate an understanding of the dynamics of Earth's atmosphere.

H.E.5A. Conceptual Understanding: Weather is the condition of the atmosphere at a particular location at a particular time. Weather is primarily determined by the angle and amount (time) of sunlight. Climate is the general weather conditions over a long period of time and is influenced by many factors.

Performance Indicators: Students who demonstrate this understanding can:

H.E.5A.1 Develop and use models to describe the thermal structures (including the changes in air temperature due to changing altitude in the lower troposphere), the gaseous composition, and the location of the layers of Earth's atmosphere.

H.E.5A.2 Develop and use models to predict and explain how the angle of solar incidence and Earth's axial tilt impact (1) the length of daylight, (2) the atmospheric filtration, (3) the distribution of sunlight in any location, and (4) seasonal changes.

H.E.5A.3 Analyze and interpret data to predict local and national weather conditions on the basis of the relationship among the movement of air masses, pressure systems, and frontal boundaries.

H.E.5A.4 Analyze and interpret data of pressure differences, the direction of winds, and areas of uneven heating to explain how convection determines local wind patterns (including land/sea breezes, mountain/valley breezes, Chinook winds, and monsoons).

H.E.5A.5 Construct explanations for the formation of severe weather conditions (including tornadoes, hurricanes, thunderstorms, and blizzards) using evidence from temperature, pressure and moisture conditions.

H.E.5A.6 Develop and use models to exemplify how climate is driven by global circulation patterns.

H.E.5A.7 Construct scientific arguments to support claims of past changes in climate caused by various factors (such as changes in the atmosphere, variations in solar output, Earth's orbit, changes in the orientation of Earth's axis of rotation, or changes in the biosphere).

H.E.5A.8 Analyze scientific arguments regarding the nature of the relationship between human activities and climate change.

Draft Submitted September 2013 for State Board of Education Approval

EARTH SCIENCE
EARTH'S HYDROSPHERE

Standard H.E.6: The student will demonstrate an understanding of Earth's freshwater and ocean systems.

H.E.6A. Conceptual Understanding: Water is an essential resource on Earth. Organisms (including humans) on Earth depend on water for life. Its unique physical and chemical properties are important to the dynamics of Earth systems. Multiple factors affect the quality, availability, and distribution of Earth's water.

Draft submitted September 2013 for State Board of Education Approval

Performance Indicators: Students who demonstrate this understanding can:

H.E.6A.1 Analyze and interpret data to describe and compare the physical and chemical properties of saltwater and freshwater.

H.E.6A.2 Obtain and communicate information to explain how location, movement, and energy transfers are involved in making water available for use on Earth's surface (including lakes, surface-water drainage basins, freshwater wetlands, and groundwater zones).

H.E.6A.3 Plan and conduct controlled scientific investigations to determine how a change in stream flow might affect areas of erosion and deposition of a meandering alluvial stream.

H.E.6A.4 Analyze and interpret data of a local drainage basin to predict how changes caused by human activity and other factors influence the hydrology of the basin and amount of water available for use in the ecosystem.

H.E.6A.5 Analyze and interpret data to describe how the quality of the water in drainage basins is influenced by natural and human factors (such as land use, domestic and industrial waste, weather/climate conditions, topography of the river channel, pollution, or flooding).

H.E.6A.6 Develop and use models to explain how groundwater processes affect limestone formations leading to the formation of caves and karst topography.

H.E.6A.7 Obtain and communicate information to explain how the convection of ocean water due to temperature and density influence the circulation of oceans.

H.E.6A.8 Develop and use models to describe how waves and currents interact with the ocean shore.

H.E.6A.9 Ask questions about the designs of devices used to control and prevent coastal erosion and flooding and evaluate the designs in terms of the advantages and disadvantages required for solving the problems.

Draft submitted September 2013 for State Board of Education Approval

SOUTH CAROLINA
STATE DEPARTMENT
OF EDUCATION

EDUCATION OVERSIGHT COMMITTEE

Subcommittee: Academic Standards and Assessments

Date: November 18, 2013

INFORMATION/RECOMMENDATION

Cyclical Review of the State Accountability System

PURPOSE/AUTHORITY

The statutory authority for the report is from the EAA, as amended in 2008 (Act 282 of 2008):

> SECTION 59-18-910. Beginning in 2013, the Education Oversight Committee, working with the State Board of Education and a broad-based group of stakeholders, selected by the Education Oversight Committee, shall conduct a comprehensive cyclical review of the accountability system at least every five years and shall provide the General Assembly with a report on the findings and recommended actions to improve the accountability system and to accelerate improvements in student and school performance. The stakeholders must include the State Superintendent of Education and the Governor, or the Governor's designee. The other stakeholders include, but are not limited to, parents, business and industry persons, community leaders, and educators.

CRITICAL FACTS

Attached is a draft of the report which will be reviewed, amended and then forwarded to the full EOC along with the report from Educational Policy Improvement Center regarding the stakeholder feedback and accountability framework.

TIMELINE/REVIEW PROCESS

January to October 2013 – Cyclical review conducted with panel, EPIC staff, stakeholders from across South Carolina, and EOC members.

ECONOMIC IMPACT FOR EOC

Cost: $163,996

Fund/Source: EOC operating budget

ACTION REQUEST

☒ **For approval** ☐ **For information**

ACTION TAKEN

☐ **Approved** ☐ **Amended**

☐ **Not Approved** ☐ **Action deferred (explain)**

DRAFT

Cyclical Review of the State Accountability System

November 18, 2013

Summary of Recommendations

1. South Carolina should adopt the following as the goal for the State accountability system:

All students graduating from public high schools in South Carolina should have the *knowledge, skills, and opportunity* to be college ready, career ready, and life ready for success in the global, digital and knowledge-based world of the 21st century.

All graduates should qualify for and succeed in entry-level, credit bearing college courses without the need for remedial coursework, in postsecondary job training, or significant on-the-job training.

2. The measures used to determine how well our children are prepared for the 21st century will require accountability for the ***knowledge, skills,*** and ***opportunity*** as summarized below:

Knowledge

a. Grade 3 summative assessments only in English language arts and mathematics

b. Grades 4 to 8 summative assessments in English language arts, mathematics, science and social studies for all students

c. Individual student growth scores should continue to be measured

d. Reporting on subgroup scores needed to close achievement gaps

e. Improving the performance of the bottom 25 percent of students to focus on students who need the most help

f. At the high school level, High School Assessment Program (HSAP) should be replaced with assessments that have a dual purpose: (1) accountability and (2) future goals of the student. All students in the 11th grade would take WorkKeys **and** ACT plus Writing. Based upon the results of the assessments, students would then receive in their 12th grade year either the remediation needed to become college and career ready or opportunities such as dual enrollment or internships to begin the next step in their career plans.

Skills

a. Incorporate extended performance tasks across all content areas as part of classroom experience and as a function of local district accountability to ensure students develop higher order thinking skills including the ability to conduct sustained research; analyze information; experiment and evaluate; communicate in various forms; use technology; collaborate with others, problem solve; and persist. These skills cannot be measured by a single assessment.

b. Annually each school board member should be required to attend three hours of training in each of the following four key policy areas for a total of twelve hours of continuing education training each year: (1) fiscal (2) accountability; (3) leadership; and (4) communication.

Opportunity

Students need multiple pathways that address college, career and life readiness and the opportunity (quality instruction, leadership, programs, etc.) to succeed.

a. Accountability for the adults in the school i.e. teacher and principal evaluations that can be used for an overall school measure. These evaluations would include student academic achievement with a focus on student growth from one year to the next as well as other measures such as school climate surveys of teachers, students and parents.

b. Access to, participation in, and performance on other measures and assessments are important including:

- Arts programs;
- Gifted and talented programs;
- World languages;
- Dual enrollment courses;
- Approved industry certification exams;
- IB/AP exams;
- Dropout recovery programs;
- Virtual or online learning;
- Students completing a college application;
- Students filling out a FAFSA form; and
- Students completing an individualized graduation plan

3. South Carolina must measure and report publically on the postsecondary success of its public school graduates and provide incentives for preparing the hardest-to-serve students for college and career.

4. Accelerating improvements in student performance will require transformative change in classroom instruction. No longer are teachers the provider of information; they are the facilitators of learning.

- Teacher education programs must give preservice teachers more hands-on practicum experience in schools before becoming classroom teachers as well as more knowledge of the needs of the 21st century graduate

- Learning must also be more personalized to each student including project-based learning, real-time diagnostic assessments, and technology-infused instruction. Blended learning opportunities using virtual courses and virtual coaching are necessary for both teachers and students.

- Transforming the classroom will require extensive professional development and ongoing research and development. The EOC supports the initiative of *TransformSC* and the schools and districts participating. The State likely will have to invest more resources in technology as well as technical support to schools, especially those without the financial or human capital to undertake such transformative changes.

Cyclical Review of the State Accountability System

Section 59-18-910 of the Education Accountability Act (EAA) requires the Education Oversight Committee (EOC) in collaboration with the State Board of Education and a broad-based group of stakeholders in 2013 to conduct a comprehensive cyclical review of the state's accountability system for public education.

> **SECTION 59-18-910.** Beginning in 2013, the Education Oversight Committee, working with the State Board of Education and a broad-based group of stakeholders, selected by the Education Oversight Committee, shall conduct a comprehensive cyclical review of the accountability system at least every five years and shall provide the General Assembly with a report on the findings and recommended actions to improve the accountability system and to accelerate improvements in student and school performance. The stakeholders must include the State Superintendent of Education and the Governor, or the Governor's designee. The other stakeholders include, but are not limited to, parents, business and industry persons, community leaders, and educators.

In December of 2012 the EOC contracted with the Educational Policy Improvement Center (EPIC) to assist the EOC in facilitating the findings and recommendations of the cyclical review. According to EPIC, South Carolina's cyclical review process "is situated within a contemporary policy context that carries deeper and more fundamental questions for a revision of the state accountability system:

- A changing economy is demanding new skills of current and future workers;
- South Carolina ranks 37th among the states in adults with post-secondary credentials;
- Fifteen years into the accountability era, a cohort of chronically low-performing schools has shown little improvement under the current set of measures and stakes;
- A wave of local innovation – aided in part by technology advances – is shifting the delivery unit of learning from seat-time to competencies; and
- States across the country are leveraging lessons learned from the early era of accountability to engage in wholesale redesigns for 'next generation' accountability systems." [1]

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[1] Collins, Sarah K. et. al. from the Educational Policy Improvement Center. *South Carolina Accountability Review & Revision: An Analytical Framework*. Provided to the South Carolina Education Oversight Committee on August 8, 2013.

Engagement of Stakeholders

Beginning in January of 2013 members and staff of the EOC identified thirty-five (35) individuals to serve on a panel to review the accountability system. (Appendix A) Nominations were taken from the committee, from the Speaker of the House, and from the President Pro Tempore of the Senate. The panel met in Columbia on the following dates and gathered information on the following:

- February 13, 2013 – The panel received an overview of the current accountability system from EOC staff, an update on the innovation initiative efforts led by New Carolina from Dr. Gerrita Postlewait, and a presentation by State Superintendent of Education Dr. Mick Zais on his recommendations for amending the accountability system.
- April 8, 2013 – Dr. David Conley, Founder and Chief Executive Officer of the Educational Policy Improvement Center (EPIC) at the University of Oregon, discussed the post-recession job growth, projections of the workforce needs of 2020, and the four keys to college and career readiness.
- June 10, 2013 – Dr. Conley and his team from EPIC presented results of three regional stakeholder meetings and an accountability framework.
- September 16, 2013 – Cyclical review panel and EOC met in a joint meeting to discuss the framework and related accountability issues.

Three regional stakeholder meetings were also held in Charleston, Columbia, and Greenville in April of 2013. Approximately 57 individuals attended the meetings with half of the members of the cyclical review panel in attendance along with representatives of the State Board of Education, business and industry, public education, higher education, parents, and community. EPIC staff led the four-hour meetings which focused on:

- Establishing the definition of and purpose of the state's accountability system;
- Reviewing the accountability systems of four peer states, Florida, Georgia, Kentucky and New Hampshire. EPIC staff selected these states "based on the following criteria: (1) the accountability system has a clear theory of action that connects purpose, goals, and indicators; (2) at least one component of the state policy context mirrors the

environment of South Carolina; and (3) the state had recently undergone an accountability redesign process, reflecting the most contemporary educational policy agenda and available metrics for measuring school quality; "[2] and

- Designing an accountability system with actual indicators.

Between August and December of 2013 members of the EOC discussed the framework and accountability system at each EOC meeting and received input from *TransformSC*, the initiative led by New Carolina, South Carolina's Council on Competitiveness, to transform the delivery system of education. The EOC also received a specific proposal from fellow board member John Warner, a business appointee to the EOC. Finally, the Academic and Standards Subcommittee of the EOC met in November to finalize the following findings and recommendations for the full EOC consideration at its December 9, 2013 meeting.

[2] Ibid.

Findings

The academic performance of students in public schools and school districts in South Carolina is measured and reported by two accountability systems that give conflicting messages to parents, educators and communities.

Quality Counts, a publication of the education newspaper, *Education Week*, annually measures each state's public education performance against six indicators, assigning both a letter grade and a numeral score to each state. Overall in 2013 South Carolina ranked at the national average. On Standards, Assessments and Accountability, the indicators for which the EOC's core mission focuses, South Carolina earned a **Grade of A** and a numerical score of **94.4** along with a national ranking of 6th best in the nation.[3]

When the Education Accountability Act (EAA) of 1998 was enacted, there was not a separate federal accountability system. South Carolina was a forerunner in establishing a formal reporting system for public schools and school districts. With passage of the No Child Left Behind Act in 2001, South Carolina public schools have been accountable to two systems – the state accountability system that the EOC is charged with creating and the federal accountability system that once was based on Adequate Yearly Progress but now is governed by the Education and Secondary Education Act (ESEA) waiver as designed by the South Carolina Department of Education and approved by the United Stated Department of Education. Prior to the U.S. Department of Education's offer for states to receive waivers from certain requirements of the No Child Left Behind Act of 2001, 20 states had both a state and a federal accountability system. [4] Furthermore, to receive Title I funds, which total approximately $212 million annually, South Carolina must participate in either No Child Left Behind or the ESEA waiver process.

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[3] *Quality Counts, 2013*. Education Week. January 2013. < http://www.edweek.org/ew/qc/2013/state_report_cards.html>.
[4] National Governors Association. "Creating a College and Career Readiness Accountability Model for High Schools." January 29, 2012. <http://www.nga.org/files/live/sites/NGA/files/pdf/1201EDUACCOUNTABILITYBRIEF.PDF>.

While the two accountability systems use the same state assessments to measure performance, the systems are markedly different and create conflicting messages in schools and communities.

- The federal accountability system combines the absolute achievement and growth in achievement into one score across subgroups. Growth is the difference between the achievement of students in the prior year to students in the current year (two different groups of students); It should be noted that these cohorts are **NOT** the same students from year to year but compare the performance of students in the school in the prior year to the performance of students in the school in the current year (i.e. different cohorts of students.) The state system requires schools and districts to receive a status rating (Absolute Rating) and a separate growth rating (Growth Rating), which measures the improvement of **individual** student performance from year to year.

- The federal accountability system is based on **average scale scores** of students. These scores measure the **average** student performance in a school as well as average score of cohorts (students by ethnicity, disability, etc.) The federal system also measures gains made by subgroups of students. The state accountability system measures whether each **individual** student is meeting state standards or passing end-of-course assessments and the High School Assessment Program and whether each **individua**l student improved from one year to the next. The state system focuses on whether students score Met, Not Met or Exemplary on the state assessment in grades 3 through 8, not on the individual student scale scores.

- Finally, due to the August release of the federal ratings, federal grades for high schools are based on the 2011-12, the previous school year's high school graduation rate and end-of-course assessments. The state ratings for high schools are based on the results of the 2012-13 school year graduate rate and assessment data.

District 2013 Federal and State Ratings

Federal Rating	Number	%		State Absolute Rating	Number	%
A	10	12%		Excellent	30	37%
B	32	39%		Good	20	24%
C	21	26%		Average	24	29%
D	9	11%		Below Average	6	7%
F	10	12%		At Risk	2	2%
Total	82				82	

While South Carolina has witnessed sustained improvement in student performance since passage of the Education Accountability Act in 1998, the rate of improvement must accelerate to meet the 21st century needs of our state. Too many South Carolina students are still ill-served by the current public education system.

Prior to enactment of the EAA in 1998, South Carolina:

- Did not have consistent standards in English language arts, mathematics, science and social studies across all districts and schools or assessments to measure student achievement across content areas;
- Did not publically report on the performance of schools or districts using consistent measures across time;
- Did not monitor individual student performance over time because unique student identifiers did not exist;
- Did not measure the achievement gaps between subgroups of students; and
- Did not know the graduation rate for its public schools because the reporting system was not available.

In the past fifteen years South Carolina students have made sustained progress. The state's graduation rate has improved from below 60 percent to 77.5 percent in 2013. South Carolina ranks in the top half of states in the percentage of students taking and passing Advanced Placement (AP) courses. South Carolina's average ACT scores increase annually. On the National Assessment of Education Progress (NAEP), South Carolina's reading and mathematics scores at grades 4 and 8 are consistently ranked 34th to 39th nationally.

However, even with the improvement, approximately 41 percent of students who enter the two-year technical college system today require remediation in English language arts and/or mathematics at a cost to taxpayers of $21.0 million. And, one out of every four students who enter the 9th grade do not graduate with a high school diploma four or five years later.

By 2020 the Georgetown University Center on Education and the Workforce projects that 62 percent of the jobs in South Carolina will require postsecondary education. [5] Of these jobs, 34 percent will require some college, an associate's degree or some postsecondary vocational certificate.[6] As of 2011 the United States Census Bureau reports that only 34 percent of the working-age population in South Carolina had at least an associate degree. Appendix B includes a list by county of the percentage of working-age population with at least an associate's degree. The relationship between public and higher education has never been so critical to the economy of our state and to the future of our citizens.

Based upon the results of the stakeholder meetings and input from the cyclical review panel, the following recommendations are presented to the EOC for consideration:

[5] *Recovery: Job Growth and Education Requirements Through 2020*. State Report. Center on Education and the Workforce, Georgetown University. June 2013. http://cew.georgetown.edu/recovery2020/states/
[6] Ibid.

Recommendations

1. South Carolina should redefine what a strong academic foundation means for students and the goal of the State accountability system.

The original goal of the Education Accountability Act was "to establish a performance based accountability system for public education which focuses on improving teaching and learning so that students are equipped with a strong academic foundation." The stakeholders defined a strong academic foundation for 21st century students as having a strong foundation in the basics, literacy and numeracy ***and*** in higher-order thinking skills. Other descriptors included students being college and career ready, having a love of learning, being global and digital literate, and having soft skills such as collaboration and personal responsibility. Consequently, the goal of the State's accountability system for public education could be stated as follows:

All students graduating from public high schools in South Carolina should have the knowledge, skills, and opportunity to be college ready, career ready, and life ready for success in the global, digital and knowledge-based world of the 21st century.

All graduates should qualify for and succeed in entry-level, credit bearing college courses without the need for remedial coursework, in postsecondary job training, or significant on-the-job training.

This definition supports the Vision and Profile of the Successful Graduate as developed and adopted by the South Carolina Association of School Administrators and supported by *TransformSC* (Appendix C) And, the "student-centered" focus is consistent with the State Superintendent of Education's recommendations for modernizing the EAA with a personalized system..

In 2013 the Arkansas legislature enacted Act 1081 which defines college and career readiness succinctly as:

> "a set of criterion-referenced measurements of a student's acquisition of the knowledge and skills the student needs to be successful in future endeavors, including credit-bearing, first-year courses at a postsecondary institution, such as two-year or four-year college, trade school, or technical school, or to embark on a career."

Florida defines students as college and career ready when they have "the knowledge, skills, and academic preparation needed in introductory college credit-bearing courses within an associate or baccalaureate degree program without the need for remediation. These same attributes and levels of achievement are needed for entry into and success in postsecondary workforce education or directly into a job that offers gainful employment and career advancement." [7] Knowledge focuses on mastery of standards as well as higher levels of demonstrated competencies as measured by SAT, ACT, Advanced Placement, International Baccalaureate or Dual Enrollment. The term "skills" includes: effective communication skills; critical thinking and analytical skills; good time management skills; intellectual curiosity and a commitment to learning. Academic preparation encompasses students earning 24 credits, four each in English and mathematics and three each in science and social studies with one course taken online.

2. South Carolina should move from an assessment system to a balanced system of multiple measures that give comprehensive, valid and vital data to ensure that every student is prepared for the 21st century.

The measures used to determine how well our children are prepared for the 21st century will require accountability for the ***knowledge, skills,*** and ***opportunity*** that students acquire. These terms are defined below:

Knowledge – Do <u>all</u> students have the knowledge to be successful in the 21st century?

At the elementary and middle levels, knowledge would focus on measuring student understanding of content standards. Specifically, schools and districts should be held accountable for:

[7] Florida Department of Education. Division of Florida Colleges. Accessed on August 27, 2013. < <http://www.fldoe.org/fcs/collegecareerreadiness.asp>.

- Absolute scores on English language arts and mathematics in grades 3 through 8 and expanding to include science and social studies in grades 4 through 8. Stakeholders want to focus on students having the numeracy and literacy skills needed by third grade;
- Student growth scores on assessments in English language arts, mathematics, science and social studies to measure development over time;
- Reporting on subgroup scores to close achievement gaps; and
- Improving the performance of the bottom 25 percent of students to focus on students who need the most help and could be missed in subgroup data if the cohort size is too small.

At the high school level, the stakeholders resoundingly believed that while graduating from high school is important, it is no longer sufficient. Instead, student assessments used at the high school level should have a dual purpose: (1) accountability; and (2) the future goals of the student i.e. college and career. The stakeholders emphasized the need to have a measure that has "high currency outside of the accountability system." Consequently, the framework should include a variety of a variety of assessments that measure both career and college readiness such as:

- Silver level or higher on WorkKeys;
- Armed Services Vocational Aptitude Battery;
- Compass; and
- ACT, SAT or Smarter Balanced 11th grade assessment.

The EOC endorses the replacement of the High School Assessment Program with assessments that measure college and career readiness. Because the two-year technical colleges already use Compass, an ACT product, because the four-year colleges and universities in the state accept ACT Plus Writing scores in making admission decisions, and because Governor Haley in collaboration with the business community have implemented SC Work Ready Communities, the EOC would recommend that the State provide to every student in public schools the following:

All students in the 11th grade would take WorkKeys **and** ACT plus Writing. Based upon the results of the assessments, students would then receive in their 12th grade year either the remediation needed to become college and career ready or opportunities such as dual enrollment or internships to begin the next step in their jobs and career. :

To address the conflicting messages over the state and federal accountability systems, the state rating for **knowledge** should be consistent with the federal rating, if at all possible. In addition, the use of student growth in the knowledge measurement is consistent with the State Superintendent of Education's recommendations to combine student achievement and student growth into one measure of performance.

Skills – Do all students have the skills to be successful? These skills include the higher order thinking skills that stakeholders value including the ability to conduct sustained research; analyze information; experiment and evaluate; communicate in various forms; use technology; collaborate with others, problem solve; and persist.

A 2012 report by the RAND Corporation evaluated 17 state assessments and determined that fewer than 2 percent of the mathematics test items and 21 percent of the English language arts test items tested students' abilities to analyze, synthesize, compare, connect, critique, hypothesize, prove or explain their ideas.[8] What is most troubling is that these were seventeen states evaluated to have the most rigorous standards and assessments.

No standardized assessment can adequately measure these abilities. Instead, states like New Hampshire and others are using quality **extended performance tasks** to measure these skills. These extended performance tasks engage students in applying their knowledge and skills to a problem or challenge. At the high school level, extended performance tasks could be linked to work-based learning, internship opportunities and service learning projects. The results of the performance tasks would be submitted to the local school board of trustees.

According to the Center for Collaborative Education, quality performance tasks "get at essential questions of curriculum and instruction: What content is impost important? What do

[8] Yuan, K. & Le, V. (2012). Estimating the Percentage of Students Who Were Tested on Cognitively Demanding Items Through the State Achievement Tests. Santa Monica, CA: RAND Corporation.

we want learners to be able to do with their learning? What evidence will show that students really understand and can apply learned content?"[9] Performance tasks are comparable to the assessments used in the performing arts.

Nationally, organizations are creating test banks with extended performance tasks which South Carolina should have the opportunity to use. Designing rubrics and training teaches in how to assess the results of the tasks would be the next step. Two school districts, Lexington 1 and Saluda County School Districts have volunteered to work with the EOC this school year to pilot the use and assessment of extended performance tasks.

Expanding the accountability functions of the local school boards of trustees will require board members to receive ongoing professional development and training. The recommendation is that annually each school board member attends three hours of training in each of the following four key policy areas for a total of twelve hours of continuing education training each year: (1) fiscal (2) accountability; (3) leadership; and (4) communication.

Opportunity – Do all students have the opportunity to be successful? The stakeholder groups identified several potential input measures whose inclusion in an accountability system could incentivize investment in a whole school curriculum and allow for multiple pathways that address college, career and life readiness.

Teacher and principal evaluations were recommended by stakeholders as a means to hold adults accountable for the overall school rating. These evaluations would include student academic achievement with a focus on student growth from one year to the next.

Within the classroom, which is the most important change agent, the quality of teachers is critical. Stakeholders also emphasized the importance of school climate surveys of teachers, students and parents.

[9] *Quality Performance Assessment: A Guide for Schools and Districts*. Center for Collaborative Education. Boston, MA. 2012.

"*School environment is one of the most important measures of school and district performance, but it is often overlooked***."**[10]

National Governors Association

Finally, beyond summative assessments at the end of the year, access to, participation in and performance on other measures and assessments are important including:

- Arts programs;
- Gifted and talented programs;
- World languages;
- Dual enrollment courses;
- Approved industry certification exams;
- IB/AP exams;
- Dropout recovery programs;
- Virtual or online learning;
- Students completing a college application;
- Students filling out a FAFSA form; and
- Students completing an individualized graduation plan

The National Governors Association in 2012 proposed that "schools and districts should receive additional credit for supporting all students on the path to college and career readiness with a special emphasis on hard-to-serve student populations. . . . . States could give more weight to a school's scores on measures for students" who are "overage and undercredited, limited English proficient, or receiving special education services and those who scored in the bottom 25 percent on assessments in eighth grade."[11]

[10] "Creating a College and Career Readiness Accountability Model for High Schools." January 29, 2012. National Governors Association. <http://www.nga.org/files/live/sites/NGA/files/pdf/1201EDUACCOUNTABILITYBRIEF.PDF>.

[11] "Creating a College and Career Readiness Accountability Model for High Schools." Page 7.

3. South Carolina must measure the postsecondary success of its public school graduates and provide incentives for preparing the hardest-to-serve students for college and career.

The relationship between public and higher education has never been so critical to the economy of our State and to the future of our citizens. The stakeholders prioritized other measures including college acceptance rates, college persistence rates, and college matriculation rates. With development and implementation of the South Carolina Longitudinal Information Center for Education (SLICE), the State will have in the future the ability to report on the success of students in post-secondary institutions. Such data could be useful in the redesign of the high school curriculum.

In September of 2013 the Colorado Department of Higher Education released an online, searchable database that provides information on college-going rates, first-year postsecondary outcomes, concurrent enrollment and remedial education for the graduates of each school district. [12]

4. Accelerating improvements in student performance will require transformative change in the classroom by teachers who are empowered professionals with the skills and technology to facilitate learning.

Teachers are the critical component of transforming the delivery system of education. Consequently, South Carolina must invest in transforming the preparation of teachers by our colleges and universities for the 21st century classroom and the delivery of instruction in the classroom.

- Students in our colleges of education must have more hands-on practicum experience in schools before becoming classroom teachers as well as more knowledge of the needs of the 21st century graduate.

- Current and future teachers must transform their classroom instruction. No longer are teachers the provider of information; they are the facilitators of learning. Students can

[12] District At A Glance. Tracking the Success of High School Graduates. Colorado Department of Higher Education. Accessed on September 6, 2013. < http://highered.colorado.gov/Publications/districtataglance/districtglancedefault.html>.

find knowledge from multiple sources; however, students must learn to think, analyze, collaborate, problem-solve and communicate.

- Learning must also be more personalized to each student including project-based learning, real-time diagnostic assessments, and technology-infused instruction. Blended learning opportunities using virtual courses and virtual coaching are necessary for both teachers and students.

Transforming the classroom will require extensive professional development and ongoing research and development. The EOC supports the initiative of *TransformSC* and the schools and districts participating. The State likely will have to invest more resources in technology as well as technical support to schools, especially those without the financial or human capital to undertake such transformative changes.

Appendix A

Members of the Cyclical Review Panel

Name	**Representative of or Expertise in:**
Dr. Larry Allen, Clemson University	Higher Education
Dr. Cynthia Ambrose, Horry County School District	District Office/ Academic Officer
Ms. Mona Lisa M. Andrews, Florence 2 School Board	Local School Board of Trustees
Mr. Mike Brenan, President BB&T South Carolina	Business and Industry State Board of Education
Dr. Ray Brooks, President, Piedmont Technical College	Higher Education
Mr. Jon Butzon, Charleston	Community Leader
Dr. Jennifer Coleman, Richland 1	District Office/Accountability, Assessment, Research and Evaluation
Dr. James R. Delisle	Gifted and Talented Education
Mr. Jim Dumm, Tara Hall Home for Boys	Community Leader
The Honorable Mike Fair	Legislator
The Honorable Nikki Haley	Governor
Mrs. Jan Hammond, Lexington 2	Classroom Teacher
The Honorable Chip Jackson, Richland 2	Local School Board of Trustees
Dr. Rainey Knight, Darlington	District Superintendent
Ms. Charlie Jean “CJ” Lake, Saluda	Recent Student
The Honorable John W. Matthews	Legislator
Mrs. Amy McAllister	State Teacher of the Year
Mr. Charles O. Middleton, Jr.	Educator/Public Charter Virtual School
Ms. Glenda Morrison-Fair, Greenville County School District	Local School Board of Trustees
Mr. Wesley Mullinax	Business and Industry
Ms. Maggie Murdock	Parent
Ms. Linda O’Bryon	President SC ETV
Dr. Darryl F. Owing, Spartanburg 6	District Superintendent
Mr. Arthur Perry	Business Leader
The Honorable Joshua A. Putnam	Legislator
Mr. Jim Reynolds	Business Leader
Dr. Janet Rose, Charleston	Retired Educator
Mr. Phillip E. Waddell, Columbia	Business Leader
Dr. Gary West, Jasper County School District	District Office/Finance and Data Management
Dr. Leila W. Williams, Colleton	District Superintendent
Dr. Reginald Harrison Williams	Early Childhood Specialist
Dr. Carol B. Wilson, Upstate	Parent and Higher Education
Ms. Lee Yarborough, Greenville	Business Leader
The Honorable Mick Zais	State Superintendent of Education
Mr. Bernie Zeiler	Business Leader

Appendix B
Percentage of South Carolina adults (ages 25-64) with at least an associate degree by county

Abbeville	26.03
Aiken	32.63
Allendale	18.68
Anderson	30.09
Bamberg	35.93
Barnwell	21.19
Beaufort	42.18
Berkeley	29.77
Calhoun	31.39
Charleston	47.75
Cherokee	20.56
Chester	19.89
Chesterfield	20.69
Clarendon	21.56
Colleton	21.08
Darlington	24.58
Dillon	15.72
Dorchester	36.92
Edgefield	25.73
Fairfield	25.73
Florence	31.43
Georgetown	30.13
Greenville	40.93
Greenwood	32.72
Hampton	18.68
Horry	33.37
Jasper	15.74
Kershaw	28.29
Lancaster	27.65
Laurens	23.92
Lee	16.03
Lexington	38.92
McCormick	27.79
Marion	20.51
Marlboro	12.93
Newberry	30.54
Oconee	32.21

Orangeburg	25.73
Pickens	34.28
Richland	46.60
Saluda	21.45
Spartanburg	32.55
Sumter	28.82
Union	22.65
Williamsburg	18.79
York	39.99

Source: U.S. Census Bureau, 2007-2011 American Community Survey 5-Year Estimates

Appendix C

2020 Vision Committee Superintendents' Roundtable (February 2013)

A clear picture of the new high school graduate will enable schools to best accomplish the goals of preparing students for the future.

Our vision for high school graduates is based on an education compass directed toward the future. Our vision and profile of our high school graduate follows. This vision is crafted toward preparing students for success and our communities, state and nation for prosperity in the 21st century world.

Vision of the EDCompass Graduate

"The EDCompass graduate of the K-12 public schools of South Carolina will be equipped for careers and college, lifelong learning and civic life in a global, digital and knowledge based world.

Our graduates will be creative, critical thinkers, problem solvers, collaborators, capable communicators and ethical."

Profile of the EDCompass Graduate

World Class Knowledge:

1. Rigorous standards in language arts and math for college and career readiness
2. Multiple languages, science, technology, engineering and mathematics (STEM), arts and social sciences

World Class Skills:

1. Creativity and innovation
2. Critical thinking and problem solving
3. Collaboration and teamwork
4. Communication, information, media and technology
5. Knowing how to learn

Life and Career Characteristics:

1. Integrity
2. Self-direction
3. Global perspective
4. Perseverance
5. Work ethic
6. Interpersonal skills

SOUTH CAROLINA ACCOUNTABILITY REVIEW & REVISION:

AN ANALYTICAL FRAMEWORK

Sarah K. Collins, Innovation Lead
Whitney Davis-Molin, Lead Researcher
Dr. Charis McGaughy, Director of Research
Dr. David T. Conley, CEO
Educational Policy Improvement Center (EPIC)

This report was prepared on behalf of the South Carolina Education Oversight Committee (EOC). The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the EOC.

ACKNOWLEDGMENTS: The authors wish to thank the staff from the EOC for their collaboration and support of this project, from framing the original analytical and public engagement needs, to organizing the three stakeholder meetings, to synthesizing and operationalizing the findings into concrete next steps for accountability in South Carolina; the 57 individuals who generously gave a collective 228 hours of their time and immeasurable insights to the stakeholder meeting process; and the EOC Cyclical Review Panel for their candor and feedback on the initial findings of the project.

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INTRODUCTION

In 1998, The Educational Accountability Act was passed by the legislature and signed into law for the state of South Carolina. The Act established a performance-based accountability system centered on the finding that "South Carolinians have a commitment to public education and a conviction that high expectations for all students are vital components for improving academic achievement."[1] The objectives of the state accountability system were sixfold: 1) to use academic standards to increase student achievement through the alignment of assessments, policies, rewards, and assistance; 2) to provide public report cards of school quality that are clear and defensible; 3) to connect the state system with local accountability; 4) to provide resources to strengthen teaching and learning; 5) to support professional development as a key component of school improvement; and 6) to expand the state's ability to evaluate the effectiveness of its public education system.

Also included in the Act was a provision that the accountability system undergoes a cyclical review and revision process every five years. Prior cyclical reviews have resulted in incremental changes to the component measures of school quality, including adjustments to how high school graduation rates are calculated and the transition away from the PSAT/PLAN assessments. The cyclical review process of 2013, however, is situated within a contemporary policy context that carries deeper and more fundamental questions for a revision of the state accountability system:

- A changing economy is demanding new skills of current and future workers;
- South Carolina ranks 37th among the states in adults with post-secondary credentials;
- Fifteen years into the accountability era, a cohort of chronically low-performing schools has shown little improvement under the current set of measures and stakes;
- A wave of local innovation - aided in part by technological advances - is shifting the delivery unit of learning from seat-time to competencies; and
- States across the country are leveraging lessons learned from the early era of accountability to engage in wholesale redesigns for "next generation" accountability systems.

To support the cyclical review process with an evidence-based analytical framework of accountability redesign and associated trade-offs, the Education Oversight Committee (EOC) contracted the services of the Educational Policy Improvement Center (EPIC). Since January of this year, EPIC has engaged in a three-part research initiative, conducting an environmental scan to understand the current policy context of South Carolina and to identify "peer state" accountability models, designing and facilitating a series of regional meetings to elicit the values and priorities of stakeholders in the education system, and constructing an analytical framework based on findings from those stakeholder meetings. The purpose of this document is to provide a summary report of these research activities alongside the formal presentation of the resulting analytical framework.

[1] *South Carolina Education Accountability Act of 1998*; GA Title 59; Chap. 18.

STAKEHOLDER MEETINGS

In April 2013, three regional stakeholder meetings were held in Charleston, Columbia, and Greenville. EPIC researchers outlined selection criteria emphasizing that the stakeholder groups have diverse representation from K12, early learning, postsecondary, business, parents, and community partners, and the EOC issued invitations to potential participants within its network. In total, 57 stakeholders participated in the meetings across the three locations. A list of the participants and their affiliations can be found in Appendix A.

One consistent criticism of policy analysis – research activities similar to the present task of developing an analytical framework – is that it undermines basic democratic processes by replacing public participation with expert analysis.[2] Too often, stakeholder meetings constitute a formal presentation of information followed by limited or contrived opportunities for participants to provide feedback. Rather than replicating such a unidirectional approach to stakeholder engagement, these four-hour meetings were highly participatory. A series of activities invited stakeholders to act as co-designers of the analytical framework, each one intentionally organized to elicit preferences, priorities, and driving rationale for measuring school quality. The following section provides a description of each activity and summarizes high-level findings. A full report of the raw data collected at the meetings can be found in Appendix A.

Activity: Defining "True North"

In the first part of this activity, stakeholders reviewed South Carolina's definition of accountability and its purpose: "to establish a performance based accountability system for public education which focuses on improving teaching and learning so that students are equipped with a strong academic foundation."[3] Next, participants discussed with a neighbor their personal vision of a strong academic foundation. To capture individual responses, one partner wrote on an index card while the other team member spoke. After five minutes, roles reversed. Reconvening as the larger group, stakeholders expressed components or definitions that emerged across pairs. These components were synthesized on a large butcher paper.

This led into the second part of the activity, in which each participant received three voting dots to place on their top three components to be included in the group's definition of a solid academic foundation. The most highly rated components became the group's "True North." The activity closed out with a discussion of how South Carolina's current accountability measures address or do not address the highest priority components of the group's True North.

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[2] Walters, L. C., Aydelotte, J., and Miller, J. (2000). Putting More Public in Policy Analysis. *Public Administration Review*. Vol. 60 (4): pp 349-360.

[3] South Carolina Education Oversight Committee (2012). *2012-2013 Accountability Manual*. Columbia, SC: South Carolina Education Oversight Committee.

While stakeholders from each of the regional meetings independently defined their True North, there was surprising consistency across the three groups. The most strongly prioritized components of a solid academic foundation were: 1) literacy and numeracy, and 2) higher-order thinking skills. Other prioritized components common across the three stakeholder meetings included: love of learning, college and career readiness, soft skills such as collaboration and personal responsibility, leadership, creativity and innovation, confidence in abilities, learning how to learn, a well-rounded education (arts, civics, health, etc.), global literacy, and digital literacy.

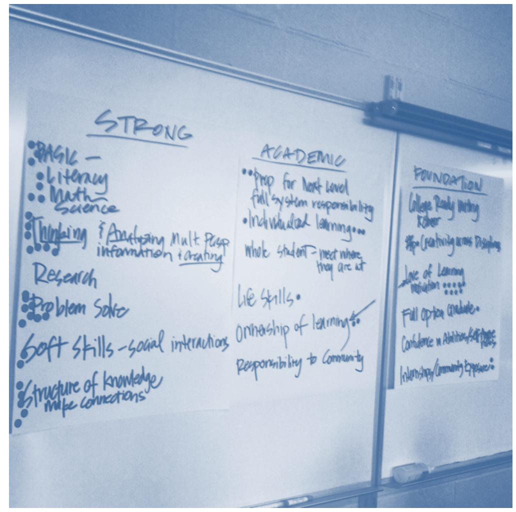

Figure 1. True North results from Columbia.

Activity: Round Robin Tournament of "Peer" States

Once participants had a common understanding of South Carolina's accountability system and a shared definition of a solid academic foundation, stakeholders were briefed on accountability systems of four peer states: Georgia, Florida, Kentucky, and New Hampshire. These states were selected based on the following criteria: 1) the accountability system has a clear theory of action that connects purpose, goals, and indicators; 2) at least one component of the state policy context mirrors the environment of South Carolina; and 3) the state had recently undergone an accountability redesign process, reflecting the most contemporary educational policy agenda and available metrics for measuring school quality. The group discussed distinguishing qualities, strengths, weaknesses, and tradeoffs for each state's accountability system. In summary, the distinguishing qualities of the state systems are as follows:

- ***Kentucky.***[4] Kentucky school ratings are comprised of data from three categories: Next Generation Learners, Next Generation Instruction and Support, and Next Generation Professionals. Within the Learner category, a score for college and career readiness is assigned alongside status, growth, and gap scores scores on subject area tests. The readiness score is computed based on percent of students meeting readiness benchmarks for college (ACT or CAMPASS placement exams), career (WorkKeys or ASVAB plus a specialized technical examination), or both. The Instruction and Support category is constituted by comprehensive school program reviews of subject areas not necessarily assessed by state exams (e.g., arts, world languages, practical living/career studies). The Professionals category takes into account performance evaluations for teachers and administrators.

[4] Kentucky Department of Education (2011). *ESEA Flexibility Waiver Request*. Accessed from US Department of Education website at http://www2.ed.gov/policy/elsec/guid/esea-flexibility/index.html

- ***New Hampshire.***[5] New Hampshire school ratings are similarly comprised of data from three categories: Knowledge, Skills, and Opportunity. The Knowledge category includes status and growth scores from state standardized tests in ELA, Math, and Science. The Skills category includes student achievement on a set of extended performance tasks designed, administered, and scored by the state. Still in pilot phase and slated for statewide roll-out in the 2014-15 academic year, these extended performance tasks take 1-2 weeks to complete and are designed to assess skills such as complex problem-solving, research, and critical thinking. The Opportunity category includes a self-assessment (subject to state audit) of whole school programs, including provision of arts and CTE coursework, information technology, and tutoring/mentoring programs.

- ***Florida.***[6] Florida school ratings include a number of data sources on student achievement and success: status and growth scores on state ELA, Math, and Science assessments; participation and performance in accelerated coursework (e.g., AP/IB, Dual Enrollment, industry certifications); students meeting college readiness benchmarks on ACT, SAT, or the state placement exam; and graduation rates. Additionally, Florida calls out its lowest-performing students – those students who are struggling the most according to the previous year's test data – as its primary subgroup of focus. School ratings include percent of the lowest-performing 25% of students who are making a year's worth of progress in reading and mathematics as well as the graduation rates for the lowest-performing 25% of students.

- ***Georgia.***[7] Georgia recently transitioned its A-F school rating system to a numeric score derived from the College and Career Readiness Performance Index, with its stated goal being "100% of Georgia high school graduates must be college and career ready and supremely competitive with students from all around the globe." The index score is composed of 19 indicators drawn from the broad categories of content mastery, post-high school readiness, and graduation rates:
    - 4-year Cohort Graduation Rate
    - 5-year Cohort Graduation Rate
    - Graduates Entering 2- or 4-Year Colleges NOT Requiring Remediation
    - Average ACT Score
    - Graduates Completing 3+ Pathway Options in the Arts or World Languages
    - Students Scoring 3 or Higher on AP Exams and/or 4 or higher on IB exams
    - Students Completing Accelerated Coursework (Dual Enrollment, AP, IB, etc.)
    - Graduated Students Earning High School 2+ Credits for a World Language

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[5] New Hampshire Department of Education (2012). *New Hampshire ESEA Flexibility Waiver Request*. Accessed from US Department of Education website at http://www2.ed.gov/policy/elsec/guid/esea-flexibility/index.html

[6] Florida Department of Education (2011). *Florida ESEA Flexibility Waiver Request*. Accessed from US Department of Education website at http://www2.ed.gov/policy/elsec/guid/esea-flexibility/index.html

[7] Georgia Department of Education (2011). *Georgia ESEA Flexibility Waiver Request*. Accessed from US Department of Education website at http://www2.ed.gov/policy/elsec/guid/esea-flexibility/index.html

- Students Completing 3+ Designated CTAE Pathway Courses
- CTAE Pathway Completers Earning a CTAE Industry-Recognized Credential
- Students Receiving a Silver or higher on the Georgia Work Ready Assessment
- Students Scoring at Meets or Exceeds on End-of-course-exams (9th Grade Literature, American Literature, Math I/Algebra, Math II/Geometry, Physical Science, Biology, US History, and Economics)

Participants were then asked to identify their preferences between state models. This was done through a maximum differential exercise – termed a "round robin tournament" – in which participants compared all possible pairs of state systems (NH vs. KY, NH vs. FL, NH vs. GA, GA vs. FL, GA vs. KY, KY vs. FL). Participants selected the model that they preferred most between the given two states and provided a rationale statement for their preference. Among the four states, Kentucky's 3-part accountability model was most preferred by stakeholders at all three meetings, receiving at total of 92 votes. Florida received 83 votes, followed by New Hampshire's 70 and Georgia's 31 votes.

While this data reveals a basic rank-order of system preferences, some clear and compelling themes emerged in the rationale statements that accompanied stakeholders' selections. Some stakeholders justified their preference based on what they didn't like about the other state. This was most often the case with Georgia's system, as many stakeholders found the single index score based on 19 indicators too confusing and lacking clarity. Those who did prefer Georgia over other state systems, however, liked the comprehensive nature of the system and the way it provided schools multiple options to support students' pathways toward college and career readiness.

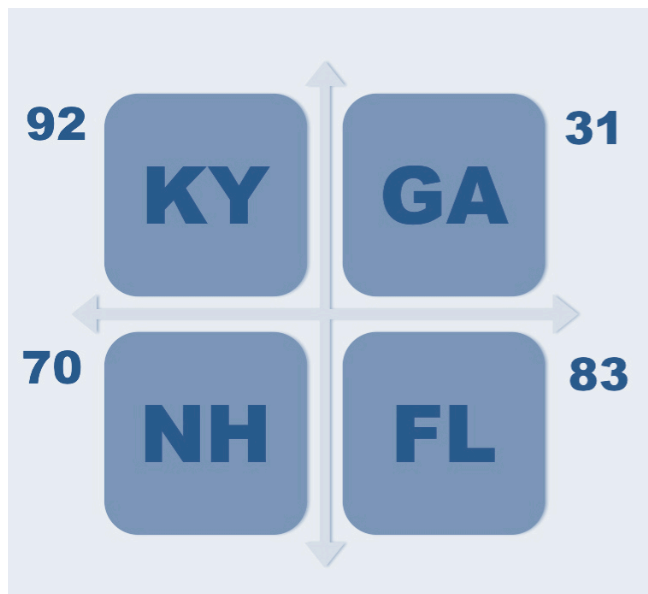

Figure 2. Overall scores from the Round Robin Tournament.

Overwhelmingly, New Hampshire's inclusion of extended performance tasks to assess more complex thinking skills was the basis of most stakeholder preferences for that state system. Comments often echoed one participant's sentiments: "If we're going to teach to the test, let's have meaningful tests worth teaching to, like the performance tasks in New Hampshire." Other stakeholders acknowledged the importance of assessing these skills but were wary of technical feasibility and financial viability of statewide performance assessments.

Stakeholder preferences for Florida's accountability model largely fell into two categories of rationale. First, the focus on the lowest-performing 25% as the state's subgroup was often viewed as an innovative and compelling alternative to racial subgroups. “It forces schools to focus on the kids who need the most support,” one stakeholder wrote. Second, the system’s inclusion of participation and performance in accelerated coursework was a compelling feature because: 1) it drove concrete behavior for school improvement beyond just increasing test scores; 2) it forced schools to provide these opportunities to students who might not have otherwise received them; and 3) performance in accelerated coursework had currency outside of the accountability system (i.e. student received college credit or industry certifications for future employment).

Similar to this last issue of currency outside the state accountability system, stakeholders often cited the college and career readiness measures for Kentucky’s accountability system as their preference rationale. Each of the assessments used to determine readiness had some sort of portability and value for the student’s future plans, whether its an ACT score for college applications, a WorkKeys score to share with potential employers, or an ASVAB score for entrance into military service. More than the currency of the readiness assessments, however, stakeholders most often cited the “balanced” and “comprehensive” approach to Kentucky’s system that holds schools accountable for student achievement, school programs, and effective educators.

“Balanced” and “comprehensive,” however, were not the sole province of the Kentucky system. These descriptors were consistently ascribed to all four systems as qualities stakeholders were looking for in an accountability model. Other common descriptors in stakeholder rationale statements included “innovative,” “feasible,” “meaningful,” “flexible,” and “easy to understand.” Several stakeholders noted how these qualities were often in opposition to one another (e.g., innovation/feasibility of performance assessments or flexibility/clarity of an index score). Others noted that no one system had a combination of qualities that fully satisfied their preferences. The opportunity to select and combine indicators to meet their preferences would be offered in the final two activities, yet with different constraints and tradeoffs attached.

Activity: Indicator Matrix

In the third activity of the day, participants independently completed a worksheet matrix with twenty-eight possible accountability indicators. Each participant individually rated every indicator on a scale of 0-3, ranging from 0 (not important) to 3 (most important) as it related to supporting the group’s True North. Stakeholders were also asked to provide a rationale statement for each rating, and they identified their top three indicators with stars. The worksheet also afforded space for indicators that stakeholders felt were missing from the list that supported components of their True North.

Data from this activity came in two forms: indicators with the highest average ratings and indicators with the most number of priority stars. Figure 3 provides a side-by-side comparison of the 10 indicators with the highest average rating and those most prioritized. These two “top 10” lists have interesting commonalities and differences. Given an unlimited set of choices, stakeholders tended to give high ratings to new indicators related to postsecondary readiness and 21st Century skills. In a situation of constrained choices, they selected more traditional measures. In fact, every component of the state's current accountability was among the stakeholders' top 10 most prioritized indicators. The only "new" or "innovative" indicators that defied this trend were extended performance tasks, measures of teacher quality, and performance on ACT/SAT, each appearing on both preference lists.

Figure 3. Comparison of Highest Average and Most Prioritized Accountability Indicators

Indicators with Highest Average Ratings	Most Prioritized Indicators
Graduation Rates	Reporting on Subgroups
Extended Performance Tasks	Growth on Standardized Test Scores
Growth on Standardized Test Scores	Extended Performance Tasks
Reporting on Subgroups	Graduation Rates
Performance on ACT/SAT	Absolute Scores on State Standardized Tests
Measures of Teacher Quality	Performance on ACT/SAT
College Remediation Rates/Placement Scores	Measures of Teacher Quality
College Persistence Rates	End of Course Exams
Absolute Scores on State Standardized Tests	% of students who filled out a career plan
Performance in IB/AP	HS Exit Exams: ELA and Math

Activity: Create Your Prototype

In the final activity of the day, stakeholders broke out into small groups to build prototypes of their optimal accountability systems. They used their worksheet matrices, comparable states models, and True North definition to select indicators to include in their systems. A facilitator joined each group to document points of contention, non-negotiables, and trade-offs that were discussed. The day concluded with each team presenting their system to the larger stakeholder group.

The activity's primary challenge was found in stakeholders reaching consensus on what elements to include in their optimal systems. Some teams accommodated this challenge by including everyone's favorite indicators, resulting in systems that looked like laundry lists and lacked coherent frameworks. Others had such difficulty coming to agreement on certain issues that their systems were composed of a scant few indicators or key concepts. One interesting outcome of some group systems was the introduction of new indicators that had not yet been addressed in the day yet met criteria and rationale that were consistent through earlier conversations. Specifically, these indicators included a school climate survey and longitudinal tracking of students well into their postsecondary education and/or career path. Appendix A contains a full listing of each group's prototype with accompanying facilitator notes, yet the following indicators were most common to the group system prototypes:

- Growth Scores on State Standardized Tests
- Performance Tasks/Extended Project
- Opportunity-to-Learn Measures
- Subgroup Data

- Educator Evaluations
- Participation and Performance Dual Enrollment/IB/AP
- Assessments of Soft Skills
- School Climate Surveys
- A CCR Indicator (undefined)

Figures 4 – 5 – 6. Stakeholders broke into small groups to negotiate and prototype optimal accountability systems.

In summary, the stakeholders convened by these three regional meetings brought a diverse set of perspectives alongside a shared commitment to improving public education for South Carolina students. Following the meetings, a survey was distributed to participants to gather feedback on their experiences. A full report of survey data is presented in Appendix B, where overall participants reported that the meetings were sufficiently diverse, informative, engaging, and effective in soliciting participants' insights. In addition to convening an engaging public process, these meetings were successful in gathering a wealth of data to inform the construction of an analytical framework for the Educational Oversight Committee to evaluate options and tradeoffs for the revision of the state's accountability system, discussed in the next section.

ANALYTICAL FRAMEWORK

The purpose of this analytical framework is to provide a structure for decision makers to consider the trade-offs associated with potential components of the next generation accountability system for South Carolina public schools. Cornerstone to the construction of the framework is the input of stakeholders into its very design. As such, researchers analyzed stakeholder meeting data to generate content for two axes of the framework: a rank-order listing of measurement options and a set of criteria to evaluate the extent to which the measures support the state's (or the stakeholders' goals and values, at the very least) underlying goals and values.

To generate the rank-order of potential measures, quantitative data from each of the stakeholder meeting activities was combined into a single preference rating for each indicator identified in the meetings. Rationale statements and facilitator notes then underwent a qualitative coding process, identifying additional counts of indicator preferences to be included in the preference ratings. A normative cut score was identified where overall ratings were two standard deviations from the mean, leaving a total of 29 indicators for consideration in the framework. Because this rating approach was a rough approximation of stakeholder preferences, criteria were sorted based on ratings yet overall scores were not reported in the framework. Appendix C defines each of the following rank-ordered indicators:

1) Growth Scores on State Standardized Tests: ELA, Math, Science, Social Studies
2) Extended Performance Tasks
3) Reporting on Subgroups
4) Input measures on School Programs/Program Reviews
5) Graduation Rates
6) Performance on College Aptitude Exam (SAT/ACT)
7) Performance on Commercial Career Readiness Exam (e.g., WorkKeys)
8) Percent Passing College Placement Exams
9) Performance in IB/AP courses
10) Performance in Dual Enrollment
11) Participation in IB/AP courses
12) Participation in Dual Enrollment
13) Educator Evaluations
14) Input measures on Teacher Quality
15) Performance or growth of the lowest 25%
16) College Persistence Rates
17) Absolute Scores on State Standardized Tests: ELA, Math, Science, Social Studies
18) End of Course Exams: ELA, Math, Science, and Social Studies
19) HS Grades
20) Participation in ACT/SAT
21) College Matriculation Rates
22) College Acceptance Rates
23) Self-Reported School Climate
24) Metacognitive Assessment
25) % of students who filled out a career plan
26) HS Exit Exams: ELA & Math
27) Performance on military exams
28) % of students completing a college application
29) % of students filling out a FAFSA

To generate the evaluative criteria, stakeholder rationale statements and facilitator notes underwent another qualitative coding process to identify the most prevalent goals and values identified through each of the meeting activities. These goals and values were aggregated into 9 thematic categories, and researchers generated “essential questions” for each category.

Documented separately in Appendix D, the criteria categories and essential questions are as follows:

- *Basic KSAs:* Does it assess the basic knowledge and skills students need to live, learn, and work in the 21st century?
- *Higher Order Thinking:* Does it assess the critical thinking and complex problem solving skills students need to live, learn, and work in the 21st century?
- *Meaningful:* Does the measure have meaning or currency outside of the accountability system?
- *Clear:* Can the measure be clearly communicated and understood by the public?
- *High Needs:* Does it address students with the highest need?
- *Pathways:* Does the measure promote high aspirations, regardless of their future pathway? (college, career, military)
- *Feasible:* Is it feasible to implement this measure with fidelity at the state level? (political, administrative, technical)
- *Whole School:* Does it hold the whole school accountable? Does it define quality across the whole school building? (curriculum, instruction, opportunities to learn, resources)
- *Aligned:* Does it promote alignment across the education system?

With the content of the axes identified based on stakeholder meeting data, researchers then completed the framework by answering the essential questions for each indicator. The extent to which the indicator satisfied each of the criteria was determined on a progressive scale of not met/satisfied, partially or conditionally met/satisfied, and met/satisfied. Figure 7 describes the symbols used in the framework to illustrate the progressive scale. The final element of the analytical framework is a brief discussion of trade-offs for each potential indicator. These trade-off discussions represent an accumulation of analysis collected through both previous EPIC policy analyses as well as research completed by other leading experts in accountability and educational measurement.

Figure 7. Framework Symbols for Criteria Rating

Symbol	Rating
	Met/Satisfied
	Partially Met/Satisfied
	Not Met/Satisfied

The following pages contain the full analytical framework, across 9 evaluative criteria and 28 indicators. A set of recommendations for using the framework closes this section of the report.

Indicator	Basic KSA	Higher Order Thinking	Meaningful	Clear	High Needs	Pathways	Feasible	Whole School	Aligned	Trade Offs	Overall Ranking
Growth Scores State Standardized Tests: grades 3- 8 (ELA, Math, Science, and Social Studies)	●	○	○	●	○	○	●	○	●	Promotes alignment and measures development over time rather than benchmark status. Constraints arehyper focus on the test scores not addressing whole school quality. Challenges at exit level where large growth gains still don't meet postsecondary readiness trajectory.	1
Extended Performance Tasks	●	●	○	◑	○	○	◑	◑	◑	Generate better data on complex thinking, and focuses curriculum on readiness skills. Tasks must be integrated into regular instruction and meet techinical adequacy requirements. Large scale version is not feasible at this point to without infrastructure to support implementation.	2
Reporting on Subgroups	◑	◑	◑	●	●	○	●	○	◑	Critical to addressing the achievement gap, highly rated by stakeholders. Technical constraints relate to N size variability - at what point is a subgroup a subgroup, statistically versus reality?	3
Input measures on School Programs/Program Reviews	○	○	●	◑	○	◑	●	●	○	Incentivizes investment in a whole school curriculum in exchange for a focus on activities vs. outcomes. Ensures curriclum is aligned with goals, allows multiples pathways that all address readiness; requires curriculum revision as an all-school activity and requires external reviews.	4
Graduation Rates	●	○	●	●	○	●	●	●	○	Critical prerequisite to postsecondary success; established and familiar foucs of policy and research; clear target motivates some students. Tends to be more of an endurance measuer than quality, with tremendous variability in KSAs and subject to manipulation.	5
Performance on College Aptitude Exam (SAT/ACT)	●	○	●	●	○	◑	●	○	○	Exchanging a measure that has high currency outside of the system for a narrow focus and non-actionable data to inform indivudal student imporvement. Offers longitudinal trend data and is normally distributed. An eligibilty not a readienss measure; no real or natural cut score.	6
Performance on Commerical Career Readiness Exam (e.g., WorkKeys)	●	○	●	●	○	●	●	○	●	Provides an alternative/complement to college readiness measures that is used by employers as well. Basic skills assessment. Trade currency for rigor/challenge.	7
Percent Passing College Placement Exams	●	○	●	●	○	●	●	○	●	Useful tool with value outside the system in exchange for a narrow focus on basic skills. Procedural representation of postsecondary readiness. Focuses attention on the problem and linked to fiscal and financial issues. Diagnostic at item level analysis with individualized interventions.	8

Indicator	Basic KSA	Higher Order Thinking	Meaningful	Clear	High Needs	Pathways	Feasible	Whole School	Aligned	Trade Offs	Overall Ranking
Performance in IB/AP courses	●	●	●	●	○	●	●	●	●	Expensive for districts, cost-saving for students. External currency and spans all subject areas. Sets a high bar. Exams consistent across disctricts and states; more complex assisgments. Access issues, bar might be too high for all students. Needs CTE complement.	9
Performance in Dual Enrollment	●	◑	●	●	○	●	●	●	●	Requires availability of dual enrollment programs, policy considerations to promote them. The higher number of college credits earned in HS, the higher the probability of postsecondary success.	10
Participation in IB/AP courses	○	○	●	●	○	●	●	●	●	Incentivizes activity over achievement. Increases access to a high bar for participating students offering more complex assignments and expectations. Not all students might need for desired career aspirations. Measure best implemented with CTE Acceleration/Certification for balance.	11
Participation in Dual Enrollment	○	○	●	●	○	●	●	●	●	Requires availability of dual enrollment programs, policy considerations to promote them. Promotes activity vs. performance. Large variance in courses requiring external review.	12
Educator Evaluations	○	○	●	○	○	○	◑	●	○	Holds adults accountable for overall school rating, yet high variability/unreliable methods for conducting evaluations when applied to such a high stakes context. Also, political feasibility is an issue that must be considered.	13
Input measures on Teacher Quality	○	○	●	◑	○	○	●	●	○	Focusing on inputs (teacher prep) and not student outcomes in exchange for holding adults accountable in the system. Need criteria to evaluate the input measures, but not strong research to understand relationship between inputs and outcomes.	14
Performance or growth of the lowest 25%	●	◑	○	●	●	○	●	◑	○	Focuses on the students who need the most help a critical population that could span (or be missed by) subgroup data, but typically applied to measures that focus on content knowledge.	15
College Persistence Rates	●	●	●	●	○	●	◑	●	●	Data systems and infrastructures challenges. Holding K-12 accountable for a higher ed measure, assumes causation for an outcome prone to factors beyond the control of K12 educators.	16

Indicator	Basic KSA	Higher Order Thinking	Meaningful	Clear	High Needs	Pathways	Feasible	Whole School	Aligned	**Trade Offs**	**Overall Ranking**
Absolute Scores State Standardized Tests: grades 3- 8 (ELA, Math, Science, and Social Studies)	●	○	○	●	○	○	●	○	●	Narrow focus on content knowledge, bubble kids, kill/drill. Well established and typically correlate to first-year college GPA. Challenges are that they have low performance levels and ceiling effect issues.	17
End of Course Exams: ELA, Math, Science, and Social Studies	●	○	○	●	○	○	●	◑	○	When done well, EOC Exams can represent the cumulative knowledge in core content areas. Too many concerns in the state about the rigor, quality, and relevance of the current instruments and they are not connected to postsecondary aspirations/pathway.	18
HS Grades	●	◑	●	●	○	○	○	●	○	Well established, familiar to public; somewhat of a composite measure; single metric for all subjects and courses; and no additional costs to administer. Challenges incude highly variable compostion; difficult to say what it measures; subject to false precision and gaming.	19
Participation in ACT/SAT	○	○	●	●	○	●	●	○	●	Promotes an activity that connects to postsecondary aspirations. Incentivizes an activity of taking the test not the quality instruction that promotes student success with them. Trading Access for learning	20
College Matriculation Rates	○	○	●	●	○	●	●	●	●	Data and technology infrastructure. Threat of gamifaction - pushing students into colleges when they are not ready nor wanting to go. Measure of how well high schools focus on college, tangible goal with strategies to increase; yet Indicator is influenced by outside factors.	21
College Acceptance Rates	○	○	●	●	○	●	●	●	●	Narrow measure of postsecondary options. Needs to be accompanied by other measures. Measure of how well high schools focus on college and promote student aspirations; eligibility does not equal readiness.	22
Self-Reported School Climate	○	○	○	◑	○	◑	◑	●	○	Can cover a much wider range of variables, can be sufficiently reliable, relatively inexpensive, and generate actionable information. Challenges are the general distrust of self-reported information, can't be linked to high stakes accountability, and requires addtional time for completion.	23
Metacognitive Assessment	○	◑	○	◑	○	○	○	●	○	Can cover a much wider range of variables, can be sufficiently reliable, relatively inexpensive, and generate actionable information. Challenges are the general distrust of self-reported information, can't be linked to high stakes accountability, and requires addtional time for completion.	24

Indicator	Basic KSA	Higher Order Thinking	Meaningful	Clear	High Needs	Pathways	Feasible	Whole School	Aligned	**Trade Offs**	**Overall Ranking**
% of students who filled out a career plan	○	○	●	●	○	●	●	●	●	By making it a box to check, may have less meaning. Important goal if implemented with fidelity providing access to sometimes privileged information and advancing aspirations. Not a measure of readiness, many students will change career plans, and wide variance in level of effort.	25
HS Exit Exams: ELA & Math	●	○	●	●	○	○	●	○	○	Too many concerns in the state about the rigor, quality, and relevance of the current instrument. Eliminating exit exam while still measuring graduation rates further incentivizes schools to push students though without having to demonstrate mastery at an exit level benchmark.	26
Performance on military exams	●	○	●	●	○	●	●	○	●	Unique indicator with outside currency for students with military aspirations; low passage rates and challenge level to prepare students for a full range of postsecondary options. Best used as complement with career and college-oriented measures.	27
% of students completing a college application	○	○	●	●	○	●	●	○	●	Important goal for accesssing important privileged procedural information and goes beyond graduation rates, measures aspiration not readiness, can be "gamed" by having everyone apply and falls short of matriculation.	28
# of Students who fill out a FAFSA	○	○	●	●	○	●	◑	○	●	Requires parent/guardian involvement, need to consider undocumented students. Should be accompanied by other efforts (e.g., financial literacy). Could help students who don't think college is affordable see it as an attainable goal.	29

Recommendations for Using the Framework

As illustrated in the previous pages, no single indicator addresses all of the framework's evaluative criteria. Nor should that be the case, as stakeholders consistently called for an accountability model that was both balanced and comprehensive. This design consideration is echoed by the Council of Chief State School Officers' recent monograph, *Roadmap for Next-Generation Accountability Systems*, which recommends using a mix of indicators to support and enhance student achievement and postsecondary readiness.[8] In identifying such a mix of indicators, this analysis recommends starting with those measures included in the current accountability system. Which evaluative criteria do these measures address? Are there certain criteria that are overemphasized in the current system while others go unaddressed? Based on both lessons learned from fifteen years of state accountability and the brief discussions of trade-offs in the framework, are there current indicators whose weaknesses outweigh their utility or strengths?

To select new - or replace current – indicators for the system, decision makers might consider using convergent consensus. Such a process would check and balance decision makers' preferences against the rank-ordered preferences captured in the stakeholder meetings. Comparing the EOC's preferences to that of the stakeholders, are there specific evaluative criteria that emerge as taking on greater importance or priority? What's the basis for this prioritization – political pragmatism, feasibility of implementation, commitment to reform, or otherwise? How does this compare to the underlying values of stakeholders' prioritization? An effective convergent consensus process would negotiate a middle ground between the priorities of decision makers and stakeholders.

Lastly, the identification of indicators should follow some structured framework for defining school quality, combining indicators in such a way that the state's theory of action or underlying values are clearly communicated. Recalling the structure of Kentucky's accountability model (Next Generation Learners, Instruction and Supports, and Professionals) or that of New Hampshire (Knowledge, Skills, and Opportunity), what framework of quality will the state's accountability measures combine to communicate? This framing issue is an important one, understanding that what is measured and reported must be tightly linked to requisite actions, supports, and interventions.

CONSTELLATION OF POLICY CONSIDERATIONS

The revision of the state accountability system does not operate in isolation. As both a process and final set of decisions, it exists within a constellation of other policy considerations with deep implications for its capacity to measure and drive school quality. While not an exhaustive

[8] Council of Chief State School Officers (2011). Roadmap for Next-Generation State Accountability Systems. Washington, DC: Council of Chief State School Officers.

list, the following considerations were derived from an environmental scan of South Carolina's policy context and a set of "parking lot" issues generated during the three stakeholder meetings.

Multiple Accountability Systems

Currently, South Carolina schools are subject to accountability measures under state and federal systems that often send conflicting messages about school quality to educators and the public at large. For example, only one district met its federal Adequate Yearly Progress goals in 2011, meanwhile nearly 70 percent of South Carolina schools were given awards through the state Palmetto Gold and Silver Program that same year.[9] Many states used the ESEA Flexibility Waiver as an opportunity to combine federal and state accountability requirements into a single system. Yet such a decision comes with trade-offs, exchanging clarity and focus for the constraints of federal requirements.

A set of alternatives exist, namely in forms of a "multiple measures" state report card and innovation districts. In a multiple measures report card, the EOC would report those measures of academic knowledge and skills as outlined by federal accountability requirements and managed by the South Caroline Department of Education, alongside new categories of school quality that emerged through the stakeholder meetings and analytical framework (e.g., 21st Century Skills, Opportunities to Learn, and Future Success Indicators). In such a system, schools would aim to earn "straight A's" across categories rather than a single rating, while at the same time the accountability system itself would communicate a more comprehensive profile of school quality to the public. Innovation districts, as were adopted by the state of Kentucky with through 2012 legislation, constitute a system within a system. In such a design, a select group of districts are released from certain state accountability provisions to develop, pilot, and incubate new models school reform and new measures of school quality.

Graduation Requirements

Across the three stakeholder meetings, graduation rates were identified as important outcomes, yet concerns were consistently raised as to the quality and rigor of the state's high school exit exam. This issue has recently been elevated to a critical level with the introduction of legislation to eliminate the exam altogether. These concurrent policy processes raise the fundamental questions of the meaning of a high school diploma, what knowledge and skills are signified by its award, and whether graduation rates then meet the quality criteria of this revision process. Furthermore, if the exit exam is removed from diploma requirements and graduation rates are retained as a component of the state accountability, the issue of "gaming" must be carefully considered. Holding aside considerations of the quality of the exam, the HSA has acted as an external check to the internal process of moving a student through high school to graduation. With no external check, the inclusion of graduation rates in a school rating

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[9] South Carolina Department of Education (2012). *South Carolina ESEA Flexibility Waiver Request*. Accessed from US Department of Education website at http://www2.ed.gov/policy/elsec/guid/esea-flexibility/index.html

creates a perverse incentive for schools to grant diplomas to students who may not necessarily be academically prepared to graduate.

There are, however, a number of mechanisms available to address this perverse incentive. An alternative assessment or external milestone could be introduced to state diploma requirements (e.g., a locally-administered senior capstone project). Graduation rates could also be given a quality rating. In this measurement approach, two schools with 70% graduation rates would receive different quality ratings if one graduated the majority of its students with the minimum diploma requirements and the other graduated the majority of its students with rigorous coursework (e.g., four years of math and science, a concentration in a career technical field that culminated in an industry certification, or focused pursuit of fine arts).

Defining the End Goal

Related to (but separate from) the issue of the high school graduation requirements is that of the end goal for students in the South Carolina public education system, and thus the target or "True North" driving school improvement through the state's accountability system. The Education Accountability Act of 1998 stated a broad goal of equipping students with "a strong academic foundation," and in 2009 the EOC adopted the 2020 Vision in which "all students will graduate with the knowledge and skills necessary to compete successfully in the global economy, participate in a democratic society, and contribute positively as members of families and communities." What is lacking, however, is an explicit and actionable description of that academic foundation or the knowledge and skills to successfully learn, live, and work in the 21st Century. Whether termed a college and career readiness definition or otherwise, the adoption of such a description is fundamental to the identification of accountability indicators and alignment with the system's theory of action. Moreover, the identification of a True North facilitates strategic investments in school and system improvements that are aligned with the state's accountability system.

CONCLUSION

The review and revision the state accountability system presents a significant occasion for South Carolina to focus its efforts on impact, opportunity, and innovation. That is no small task, and this analytical framework aims to support the revision process by laying out an array of options, gathering feedback from stakeholders on their priorities and preferences, and exploring the tradeoffs associated with different accountability measures and models.

APPENDIX A – Stakeholder Meeting Raw Data

In April 2013, three stakeholder meetings were held in Charleston, Columbia, and Greenville. This included a total of 57 participants that were selected by the South Carolina Education Oversight Committee (EOC). Researchers requested that the EOC issue invitations to potential participants within their network. EPIC outlined selection criteria emphasizing that the final group have a diverse representation across K12, Early Learning, Postsecondary, Business, Parents, and Community partners. A list of the participants and their affiliations follow. Stakeholder meetings were specifically designed to elicit preferences, priorities, and driving rationale for measuring school performance.

Table A-1. Participants from Stakeholder Groups

Participant	Affiliation
Dr. Tammie Pawloski	Director of Center of Excellence to Prepare Teachers for Teaching Students in Poverty
Dr. Windy Schweder	Associate Professor of Special Education, USC-Aiken
Ms. Melanie Cohen	Principal, River Springs Elementary School
Dr. Karen Woodward	Superintendent, Lexington One School District
Mr. Chip Jackson	Chair, Richland School District Two Board of Trustees
Ms. Mary Margaret Hoy	Richland School District One, Div. of Accountability
Ms. Marjorie Cooper	Student at Columbia College, Teaching Fellow interning at EOC
Ms. Bunnie Lempesis Ward	Director, Early Education and Policy, United Way of the Midlands
Ms. Mildred Phyllis Harris	Parent
Ms. Rebecca Kolb	Youth and Family Services Supervisor, Richland Library
Mr. Ken May	Director, SC Arts Commission
Ms. Janet Lawrence-Patten	Principal, Aynor High School
Dr. Reginald Harrison Williams	SC State professor
Mr. Shawn Rearden	Parent
Ms. Kristen Setzker Simensen	Director, Calhoun County Library
Cindy Ambrose	CAO, Horry County Schools
Phil Waddell	South Carolina Chamber of Commerce
Lemuel Watson	Dean of USC School of Education
Dr. Tony Johnson	Dean, School of Education, The Citadel
Mr. Michael Petry	Teacher, Cane Bay High School
Mr. Brian Solski	Teacher, R.B. Stall High School
Gary West	Jasper County School District Office
Mr. Bill Jordan	Public Affairs Consultancy, Jordan House
Adrian R. King	Parent
Ms. Diette Courrege Casey	Reporter, Charleston Post and Courier
Jon Butzon	Charleston Education Network
Janet Rose	(Retired) Dir. Of Accountability with Charleston County School District
Jim Dumm	Tara Hall Home for Boys
Ms. Eileen Rossier	Trident United Way, VP of Education and Program Evaluation
Mr. Jim Frye	(Retired) Businessman
Dr. David Longshore (maybe)	SC State Board of Education
Ms. Alana J. Ward	Parent
Ms. Erika Taylor	Exec. Dir. Strategy and Communications, Charleston County School District

Ms. Lisa Patrick	Dept. of Assessment and Accountability, Dorchester School District 2
Jessica Jackson	K-12, Boeing
Barbara Hairfield	EOC
Ed Moore	Berkeley County School District Curriculum Specialist
Drew Miller	Science Applications Int'l Corp.
Sarah Hogenson	Boeing
Mike Petry	Berkeley County School ELA HS Teacher/Business Owner
Brian Solski	Charleston County HS SS Teacher
Sean Alford	Dorchester 2 School District
Ms. Dana Howard	Teacher, Daniel High School
Mr. Wallace Hall	Director of Special Projects, Greenwood 52
Ms. Dru James	SC State Board of Education
Glenda Morrison-Fair	Greenville County School Board
Dr. Darryl Owings	Superintendent, Spartanburg County School District 6
Ms. Cheryl Smith	FLUOR, Community and Public Affairs
Lee Yarborough	Propel HR and a parent
Geier Mullins	Director, Public Education Partners
William W. Brown	Wealth Coach / Family Legacy Inc.
Charles Middleton	Cyber Academy of NC; Cyclical Review Committee
Greg Tolbert	Director, Spartanburg Boys and Girls Club
Herb Johnson	Michelin North America
Jason McCreary	Greenville County Schools, Div. of Accountability and Quality Assurance
Dr. Sandy Addis	Associate Director, National Dropout Prevention Center, Clemson University
Ms. Jacki Martin	The Riley Institute, Furman University

Activity: Defining Our "True North"

In the first phase of this activity the stakeholder group reviewed South Carolina's definition of accountability and its purpose: "to establish a performance based accountability system for public education which focuses on improving teaching and learning so that students are equipped with a strong academic foundation" (2012-2013 Accountability Manual, Education Oversight Committee).

Next, Participants discussed with a neighbor their personal vision of a strong academic foundation. To capture individual responses, one partner wrote on an index card while the other team member spoke. After five minutes, roles reversed. Reconvening as the larger group, stakeholders expressed components or definitions that emerged across pairs. These components were synthesized on a large butcher paper.

This led into the second phase of the activity, in which each participant received three voting dots to prioritize the components of a solid academic foundation. They were asked to place their voting dots on the top three components to be included in our group's definition of a solid academic foundation. The most highly rated components became the group's True North. The activity closed out with a discussion around South Carolina's accountability measures and how the current indicators address or do not address the highest priority components of our True North.

Table A-2. Data collected from True North Activity

CHARLESTON		COLUMBIA		GREENSVILLE	
Themes	**Votes**	**Themes**	**Votes**	**Themes**	**Votes**
Thinking Skills/Analysis	15	Love of learning/motivation	9	College/Career/Citizen Readiness	11
Literacy	10	Thinking and Analyzing Multiple Perspectives, information and creating	7	Knowledge + Skills + Dispositions in context	8
Numeracy	7	Problem Solving	7	Basics R's	8
Soft Skills (Characters, Ownership)	5	Basic Literacy, math, science	6	Beyond the basics (Science skills, civics/history, arts education, physical/health)	5
Learn how to learn	4	Structure of Knowledge - make connections	5	Critical Thinking/Higher Order	3
Multiple Language	4	Full system responsibility	4	Soft Skills	2
Problem Solving	3	Soft Skills - social interactions	2	Communication	1
Current Events, Globally	3	Prep for next level	2	Individualized	1
Modes of Inquiry	3	Ownership of Learning g	2	Healthy Kids - Exercise and Diet	0
Collaboration Teamwork	2	Internship/community Exposure	2	Leadership	0
Disciplines for Broad Education	2	Life skills	1	Raising the bar to be competitive nationwide	0
Research Evaluating Information	2	Creativity Across Disciplines	1	Social Skills	0
Creativity/Innovation	2	Full Option Graduate	1	Well-Rounded Child/Full-Option Graduate	0
Digital Literacy	2	Research	0	Desire to Learn	0
Standard English	1	Individualized Learning	0		
Civics, Democracy	1	Whole Student - meet where they are at	0		
Life Ready Knowledge and Skills	0	College and Career Ready Writing	0		
Reading to 12th Grade	0	Motivation	0		
Scientific Inquiry	0	Confidence in Abilities/Self-Awareness	0		
Humanities Beyond Employability	0	Responsibility to community			

Life long learner	0				
Global Metric	0				
Competency, not seat time	0				
Individualized Learning	0				
Flexibility/Adaptability	0				

Activity: Comparable States

Once participants had a common understanding of South Carolina's accountability system, stakeholders were briefed on accountability systems of four peer states: Georgia, Florida, Kentucky, and New Hampshire. These four states were selected based on the following criteria: 1) the accountability system has a clear theory of action that connects purpose, goals, and indicators; 2) at least one component of the state policy context mirrors the environment of South Carolina; and 3) the state had recently undergone an accountability redesign process, reflecting the most contemporary policy agenda and available metrics for measuring school quality. The group discussed distinguishing qualities, strengths and weaknesses, and indicator tradeoffs for each state's accountability system. In summary, the distinguishing qualities of the state systems are as follows:

- ***Kentucky.*** Kentucky school ratings are comprised of data from three categories: Next Generation Learners, Next Generation Instruction and Support, and Next Generation Professionals. Within the Learner category, an index score for college and career readiness is assigned alongside status, growth, and gap scores scores on subject area tests. The readiness index is computed based on percent of students meeting readiness benchmarks for college (ACT or CAMPASS placement exams), career (WorkKeys or ASVAB plus a specialized technical examination), or both. The Instruction and Support category is constituted by comprehensive school program reviews of subject areas not necessarily assessed by state exams (e.g., arts, world languages, practical living/career studies). The Professionals category takes into account performance evaluations for teachers and administrators.

- ***New Hampshire.*** New Hampshire school ratings are similarly comprised of data from three categories: Knowledge, Skills, and Opportunity. The Knowledge category includes status and growth scores from state standardized tests in ELA, Math, and Science. The Skills category includes student achievement on a set of extended performance tasks designed, administered, and scored by the state. Still and pilot phase and slated for statewide roll-out in 2014-15, these extended performance tasks take 1-2 weeks to complete and are designed to assess skills such as complex problem-solving, research, and critical thinking. The Opportunity category includes a self-assessment (subject to state audit) of whole school programs, including provision of arts and CTE coursework, information technology, and tutoring/mentoring programs.

- ***Florida.*** Florida school ratings include a number of data sources on student achievement and success: status and growth scores on state ELA, Math, and Science assessments; participation and performance in accelerated coursework (e.g., AP/IB, Dual Enrollment, industry certifications); students meeting college readiness benchmarks on ACT, SAT, or the state placement exam; and graduation rates. Additionally, Florida calls out its lowest-performing students – those students who are struggling the most according to the previous year's test data – as its primary subgroup of focus. School ratings include percent of the lowest-performing 25% of students who are making a year's worth of progress in reading and mathematics as well as the graduation rates for the lowest-performing 25% of students.

- ***Georgia.*** Georgia recently transitioned its school rating system to its new College and Career Readiness Performance Index, with stated goal being "100% of Georgia high school graduates must be college and career ready and supremely competitive with students from all around the globe." The index is composed of 19 indicators drawn from the broad categories of content mastery, post-high school readiness, and graduation rates:
    - 4-year Cohort Graduation Rate
    - 5-year Cohort Graduation Rate
    - Graduates Entering 2 or 4 Year Colleges NOT Requiring Remediation
    - Average ACT Score
    - Graduates completing 3+ Pathway Options in the Arts or World Languages
    - Students Scoring 3 or Higher on AP Exams and/or 4 or higher on IB exams
    - Students Completing Accelerated Coursework (Dual Enrollment, AP, IB, etc.)
    - Graduated Students Earning High School 2+ Credits for a World Language
    - Students Completing 3+ Designated CTAE Pathway Courses
    - CTAE Pathway Completers Earning a CTAE Industry-Recognized Credential
    - Students Receiving a Silver or higher on the Georgia Work Ready Assessment
    - Students Scoring at Meets or Exceeds on End-of-course-exams (9^{th} grade Literature, American Literature, MathI/Algebra, MathII/Geometry, Physical Science, Biology, US History, and Economics)

Participants were then asked to identify their preferences between state models. This was done through a maximum differential exercise – termed a "round robin tournament" – in which participants compared all possible pairs of state systems (NH vs. KY, NH vs. FL, NH vs. GA, GA vs. FL, GA vs. KY, KY vs. FL). Participants selected the model that they preferred most between the given two states and provided a rationale statement for their preference.

Table A-3. Data from Round Robin Activity

New Hampshire	Kentucky
18	29
• Like the extended performance task for it focuses on assessing critical thinking. • More simplified but covers enough areas; project based. • I like the project based assessments; seems more simple. • Extended performance tasks. • Extended performance task; allow for a clearer measure of student ability. • Extended performance tasks can be project based learning with crossover; measures geared toward "real world" application. • NHs extended performance tasks as a measurement are good addition; Kentucky relies on evaluations that can be gamed. Ex. Teacher evaluation. • Seems to be the most comprehensive and thoughtful in terms of helping the state read its long-term goals. • Longitudinal data and performance tasks. • Liked the opportunity to assess skills. • Performance tasks. • Like the summative, formative, and interim approach. • Forward thinking and ambitious, balanced. • The opportunity and potential to go beyond into the realm of qualitative measurement. • Although largely undefined, I believe the focus on performance tasks is what results in creating a love of learning in children and a confidence of readiness in a state education's system. • NH through underdeveloped has a balanced approach. • Skills w/ performance. • I don't believe test scores are an adequate way to see what students know because they are narrow and never written in a students perspective, so extended performance task are a better way of students being able to show what they learn.	• Provides a range of assessments. • Diversity of evaluation along with teacher accountability. • Student indicators. • Multifaceted; student performance linked to CCR. • System versatility. • More complex measure that is not simplistic. • I like the program reviews and the readiness index; performance tasks may complicate things a bit. • Program reviews. • Prefer the next generation of educators. • Program reviews if they are done thoroughly and objectively; I don't agree with the use of teacher and principal evaluations. • NH is not practical at this point; KY includes program evaluation and education. • They address the K-3 grades. • Innovative Elements (with program reviews and next gen approach) but also doable "realistic" not as "too" outside the box like the NH extended performance tasks. • Looks at varying factors to determine success/achievement (skills, performance, key stakeholders). • More comprehensive/holistic by being international about educator's quality and their accountability is realistic – fuel system responsibility. • More detail – was easier to feel comfortable it would get measured. • Detailed scoring and college/career preparedness; included instructional/support and professionals. • Includes input, through puts, and outputs. Assessments are portable. Gave kids options. • Looks at teachers, looks at other programs besides the basics, liked the benchmarks for college/career. • I like the fact they are calling out next gen learner, instruction/support, and professionals. • NH not tenable for SC population. • Program reviews, college readiness benchmarks, multiple measure for students, and gap/growth scores. • KY is more comprehensive, more measures. • Many stakeholders involved. • College/Career Readiness, Gap Scores, Program Reviews • Multiple measures, instructional support- applies to teaching and learning. Principal/teacher performance, gap scores, and College and Career. • College/Career Readiness – includes industry aptitude and teacher evals. • You didn't ask me which I found to be most practical…that's a whole other story – I like the concept of NHs 2-week project - I just can't see how it's implemented

Florida	Kentucky
18	26
• High risk students + accelerated learning. • High risk students. • I like the focus of Florida as opposed to KYs. • Like FL focus on at risk students + accelerated learning. • Florida's focus on at-risk students is a great idea! • Wider range of assessments + inclusion of high risk students. • Florida participation balance and Kentucky is one dimensional. • Florida is attempting to design a system that's flexible. • Access – gets to the most of student resource equality. • Proven results, subgroups recognized. • Accelerated learning, focus on high risk, looks at low, middle, and high performers. • Focuses on increasing access to AP/IB and focus on lowest 25% + minority groups. • FL drove behavior better. • Lowest 25% growth, accelerated course work available to all students. • Because of their focus on desired outcomes. • FLA rocks – few measures focus on high school performance and pushing schools to push students which is the best measure of future college success.	• Next generation educators – emphasis on teacher performance. • Kentucky has next generation for educators + program reviews. • Programs review. • I like that KY has the option of program reviews and an option for tracking teachers. • More focus on casual factors. • Focus on educational professions and CCR. • Kentucky was my favorite of all – not just focused on a student. • I like the reliance – program reviews and the focus on next generation education. • Focus on school staffing and programs vs. student achievement. • Good components. • Program review is balanced. • Their focus on the readiness in K-3. • This is tough. Forced to choose KY in that it is forward focused. Would like to see access to programs as part of the KY system. • Balanced approach. • Varied level of assessment – accountability. • Like systems approach with next generation indicators. • Inclusion – instruction/support & details – college/career. • Evaluate educators and program reviews. • Includes inputs and outputs, portable assessments, exit options. • Readiness index, program reviews, multiple measures of students • College readiness, Gap scores. • College Career Readiness tracks • Multiple measures • The clear breakdown of components that influence. Multiple entry points for success for differently abled students.

Georgia	Kentucky
9	37
• College and Career Readiness • Wider range of assessments. • Like the focus on factors to create a rating. • I like Georgia's plan! • Comprehensive; College • Practically speaking? Kentucky works – but this is my choice, right? I still like Georgia's multiple entry points for influence of all of the members of the school community. • # scale, multiple measures • Graduation Rate.	• Program reviews – match program + achievement. • Fewer measurement indicators for consideration. • KY is slightly better, but neither is acceptable. • Don't like KYs use of teacher evals, but GA system is too complicated. • Measurements focus on 3 specific areas, not just standards. • I like the program review and next gen educators. • I like the program reviews and next generation educators for their plan. • More inclusive of casual measures. • Next generation educators – emphasis on teacher effectiveness. • Next generation. • I just don't like GAs at all. • Streamlined and 3 pronged. • More specific access; wider spectrum looked at whole school. • Easier to understand – transparency; system accountability includes educators. • GA is too complicated; KY is balanced. • Has a little focus on K-3. • More focused – GA tries to put too much in the formula. • KY seems to be more forward focused and does have program focus that includes things beyond typical standardized areas. • Evaluation included non-traditional consideration. • ACT Workkeys, skills assessment. • Readiness allows for different types of learners; program reviews. • Like causal factors in KY. • Seems less complicated. • Varies levels of accountability! • Forward thinking ability to instigate real change "whole system" approach looks at educators, schools, and students. GA seems hard to implement and managed – too complicated and focus is only on students.

Georgia	Florida
10	36
• Like Georgia's comprehensive approach vs. Florida's targeted approach. • Multi-path for college/career readiness. • GA more inclusive; not subgroups. • Don't like FL, GA allows multi-dimensions. • College/Career Readiness, multiple facets. • Same old story here…Georgia gives voice to so many stakeholders at the school level and without being across the curriculum will there even be school-wide efforts to reform? • No letter grades, # score.	• I like that Florida has the option to look at student grades as an indicators for efficacy; Georgia's system seems too complicated. • I like the focus on high risk students. • I like the attention or focus on High Risk students. • Florida is better, but not acceptable. • Florida has a good mix and is less confusing. • Focus on high risk students. • Florida – good to focus on at risk students; GA too complicated, impossible to explain to public. • Inclusion of high-risk students. • GA is too complicated, FL focuses on high risk students. • Easier to read, better focus on their mission/vision. • Florida has participation: balance 'jumping off ledge" vs. "being conservative" ; GA is "full" but complicated. Where are special needs students? • Hard to decide, but FL seems easier to implement and understand. Access focus is also a big difference. • Acknowledged awareness of the need to educate ALL kids and especially grouping different populations of students. • Access to courses. • Access/Accelerated. • Opportunities driving behavior – focus on lowest 25%. • Focus on all students and at risk students; proven results. GA is too complicated. • GA is too prescriptive + FL is open access for opportunity • GA is too complicated; FL focus on accelerated learning. • FL is more streamlined and responsive. I like focus on increasing access to AP/IB and on lowest 25%. GA doesn't include enough incentive for real change. Focus on college/career is too extreme. • Focus on high risk students + subgroups + accelerated learning in readiness index. • Easier to understand; incentive-based and access to courses. • Focus on high risk students. • Drives innovation.

New Hampshire	Florida
18	29
• Unfair to compare schools based upon AP/IB excellent + performance. • Although the Florida focus at risk students, again like the different system of accountability that NH has. • Florida focus on high risk is fools gold, look at total population. • Florida's approach seems to black or white. • NH more inclusive of student results rather than smaller populations. • NH provides a broader measure. • It's better. • Again, the NH reliance upon a kind of portfolio assessment has the potential for a more authentic assessment. • Same.. performance tasks, project based learning, real world app. • NH just isn't well defined in my opinion. • Forced to choose? NH because I think it would be modified to include those incentives (focus on lowest 25% and incentives opportunities) and would still have performance task focus. • Close – NH authentic measure, self-assessment, though with FL participation is included. Weakness for both: implementation. • Method of assessment. • Performance tasks. • Tough choice, but skills assessment wins. • Don't like FL, FL – same out acct stuff. • FL is too predictable and "Safe." I like focusing on the lowest 25%, but I feel like the middle kids are ignored in the model – and there's the fact that FL's track record with past data interpretation is a little suspect. So, NH is my winner not because I love it (or completely understand it) but because the gaps and stat quo of some elements of FL are displeasing to me.	• Takes into account high risk/starting point. • Florida because I think they are more defined. • Focus on high risk students. • Florida has a good mix of exactly what it is covering. • Focus on high risk groups – this is the challenge for all states. • Focus on high risk students and accelerated learning. • I think that Florida includes a grading component (looks at course grades). If administered objectively, this should be a good indicator. • Florida is the best so far, but I still don't like any of the models. • Inclusion of high risk student assessment. • NH is less practical, FL focuses on high risk students. • Looks at all groups and then their focus on high risk students. • Multi-cultural recognition of different learners. • Opportunities for accelerated learning – FL drives behavior. • FL was realistic and thoughtful; I like the measurement of performance and access too. Lowest 25% focus is important. • Like breakout of 25%, incentive base for schools to take on more (participation), didn't fully understand NHs model – vague? • More room for accountability, but hard to navigate. • More specifics available. • Lowest 25% measures of readiness. • Lowest 25% measure, plus push for AP. • Calling out and focusing on lowest 25%. • FLA plan rocks, we can up their 25% to 35% or 40%. • Dual credit/AP; focus on 25%. • Lowest 25%, access to/and performance in rigorous accelerated coursework, performance and gains. • Accelerated coursework, at risk emphasis. • FL because of focus on under performing population and accompanying incentives. • Lowest 25% growth, accelerated course work available to all students.

New Hampshire	Georgia
34	12
• I think NHs project-based learning assessment is an excellent idea! • Again, prefer the possibility of a more meaningful and more authentic assessment of student performance. • Like NHs performance tasks; GA system way too complicated. • Something different then what's being done in most states – allows more innovation and creativity. • I still don't like either, but I like GAs even less. • Innovative and like emphasis on project-based learning. • Extended performance tasks (focus on what kids can demonstrate). • Impossible to really know without seeing the weights of Georgia's measures. • Extended performance tasks. • Comprehensive had a lot of soft/squishy stuff. • NH is more simplified but covers what it needs; GA is too complex. • I think GAs system is a bit too complex in terms of a complete measure. • Projects, multi-prong. • NHs same as last time. • Speaks to more different and diverse students. • Individualized performance/application based. • NH is trying something different – it could work; GA is too bulky and complicated – I don't see it making a real impact. • Performance based and longitudinal. • Performance assessment offers great opportunities; GA too cumbersome and complicated. • Performance tasks and GA it too opaque. • Like summative, formative, interim approach – balanced – extended performance task. • Focus is not on tests only. Performance tasks are necessary. Instead of achievement of a set goal. • More clearly defined measures that don't appear to track students or label them. • Performance tasks would more clearly demonstrate what students can do (not just recall) and would be targeted to real world need (be they college, vocational, life skills, etc.) • Again, unlike NH, GA does not have a balanced approach. They include authentic measures and self-assessment. • Focus more on performance then testing. • GA is too complicated; NH input measures. • More holistic; more complete • Simple, allows more targeted resources to schools.	• College Readiness Indicators • CCR; business industry competition • Career Readiness Comprehensive college includes more students, teachers and content and opportunities for various levels of students. • Again broad range of assessments. • Didn't it choose either because I wasn't sure about GA and I don't like NH. • Because they use the indexes instead of just using the standardized test scores. • College/Career, ACT score, Multiple Scores • Dual enrollment and pathway • NH not feasible in SC, GA has many of the good measures • Dual enrollment, pathway courses, holistic approach • All areas of Georgia Index covers entire curriculum of school • More comprehensive, grad rate, more involvement • Modules/lots of options, everyone included. • I love that GA provides involvement for everyone at the school level – despite the fact that it covers an almost obscene number of factors – I can't imagine helping parents process this information in a meaningful way.

Activity: Indicator Matrix

Participants completed a matrix with twenty-eight possible accountability indicators. Each participant individually rated every measure on a scale of 0-3, provided a rationale statement for each rating, and starred their top three indicators.

0: Not Important
1: Low Importance
2: Medium Importance
3: Most Important

Participants were asked to list indicators that were missing or that they thought should be represented based on their True North.

Table A-4. Data collected from Indicator Matrix

INDICATORS	AVERAGE	MODE	STARRED
Graduation Rates	*2.44*	*3*	*9*
Extended Performance Tasks	*2.39*	*3*	*20*
Growth Scores State Standardized Tests: grades 3- 8 (ELA, Math, Science, and Social Studies)	*2.35*	*3*	*21*
Reporting on Subgroups	*2.29*	*3*	*10*
Performance on ACT/SAT	*2.22*	*2*	*4*
Input measures on Teacher Quality	*2.16*	*3*	*5*
Percent Passing College Placement Exams	*2.06*	*2*	*1*
College Persistence Rates	*2.05*	*2*	*3*
Absolute Scores State Standardized Tests: grades 3- 8 (ELA, Math, Science, and Social Studies)	*2.04*	*2*	*9*
Performance in IB/AP courses	*2.03*	*2*	*1*
Performance in WorkKeys	*2.02*	*2*	*4*
Input measures on School Programs	*2.01*	*3*	*2*
Participation on ACT/SAT	*1.99*	*2*	*0*
Performance in Dual Enrollment	*1.97*	*2*	*1*
Participation in Dual Enrollment	*1.96*	*2*	*0*

End of Course Exams: ELA, Math, Science, and Social Studies	*1.92*	*2*	*5*
Participation in IB/AP courses	*1.90*	*2*	*0*
College Matriculation Rates	*1.90*	*2*	*2*
HS Grades	*1.81*	*2*	*4*
% of student who filled out a career plan	*1.79*	*3*	*5*
College Acceptance Rates	*1.78*	*2*	*0*
Self-Reported School Climate	*1.72*	*3*	*4*
ENGAGE or other Metacognitive Assessment	*1.71*	*2*	*4*
HS Exit Exams: ELA & Math	*1.67*	*2*	*5*
Performance on military exams	*1.65*	*2*	*0*
% of students completing a college application	*1.27*	*2*	*0*
# of Students who fill out a FAFSA	*0.86*	*0*	*0*

Activity: Create Your Prototype

Participants broke out into small groups to build a prototype of their optimal accountability systems. They used their indicator matrices, comparable states framework, and True North definition to select indicators to include in their hybrid system. A facilitator joined each group to document points of contention, non-negotiables, and trade offs that we discussed. Each team presented their system to the larger stakeholder group.

Table A-5. Prototypes and Facilitator Notes

	CHARLESTON	
	Chart Paper Transcript	Facilitator Notes
Group 1	• Measure growth as opposed to status. • Focus on low achievers and closing the achievement gap.: sub groups by race are not valuable. • Performance Review (objective and comprehensive) • End of course exams for math, ELA, science, History, Etc.	
Group 2	• Growth – long tests thru elementary, middle, and high school. • Subgroups vs. low achievers (?) • Some sort of extended project. • Connectivity.	*growth, going back and forth - longitudinal test from element - hs to show growth (learning progression); difficult to agree. Future ready indicators and connectivity (relevance)*
Group 3	• Simple, clear • Based on growth • Extended performance • Measure the things that cause learning • Somebodies called to account • Measure what children need to know and be able to do – whatever that is. *Sticking Points:* • Perceived different between college and career readiness. • Political, economic, community	*Simple, clear* *based on growth (some disagreement)* *Extended performance measure instead of just a number on a test* *measure the things that cause learning (need to identify those)* *Measure or not that makes any difference? Hold the accountability system accountable.* *Somebody needs to be held accountable.*
Group 4	• Comprehensive list of standardize tests/certifications/classes. • Employment -> how man hs graduates find employment? Track students post graduation. • Program review • Portfolio review • Teacher development – by actual teachers. • Prerequisite skills updated.	*Comprehensive and Varietal - standardized test, certifications* *-Employment: track students post graduation, how many are employed? HS, 2 year, etc.* *-Program Review* *-Portfolio Review* *Instead of Teacher Evaluation, talking bout teacher development by actual teacher (not someone who hasn't actually been in the college)* *How to measure what's necessary in the prerequisites.* *Tension around hi-stakes*

	COLUMBIA	
	Chart Paper Transcript	Facilitator Notes
Group 1	• Performance Tasks •Grades •Well-designed standardized tests – performance, growth, readiness baseline, subgroups •Soft Skills •College/Career Readiness •Graduation Rate •Opportunity Measures (programs, facilities, Arts) •Teacher Evaluation •"Schools like ours"	*Performance tasks* *Grades* *Well designed standardized tests (performance and growth, readiness baseline that starts at school entry, lowest quartile of students and subgroups).* *Soft Skills* *College/Career Readiness* *Graduation Rate* *Opportunity measures - program availability, arts, community resources, to measure the school climate* *Teacher Evals - tiptoed into this knowing its contreverisal, value-added measures, and whole schools like ours measures to be certain we're comparing similar schools.* *Lens "schools like ours"* *Soft skills - metacognitive assessments, engage functioning skills (empathy, attitude leader indicators)… standardized and authentic. Soft - Skills, Metacognitive Assessments, engage functioning skills*
Group 2	• System that supports competencies •Variety of assessments with summative accountability measures at key points (not all at the end of the year) •Use of extended performance tasks (metacognitive) •Consideration of resources and inputs/out of school factors •Focus on college/career readiness indicator •Focus on critical content standards •Postsecondary longitudinal measures	*System that supports competencies not finite skills (a comment learning)* *variety of assessment with summative accountability measures at key points (not all the end of the year, and not all of the time) Not testing all the time for summative testing for accountability, but formative assessment to inform how we're teaching our students. Use of performance task within soft skills (setting goals to accomplish the task), consideration of resource, inputs, out of school factors necessary for our students to achieve. Focus on CCR indicators (pathway out and after high school) to be a productive citizen. Post secondary longitudinal measures.* *Focus on critical content standards. Where are our students 10 years down the road - maybe they got into college, but they weren't able to finish but they went back 10 years and are now a productive citizen, but are incarcerated (community resources)* *Differences in formative and summative reports to move forward and revamp some things vs. what we hold in regard to student achievement.* *Empirical data to support* *Sticking points: absolute scores vs. growth*
Group 3	• School Climate (objective and subjective) inclusive of community • Productive Citizen Measure (GED, HS, Diploma, Get a Job, Military, not living off of	*Climate self-study of positive and negative about what makes their school functions well to diagnose what they need to do. Don't trust self assessment overall. Make it work if the rest of the*

	unemployment, not in jail) •Teacher/Principal Evaluation •Growth/absolute K-2,3-8, 9-12 (achievement and readiness measures) •Extended Performance Tasks •High Expectations of reporting for all subgroups •Including soft skills measurements •Portfolio/authentic assessment component, evidence measure •SAT/ACT	*accountability system … condition of the school building, objective measure that an building engineer could look at. opposed to someone giving subjectivity. Need to build in self-reflectiveness. Subjectivity and objectivity - push/pull balanced. Graduation Rate vs job - our are students able to leave in 4 years with a diploma? Subgroup. When they leave the hs, measure to move forward to being a productive citizen? OBSAP Productive Citizen Measure.* *Evaluation - teacher qualification, building managers? or leadership for the teachers? Teacher and principal evaluation. Not anybody that's directly accountable. Superintendent can be fired by the board. Tension between growth and absolute.* *(could an elementary student or middle school students)* *Special education and make sure its not an excuse for poor performance.* *Soft skills/metacognitive assessment* *Need to measure how a school functions a learning environment - objectives and subjective, inclusive of the community.* *Product Citizen Measure - what do they look like when the leave (GED, HS, Get a job, Military, not living off of unemployment, not in jail)* *Teacher/Principal Evaluation - both in some way to see inputs are putting in both sides and contributing to an effective school.* *Growth/Absolute - k-2, 3-8, 9-12 achievement measures and readiness measures. Hit all these levels, no accountability for K-2, needs to be standardized and developmentally appropriate.* *Extended performance tasks with project based learning, community exposure and internships, talked about HS but could be brought down grade wise. Progression of writing, creativity… etc.* *High expectations of reporting for all subgroups with high expectations.* *Including soft skills measurements - curiosity, professional academic dispositions* *Portfolios/authentic assessment component evaluative measure - observational protocols, not just about a test informal authentic measure.* *ACT/SAT college readiness benchmark - common measure to college entrance. Accepted to college.* *Growth and absolute measures was a discussion and climate object/subject fear of gaming*

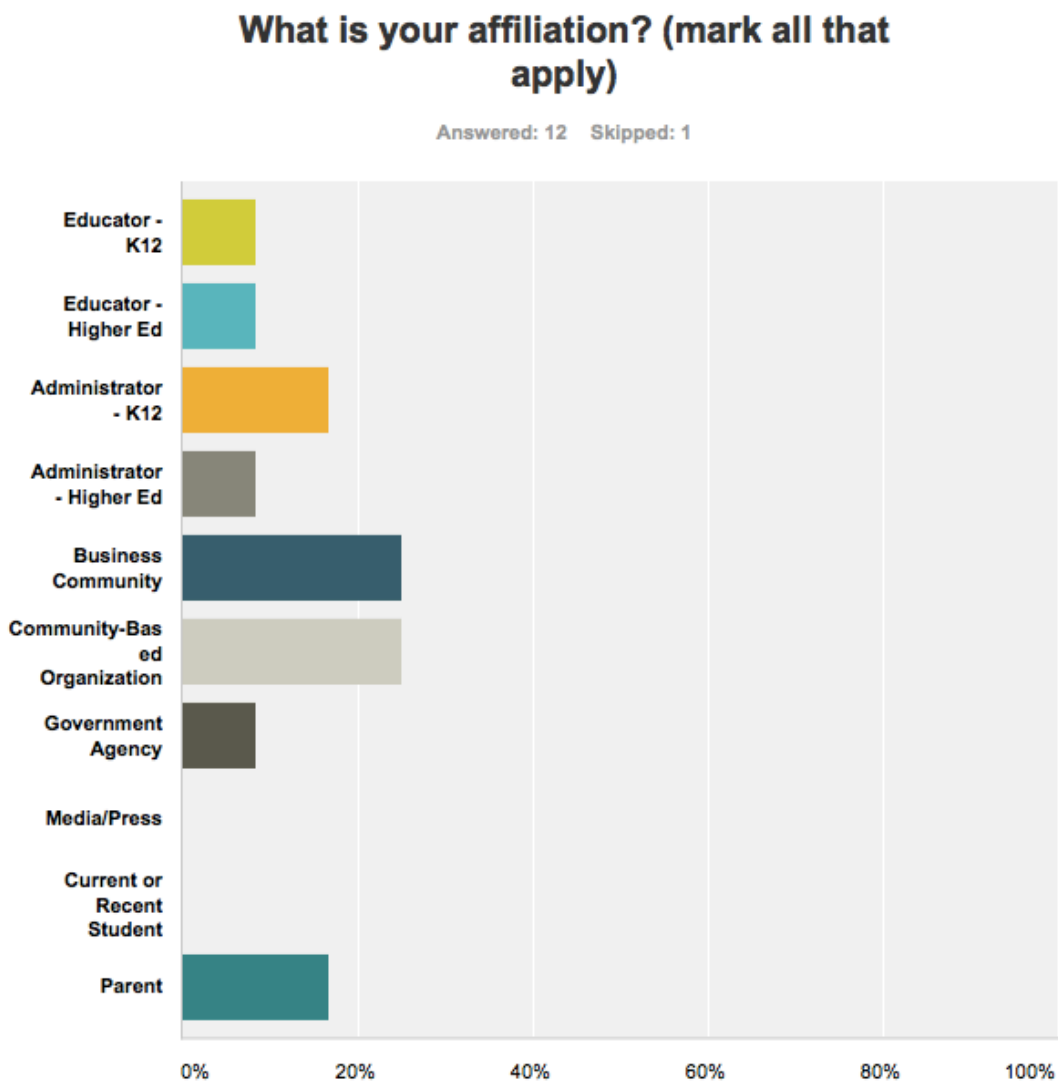
	GREENVILLE	
	Chart Paper Transcript	Facilitator Notes
Group 1	• Growth •Diagnostic •Basic R's – emphasize Reading •Dual Credit •Opportunity to Learn	*1) Growth* *2) Diagnostic - actionable and usable* *3) Basics Rs - emphasize Reading* *4) Dual Credit* *5) Opportunity to Learn - input measures* *A lot of performance, dual credit (CCR indicator), balance with OTL measure.* *Lot of time thinking about backwards design and meaningful long term, policies, changes to curriculum, daily operating procedures that must changed… a lot has to be done on the front end. What other industry in the world has stayed on the same schedule.*
Group 2	• Content – absolute + growth measure • Skills & dispositions – work keys or others • Climate – teachers, students, parents, input • Opportunity – exposure to college/careers • College Readiness – matriculation, persistence, remediation Less is more	*IDEAL SCA* *"Less is more"* *Content - absolute and growth measure. recognized that there was a place for absolute, from the perspective of a parent. great if they are 8th grade and shows 2 years, but they are at a 5th grade level we need to know what to do.* *Skills + dispositions - work keys or others, is the student going thru the system successfully and how do we measure those success points. Year after - matriculation, persistence, and rumination.* *Climate - teachers + students + parents input o how well a school is doing. Climate is the under foundation for so much of this, much of these measures won't work. and this is in the hands of staff. NM includes a 10 Qs that goes to teachers, parents, and students.* *Opportunity - exposure to college and careers. What's exposure - opportunities if the kids don't know there is an opportunity to have someone speak to them or visit a place, won't know what's avail to them.* *What is our accountability measure for career readiness.*

Group 3	• Graduation Rates - % of students participating/completing AP/IB/Dual Enrollment • Measure schools ability to produce opportunities to identify and explore college/career interests • Measures (static and growth) – Kindergarten Readiness, 3rd grade reading and math literacy, 8th grade pre-college assessment, gap measures	*Philosophically, opportunity to allow every child to reach the most potential. What can you do to set an accountability system to drive that. Makes a school system that becomes all things for all kids.* *1) graduation rates (started with end in mind) all kids by 10th grade be college and career ready. Opportunity to experience at least a college course for credit, % participation/completion of AP?IB/enrollment.* *2) measure a schools systems ability to say what is your college/career passion and what's your roadmap to get there. What is your passion, virtual shadowing, getting in a class, or turning in for someone to look at. Identify a car roadmap to get there.* *3) kindergarten, 3, 8 - status and growth and college readiness at 8th grade (what are we going to do at the lower levels to remediate earlier to the maximum potential)* *4)GAP measures*
Group 4	• Measure of Readiness K-4 • Measure of Growth 2-8 • Measure of performance on EOCs (redesigned assessments) • Measure of performance on ACT/SAT/AP/ASVAB/COMPASS/WORKKEYS • Improvement of Subgroups • Project-based performance task •Participation AP/IB/DE • Subgroup Improvement • Teacher and Principal Evaluation • College Remediation Rates	*Longitudinal study across all grade levels - measures of performance on redesigned assessments. Redesigned to have feedback and be more performance driven. Room for improvement. A little more actionable.* *Evaluation of levels of improvement.* *Project-based performance task, success with project based learning.* *Participation in college experiences - expanding dual enrollment career specific. Broaden and expand Teacher/principal evaluation piece - remediation, matriculation, and persistence - in a nice tidy number.*

APPENDIX B – Stakeholder Feedback Survey

Approximately one week after the stakeholder meetings, a survey was distributed to participants to gather feedback on their experiences. Out of 57 participants, 13 completed the feedback survey (response rate of 23%). The following pages present summaries of data to for each survey question.

Answer Choices	Responses	
Charleston - April 9, 2013	**38.46%**	5
Columbia - April 10, 2013	**30.77%**	4
Greenville - April 11, 2013	**30.77%**	4
Total		13


What is your affiliation? (mark all that apply)
Answered: 12 Skipped: 1
Educator - K12
Educator - Higher Ed
Administrator - K12
Administrator - Higher Ed
Business Community
Community-Based Organization
Government Agency
Media/Press
Current or Recent Student
Parent
0%
20%
40%
60%
80%
100%

Please rate the extent to which you agree with the following statements:

Answered: 13 Skipped: 0

	Strongly Agree	Agree	Undecided/Neutral	Disagree	Strongly Disagree	Total
The meeting convened a diverse group of stakeholders engaged in South Carolina public education.	83.33% 10	8.33% 1	8.33% 1	0% 0	0% 0	12
The meeting allowed diverse perspectives to be heard.	76.92% 10	15.38% 2	7.69% 1	0% 0	0% 0	13
Meeting facilitators provided adequate information to foster rich discussion by stakeholders.	66.67% 8	33.33% 4	0% 0	0% 0	0% 0	12
Meeting activities were engaging.	61.54% 8	38.46% 5	0% 0	0% 0	0% 0	13
Meeting activities effectively captured my insights and perspectives.	69.23% 9	23.08% 3	7.69% 1	0% 0	0% 0	13
I learned something new in the meeting.	84.62% 11	15.38% 2	0% 0	0% 0	0% 0	13

If you have any questions or comments about the process or content of the stakeholder meetings, please share them here.

Answered: 3   Skipped: 10

Responses (3) | Text Analysis | My Categories

Categorize as... | Filter by Category | Search responses

Showing 3 responses

What is next?
4/16/2013 1:29 PM   View respondent's answers

I thought the process was effective in helping to determine the ideals we hold dear. It also was thought-provoking.
4/16/2013 1:22 PM   View respondent's answers

Noble work but in the end we will allow 1/3 to not get a minimally adequate education, and a much larger portion will not have the skills to compete and thrive as adults. It's bigger than schools but we are looking to the schools to do it. We need to broaden our vision to include social connectedness for all and low cost interventions for those destined to fail.
4/16/2013 11:01 AM   View respondent's answers

APPENDIX C – Framework Indicators Defined

Indicator	Definition
% of Students who fill out a FAFSA	Number of students who complete the Free Application for Federal Student Aid, a form that is submitted annually by prospective (and current) college students to determine eligibility for financial aid.
% of students completing a college application	Percentage of students who fill out an application for college admission, which generally consists of academic transcripts, letters of recommendation, and essay responses.
% of students who filled out a career plan	Percentage of students who create a structured outline of career goals and the action steps required to meet their individual goals.
Absolute Scores State Standardized Tests: grades 3- 8 (ELA, Math, Science, and Social Studies)	Student achievement results from state standardized tests, as benchmarked against performance standards.
College Acceptance Rates	Percentage of students who are accepted into a college or university.
College Matriculation Rates	Percentage of students who enroll into a college or university.
College Persistence Rates	Percentage of students continuing college after their freshman year.
End of Course Exams: ELA, Math, Science, and Social Studies	Measures student acquisition of content knowledge at the end of a course of study.
Extended Performance Tasks	Project that requires students to apply a wide range of skills to solve a complex problem.
Graduation Rates	Percentage of students that successfully graduated high school by meeting state or local diploma requirements.
Growth Scores State Standardized Tests: grades 3- 8 (ELA, Math, Science, and Social Studies)	Measures change in students' scores on state achievement tests from one year to the next.
HS Exit Exams: ELA & Math	Tests that students must pass to receive a diploma and graduate from high school.
HS Grades	Summative classroom-based evaluation measures of student performance in individual courses often aggregated up to a 4-point scale.
Input measures on School Programs/Program Evaluation	May include an array of inputs and activities within a school building which the state deems important for students' opportunity to learn. This could include curriculum review for each subject area and other input metrics (e.g., student-to-computer ratio, average instructional time, access to tutoring services).

Indicator	Definition
Input measures on Teacher Quality	Reports on staff certification levels within a school building.
Metacognitive Assessment	Students fill out a self-report survey regarding non-cognitive skills (e.g., time management, goal setting, persistence).
Participation in ACT/SAT	Measures how many students are taking the ACT/SAT standardized test, which assesses a student's aptitude for college and is used for most college admissions.
Participation in Dual Enrollment	Measures how many students are accesses the Dual Enrollment program, which involves high school students taking college courses at a local institution of higher ed while they are still enrolled in high school.
Participation in IB/AP courses	Measures how many students are accessing the International Baccalaureate or Advanced Placement programs, which offer college-level curriculum and examination to high school students.
Percent Passing College Placement Exams/Remediation Rates	Postsecondary Institutions use assessment instruments in subjects like math and English to check the academic levels of entering students. These test scores are used to decide if a student is ready for entry-level credit bearing courses.
Performance in Dual Enrollment	Measures student achievement in a program which involves high school students taking college courses at a local institution of higher ed while they are still enrolled in high school.
Performance in IB/AP courses	Measures student achievement in International Baccalaureate or Advanced Placement programs, that offer college-level curriculum and examination to high school students.
Performance in Commercial Career Readiness Assessment (e.g., WorkKeys)	Measures student achievement on a job skills assessment which looks at common skills required for success in the workplace.
Performance on ACT/SAT	Measures student performance on the ACT/SAT standardized test, which assesses a student's aptitude for college and is used for most college admissions.
Performance on military exams	Measures student achievement on the Armed Services Vocational Aptitude Battery, which determines whether a student is qualified to enlist in the U.S. military.
Performance or growth of the lowest 25%	Reports results for students who performed in the bottom 25% in the previous year's standardized tests.
Reporting on Subgroups	Compares/Isolates student test results for African-American, Hispanic, Native American, special education, low income, and ELL students.
Self-Reported School Climate	Results from a survey taken by staff, students, and parents in regards to the school's environment (i.e., physical, social, and academic).

APPENDIX D: Framework Criteria Categories and Essential Questions

Criteria	Essential Question
Basic KSAs	Does it assess the basic knowledge and skills students need to live, learn and work in the 21st century?
Higher Order Thinking	Does it assess the critical thinking and complex problem solving skills students need to live, learn, and work in the 21st century?
Meaningful	Does the measure have meaning or currency outside of the accountability system?
Clear	Can the measure be clearly communicated and understood by the public?
High Needs	Does it address students with the highest need?
Pathways	Does the measure promote high aspirations, regardless of their future pathway? (college, career, military)
Feasible	Is it feasible to implement this measure with fidelity at the state level? Political, administrative, technical
Whole School	Does it hold the whole school accountable? Does it define quality across the whole school building? (Curriculum, instruction, opportunities to learn, resources)
Aligned	Does it promote alignment across the system?