SCIENCE

South Carolina

GRADE	SCORES		TOTAL SCORE
A-	Content and Rigor	6/7	9/10
	Clarity and Specificity	3/3	

REPORT CARD

Content & Rigor	**5.7**
Scientific Inquiry & Methodology	5
Physical Science	4
Physics	6
Chemistry	6
Earth & Space Science	6
Life Science	7
Clarity & Specificity	**3.0**

Average numerical evaluations

Overview

While too many states sacrifice clarity or content for the sake of brevity, South Carolina provides science standards that are clear and succinct, but that also outline most of the essential K-12 content that students need to learn.

Organization of the Standards

South Carolina provides grade-specific expectations for grades K-8 and course-specific expectations for high school physical science, biology, chemistry, physics, and earth science. These expectations are divided first into standards (with a parenthetical linking the standard to the domain of either life science, physical science, or earth science). Finally, grade-specific indicators are provided.

Included with these standards are a series of "support documents" that further clarify the grade-specific indicators and provide assessment guidelines for each indicator.

Content and Rigor

South Carolina has produced a set of workmanlike standards of consistent, high quality. Most disciplines cover all of the essential content with admirable thoroughness and attention to detail. Concepts develop over the advancing grades with clear and logical progression. This laudably systematic treatment reveals a firm scaffold upon which educators in the Palmetto State can build a science curriculum.

Scientific Inquiry and Methodology

The South Carolina inquiry standards are reasonably strong and include much of the essential content. In addition, the state has integrated critical process standards with content standards, making the link between the two clear. Unfortunately, by linking process with content, some important standards that should be repeated across strands are included only once. For example, high school physical science and biology students are asked to "generate hypotheses on the basis of credible, accurate, and relevant sources of scientific information." This is a critical skill that should not be limited to the study of physical science and biology, and yet it is not included among the expectations for physics, chemistry, or earth sciences. In the reverse, high school physics, chemistry, and earth science students are asked to use significant digits correctly, something that

Document(s) Reviewed

► *South Carolina Science Academic Standards*. 2005. Accessed from: http://ed.sc.gov/agency/pr/standards-and-curriculum/Science.cfm

should *also* be asked of students in physical science and biology courses.

In addition, the standards make no mention of the historical development of science or of its role in modern life/society.

Physical Science

Virtually all essential physical science content for Kindergarten through eighth grade is included in the South Carolina standards, and is developed systematically, clearly, and cogently within and across grades. Take, for example, the development of magnetism, which first appears in Kindergarten:

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

The concept is then extended in second grade:

> **The student will demonstrate an understanding of force and motion by applying the properties of magnetism.**
>
> - **Use magnets to make an object move without being touched.**
> - **Explain how the poles of magnets affect each other (that is, they attract and repel one another).**
> - **Compare the effect of magnets on various materials.**
> - **Identify everyday uses of magnets. (grade 2)**

In fourth grade, we read:

> **Summarize the properties of magnets and electromagnets (including polarity, attraction/repulsion, and strength).**
>
> **Summarize the factors that affect the strength of an electromagnet. (grade 4)**

Then, in sixth grade:

> **Explain how magnetism and electricity are interrelated by using descriptions, models, and diagrams of electromagnets, generators, and simple electrical motors. (grade 6)**

Finally, in eighth grade:

> **Compare the wavelength and energy of waves in various parts of the electromagnetic spectrum (including visible light, infrared, and ultraviolet radiation). (grade 8)**

Similarly clear, thorough, and appropriately rigorous standards can be found throughout.

The high school standards that cover physical science are cleanly divided into segments covering chemistry and physics, and both are clear, thorough, and appropriately rigorous. The level of the material clearly implies that both subjects are intended for a ninth-grade course in physical sciences.

High School Physics

High school physics is divided into ten standards. The first five are required: scientific inquiry; mechanics; energy, momentum, conservation principles, and oscillations; electromagnetism; and waves. Of the remaining five, two are to be selected and taught. These are: sound; light and optics; modern physics; fluid mechanics; and thermodynamics. The division is conventional and logical; one may argue about whether optics, modern physics, and thermodynamics should be optional, but of course time constraints in the classroom are very real.

Each of these ten subjects is set forth in a systematic, logical, and solid manner. For example, mechanics is introduced with emphasis on kinematics and a brief introduction to Newtonian dynamics and its applications: vectors, one- and two-dimensional motion, Newton's laws, falling bodies, projectile motion, friction, rotation, and so forth.

A subsequent section introduces kinetic and potential energy, conservation principles, and power, followed by a brief treatment of momentum, collisions, and oscillatory motion.

The other necessary physics content is covered in a similarly systematic fashion.

High School Chemistry

The South Carolina standards include nearly all of the high school chemistry content one would expect to see, but they often lack the detail and clarity of the best state standards we have reviewed, as in the following:

> **Summarize the concept of equilibrium and Le Châtelier's Principle. (high school chemistry)**

What here tells the student specifically what she is expected to know? Is it the definition of equilibrium? Its dynamic nature? Equilibrium constants? Stress factors? Shifts? All of the above?

Chemical bonding is presented, but specifies only ionic and covalent bonds. Missing in the standards are metallic bonding and intermolecular forces like hydrogen bonding and dipole-dipole bonding.

Still, the topic of chemical bonding is enriched somewhat with related indicators:

> **Explain how the types of intermolecular forces present in a compound affect the physical properties of compounds (including polarity and molecular shape).**
>
> **Explain the unique bonding characteristics of carbon that have resulted in the formation of a large variety of organic structures.**
>
> **Explain the effect of electronegativity and ionization energy on the type of bonding in a molecule. (high school chemistry)**

Some topics are well addressed, including solutions, and acid/base solutions in particular:

> **Summarize the properties of salts, acids, and bases.**
>
> **Distinguish between strong and weak common acids and bases.**
>
> **Represent common acids and bases by their names and formulas.**
>
> **Use the hydronium or hydroxide ion concentration to determine the pH and pOH of aqueous solutions.**
>
> **Explain how the use of a titration can determine the concentration of acid and base solutions.**
>
> **Represent neutralization reactions and reactions between common acids and metals by using chemical equations. (high school chemistry)**

Overall, South Carolina has made a good attempt to provide the framework for a rigorous, academic, college-prep chemistry course. In the future, careful editing will move this set of chemistry standards from good to excellent.

Earth and Space Science

South Carolina offers students plenty of interesting material in earth sciences—notably in eighth grade and in astronomical topics at the high school level. For example:

> **Summarize the three layers of Earth—crust, mantle, and core—on the basis of relative position, density, and composition. (grade 8)**
>
> **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). (high school earth science)**

While the standards themselves are sometimes terse, the necessary content is fleshed out well in South Carolina's strong supporting materials. Further, the standards for Kindergarten through eighth grade lay a strong foundation for a rigorous high school curriculum. The following fifth-grade standard will provide some extra support for the study of plate tectonics later:

> **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). (grade 5)**

That said, there are a few holes and slip-ups. Some standards are so broad they become meaningless:

> **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. (grade 5)**

And occasionally, the standards reinforce popular misconceptions. Take, for example, the following sentence in the eighth-grade support material:

> **Because earthquake waves travel faster through the mantle than through the crust, scientists know that the mantle is denser than the crust. (grade 8)**

Seismic velocity is actually inversely related to density.

Life Science

The coverage of life science from Kindergarten through eighth grade is reasonably solid and includes good coverage of genetics and physiology, as well as a strong introduction to evolutionary concepts.

In general, the high school biology materials are excellent, save for the complete omission of physiology: While the seventh-grade standards include strong coverage of this important topic, nothing appears after that year.

The coverage of evolution is occasionally evasive. For instance, while the eighth-grade standards do raise the important concepts of evolution, they do so without using the term. Further, natural selection shows up only in the support documents for that grade. Fortunately, at the high school level, evolution is treated excellently and the support documents are exemplary.

Overall, South Carolina has produced standards that are quite strong, and earn an average score of six out of seven for content and rigor. (See Appendix A: Methods, Criteria, and Grading Metric.)

Clarity and Specificity

The South Carolina standards are presented clearly and are nicely linked to support documents, which add significant value by providing specific details and clarifying what, precisely, students should know and be able to do. The

one lapse in clarity is the use of such terms as "analyze," "represent," "identify," "illustrate," "infer," "recognize," and "distinguish"—instead of the words "know" and "calculate." The use of these soft terms does not set forth a clear expectation of student performance or achievement, as in the following:

> **Illustrate the major structures of plants (including stems, roots, leaves, flowers, fruits, and seeds). (grade 1)**

Would drawing a picture suffice?

Taken together, these earn the South Carolina standards an average score of three out of three for clarity and specificity. (See Appendix A: Methods, Criteria, and Grading Metric.)