



# 2018 Mississippi College- and Career-Readiness Standards for Science Overview

## Research and Background Information

In today's modern world and complex society, our students are required to possess sufficient knowledge of science and engineering to become vigilant consumers of scientific and technological information. To meet the growing challenges facing our future workforce, the National Research Council (NRC) published a research-based report on teaching and learning science in a 2012 document titled *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012). This document proposes a new approach to K-12 science education through the integration of science and engineering practices (SEPs), crosscutting concepts, disciplinary core ideas, and engineering design within the context of science instruction.

### Core Elements in the Use and Design of the *MS CCRS for Science*

The *MS CCRS for Science* are goals that reflect what a student should know and be able to do. This document does not dictate a manner or methods of teaching. The standards in this document are not sequenced for instruction and do not prescribe classroom activities, materials, or instruction strategies. These standards are end-of year expectations for each grade or course. The standards are intended to drive relevant and rigorous instruction that emphasizes student mastery of both disciplinary core ideas (concepts) and application of science and engineering practices (skills) to support student readiness for citizenship, college, and careers.

The *MS CCRS for Science* document was built by adapting and extending information from *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012) and combining with Mississippi's previous science framework process strands (i.e., science as inquiry, unifying concepts and processes, science and technology, science in personal and social perspectives, and the history and nature of science). These concepts connect information across the science content strands (i.e., life science, physical science, and Earth and space science) with the disciplinary core ideas (e.g., ecology and interdependence, motions, forces, and energy, Earth systems and cycles) and are essential to both scientists and engineers because they identify common properties and processes found in practice.

The core elements are integrated across standards and performance objectives in each grade and course. A brief description of each core element is presented below.

1. **Nature of Science: Science and Engineering Practices (SEPs)** replaced the Inquiry Strand included in the *2010 Mississippi Science Framework*. Beyond integration within the standards, these practices must be mastered by students to produce a more scientifically literate citizenry and to develop students that are more excited about STEM (Science, Technology, Engineering, and Mathematics) topics and careers. Inquiry verbs, along with the SEPs, are woven throughout the standards, especially in the performance objectives. Each has a deliberate placement to indicate the depth of understanding expected of students.

The practices describe the behaviors that scientists engage in as they investigate and build models and theories about the natural world. They also describe the key set of engineering practices that engineers use as they design and build models and systems. These practices work together (overlap and interconnect) and are not separated in the study and investigation of science concepts. For example, the practice of *mathematical and computational thinking* may include some aspects of *analyzing and interpreting data*. The data often come from *planning and carrying out an investigation*. The writing task force for the *MS CCRS for Science* incorporated this language into the

performance objectives to emphasize the importance of a student-centered science classroom and not a teacher-centered classroom. A list of these eight practices is listed below.

- a. **Ask Questions (science) and Define Problems (engineering)**
  - b. **Develop and Use Models**
  - c. **Plan and Conduct Investigations**
  - d. **Analyze and Interpret Data**
  - e. **Use Mathematical and Computational Thinking**
  - f. **Construct Explanations (science) and Design Solutions (engineering)**
  - g. **Engage in Scientific Argument from Evidence**
  - h. **Obtain, Evaluate, and Communicate Information**
2. Crosscutting concepts: These seven, binding concepts were adopted directly from the National Research Council's *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012) and should be woven into instruction for every grade and course. Crosscutting concepts are designed to help students see the unity of the sciences. Students often are confused when they study ecosystems for three weeks, then weather for two weeks, and finally motion and forces for several weeks. A concept is crosscutting if it communicates a scientific way of thinking about a subject and it applies to many different disciplines of science and engineering. Crosscutting concepts are sometimes called "the ties that bind." The seven concepts are listed below.
- a. **Patterns**
  - b. **Cause and effect: Mechanism and explanation**
  - c. **Scale, proportion, and quantity**
  - d. **Systems and system models**
  - e. **Energy and matter: Flows, cycles, and conservation**
  - f. **Structure and function**
  - g. **Stability and change**
3. Technology: If Mississippi students are to compete on a global stage and exit high school prepared for college, career, and life, technology should be used in the classroom in a way that suits 21st-century learners and reflects the modern workplace. Technology is essential in teaching and learning of science; it influences and enhances students' learning. Flexible access, customized delivery, and increased convenience for the user are core tenets. K-12 learners have fundamentally changed over the past few decades, and our classrooms should adapt to accommodate them. Dr. Ruben Puentedura's SAMR (Substitution, Augmentation, Modification, and Redefinition) model is a resource that can be considered by teachers, administrators, and technology staff as they integrate meaningful and appropriate digital learning experiences into the classroom. At the basic level, technology enhances instruction.
4. Science and society: This core element assures exploration of science's impacts on society and the feedback loop that must be cultivated and sustained to continue improvement of systems.
5. History of science: Because most modern-day scientific advancement derives from past discoveries, it is essential that students understand the breakthroughs that make today's work possible.
6. Engineering design process (EDP) is the method of devising a system, component, or process to meet desired needs. Engineering standards are represented in some performance objectives with grade-banded, specific wording that prompts educators to approach learning and exploration using the engineering process. These performance objectives are marked with an \*. It is important to

note that the EDP is flexible. Most students will approach the process in various ways. The EDP is also a cycle—there is no official start or end point. Students can begin at any step, focus on just one step, move back and forth between steps, or repeat the cycle. Professional development and teacher resources will be developed for Mississippi teachers as EDP is incorporated into Mississippi standards.

Students should be provided a safe environment for failure without consequence, which is one of the most powerful drivers in learning. Providing many opportunities for students to fail, learn, and try again, with appropriate levels of support, fosters a deeper level of understanding and greater student interest and engagement.

### Other Important Core Elements

Mathematics is integrated throughout the science standards document because it is essential to the scientific process, requiring students to quantify, analyze, and present results. Students must be familiar with data analysis, critical thinking, and recording their own data; students must organize and analyze it before presenting their findings. Analysis of scientific studies and publications from a quantitative perspective is also very important.

English/language arts skills are also integrated into the science standards. Students will be required to read informational text for understanding as well as process and critique information. Students must be able to articulate a critical point of view using proper terminology. In addition, the K-4 science curriculum should be increasingly tied to language arts to lay the foundation for students to have access to science before fifth grade.

## Content Strands and Disciplinary Core Ideas

Science (and engineering) fields can be divided into three content-strand domains based on relative content presented in strands, extending from kindergarten to eighth grade. Grouping content in this way allows for vertical alignment of competencies and objectives to better organize content distribution. Content strands are not included in the Grades 9-12 course organization, which allows for a more logical, sequential placement and flow of content. Content strands are subdivided into 10 disciplinary core ideas in which standards and performance objectives for science content can be placed in grades K-8.

**K-8 content strands with the 10 disciplinary core ideas include:**

#### Life Science

1. Hierarchical Organization
2. Reproduction and Heredity
3. Ecology and Interdependence
4. Adaptations and Diversity

#### Physical Science

5. Organization of Matter and Chemical Interactions
6. Motions, Forces, and Energy

#### Earth and Space Science

7. Earth's Structure and History
8. Earth and the Universe
9. Earth Systems and Cycles
10. Earth's Resources

## Structure of the Standards Document

The organization and structure of this standards document are as follows:

- **Grade-band overview:** An overview that describes the general content and themes for the grade-level band or the high school courses. Outputs and outcomes are provided along with examples of, and references to, science and engineering practices and connecting concepts.
- **Grade-level or course overview:** An overview that describes the specific content and themes for each grade level and/or high school course. The K-8 standards are presented with each grade focused on a grade-level theme. High school courses provide an overview of the major ideas and strategies to use when planning instruction for the course.
- **Content strand:** Domains into which science fields can be divided based on relative content extending from kindergarten to eighth grade. In grades K through 8, the content strands are organized into three distinct areas: (1) life science, (2) physical science, and (3) Earth and space science. For the Grade 9-12 courses, the content areas are organized around the core ideas of each course.
- **Disciplinary core ideas:** Subdivision of the main content strands providing recurring ideas from the three content strands. The core ideas are the key organizing principles for the development of learning units. The K-8 vertical alignment is designed in a spiral arrangement, which places emphasis on one of the three content strands in each grade level. All content strands will be found in each grade level, but all disciplinary core ideas will not be found in every grade level in K-8 due to the spiral arrangement of content.
- **Conceptual understanding:** Statements of the core ideas for which student should demonstrate an understanding. Some grade level and/or course topics include more than one conceptual understanding with each guiding the intent of the standards.
- **Content standards:** Written below each disciplinary core ideas and conceptual understanding, the standards are a general statement of what students should know and be able to do because of instruction.
- **Performance objectives:** Detailed statements of content and skills to be mastered by the students. Performance objectives are specific statements of what students know and can do because of the science instruction at that level. These statements contain SEP and inquiry verb language.

Standards will appear in the following format:

Grade-Band Overview

Grade Level Theme (K-8)

Grade Level (K-8) or Course Overview (9-12)

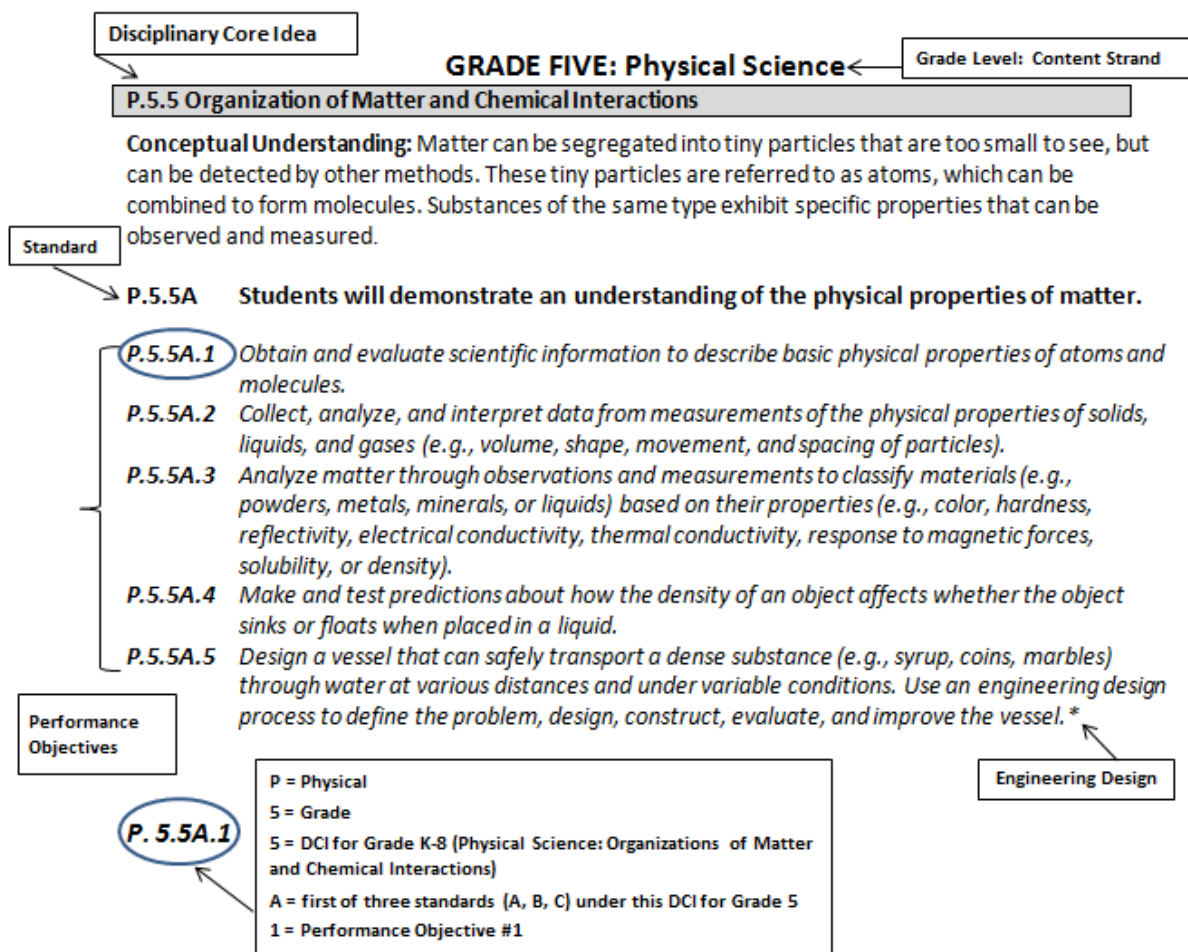
Grade Level: Content Strand (K-8); Course Name (9-12)

Disciplinary Core Idea (DCI)

Conceptual Understanding

Standard

Performance Objectives



## Safety in the Science Classroom

The National Science Teachers Association (NSTA) encourages K–12 school leaders and teachers to promote and support the use of science activities in science instruction and work to avoid and reduce injury. NSTA provides the following guidelines for school leaders and teachers to develop safety programs that include the effective management of chemicals, implement safety training for teachers and others, and create school environments that are as safe as possible (NSTA 2013).

- 1) National Science Teacher Association’s *Safety in the Science Classroom*, accessible at <http://www.nsta.org/docs/SafetyInTheScienceClassroom.pdf>.
- 2) An extensive list of safety resources is available at <http://www.nsta.org/safety/>.

## Support Documents and Resources

The MDE will develop support documents after these standards have been approved by the State Board of Education. Local districts, schools, and teachers may use these documents to construct standards-based science curriculum, allowing them to customize content to fit their students’ needs and match available instructional materials. The support documents will include suggested resources, instructional strategies, essential knowledge, and detailed information about the core elements (e.g., SEPs, crosscutting concepts).

Professional development efforts will be aligned with the standards and delivered in accord with teacher resources to help expand expertise in delivering student-centered lessons (e.g., inquiry-based learning, 5-E instructional models, or other best practices in STEM teaching). The most successful national models and programs will be referenced for a capacity-building effort that can develop a more effective culture of science education in Mississippi.

### **Investigate, Apply, and Understand**

It is important that the pedagogical paradigm of Mississippi's science classroom reflects the nature of the content being learned. The essence of science is natural to children and includes discovery, observation, questioning, design, testing, failure, iteration, and hands-on application. Research-based approaches such as inquiry-based (IB), project-based, and discovery learning are all pedagogical pathways that make sense, especially in the science classroom. Mississippi's science teachers are encouraged to embrace the growth mindset and constantly seek to upgrade classroom approaches by experimenting and adopting methods that excite students to learn and become functional, autonomous learners and contributors. Students should be provided increased maneuverability in the classroom to formulate their own ideas to investigate and understand the scientific and engineering design processes.

## **References**

- ACT. (2014). *ACT college and career readiness standards—Science. (2014)*. Retrieved from <http://www.act.org/content/dam/act/unsecured/documents/CCRS-ScienceStandards.pdf>
- Alabama State Department of Education. (2015). *Alabama course of study: Science*. Montgomery, AL: Author.
- Indiana Department of Education. (2016). *Indiana's Academic Standards for Science – 2016*. Retrieved from <http://www.doe.in.gov/standards/science-computer-science>
- Massachusetts Department of Elementary and Secondary Education. (2016). *2016 Massachusetts science and technology/engineering curriculum framework*. Malden, MA: Author.
- Mississippi Department of Education. (2008). *2010 Mississippi science framework*. Jackson, MS: Author.
- Mullis, I. V. S., & Martin, M. O. (Eds.). (2013). *TIMSS 2015 assessment frameworks*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.
- National Assessment Governing Board. (2014). *Science framework for the 2015 National Assessment of Educational Progress* (Contract No. ED-04-CO-0148). Washington, DC: U.S. Government Printing Office.
- National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academies Press.
- National Science Teachers Association. (2013). *Safety in the science classroom, laboratory, or field sites*. Retrieved from <http://www.nsta.org/docs/SafetyInTheScienceClassroomLabAndField.pdf>
- Next Generation Science Standards Lead States. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: The National Academies Press.

Schrock, K. (2013, Nov. 9). Resources to support the SAMR model [Blog post]. Retrieved from <http://www.schrockguide.net/samr.html>

South Carolina Department of Education. (2014). *South Carolina academic standards and performance indicators for science*. Columbia, SC: Author.

Virginia Department of Education. (2010). *Science standards of learning for Virginia public schools*. Richmond, VA: Author.