2025 Expanded High School Science *Standards of Learning* for Virginia Public Schools

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Science *Standards of Learning* Introduction

The goal of the 2025 Expanded High School Science *Standards of Learning* is to provide a foundation in scientific concepts and skills that will prepare students to pursue STEM career fields as well as participate in society as scientifically literate citizens. Students will be equipped with the ability to analyze data to solve problems and think analytically, communicate effectively, and collaborate with diverse groups in their community, workplace, and postsecondary education. As students progress through the school years, they are active learners in developing and applying the Scientific and Engineering Practices as they engage with increasingly complex science concepts. The 2025 Expanded High School Science *Standards of Learning* reflect the commitment to provide clear and specific standards for teachers.

This introduction provides a brief overview of the following context around these standards.

1. Guiding Principles
2. Standards vs. Curriculum
3. Investigate and Understand
4. K-12 Safety

Guiding Principles

The 2025 Expanded High School Science *Standards of Learning* indicate the scientific concepts and practices that will ensure that every Virginia student graduates high school with the science knowledge and skills needed to be ready for enrollment in a postsecondary program, enlistment in the military, or employment in an in-demand field, as described in the 3E Framework. The following principles guided the development of the Standards:

1. Reflects accurate and current science content.

Technological advancements lead to a deeper understanding of natural phenomena and may result in new scientific discoveries. Accurate standards based on current understanding of science concepts and practices allow students to appreciate the dynamic nature of scientific inquiry and cultivate informed graduates who can make evidence-based decisions and contribute meaningfully to society. The 2025 Expanded High School Science *Standards of Learning* were developed to be best in class and reflect current scientific knowledge.

2. Prepare students for enrollment, enlistment, or employment.

A foundation in science concepts and practices, including the ability to analyze data, construct and critique explanations, and communicate information are critical skills needed for enrollment, enlistment, or employment. Scientifically literate citizens are essential for contributing to a skilled workforce and for making informed decisions that affect their lives, their communities, and the world.

3. Incorporates Virginia context to support science instruction.

Personal interest and experience are critical to helping students learn science. The 2025 Expanded High School Science *Standards of Learning* provide opportunities for teachers to use Virginia phenomena and their local context to engage students. This connection to the local community, and how it fits in a global context, prepares students for their postsecondary goals of enrollment, enlistment, or employment.

4. Conveys high academic expectations for all students.

For the first time, teachers will have standards for these courses. These standards ensure equal and rigorous expectations and opportunities for students across the Commonwealth.

Standards vs. Curriculum

The 2025 Expanded High School Science *Standards of Learning* define the concepts and skills that are to be taught in each year of K-12 science instruction. Divisions can adopt High Quality Instructional Materials (HQIM) to assist with curriculum and instruction. The Science *Standards of Learning* indicate the expectations of students to demonstrate mastery of grade level scientific concepts. School divisions determine the order that these standards are to be taught.

Investigate and Understand

The standards in the 2025 Expanded High School Science *Standards of Learning* begin with the phrase "The student will investigate and understand." This phrase communicates the wide range of science knowledge, skills, and practices required to effectively make meaning of the natural world.

"Investigate" refers to the student application of the Scientific and Engineering Practices. Science utilizes observation and experimentation along with existing scientific knowledge, mathematics, and engineering technologies to answer questions about the natural world. Engineering employs existing scientific knowledge, mathematics, and technology to create, design, and develop new devices, objects, or technology to meet the needs of society. By utilizing both scientific and engineering practices in the science classroom, students develop a deeper understanding and competence with techniques at the heart of each discipline. These practices are integrated and scaffold K-12 and should be embedded in instruction throughout the year. The Scientific and Engineering Practices are:

- asking questions and defining problems;
- planning and carrying out investigations;
- interpreting, analyzing, and evaluating data;
- constructing and critiquing conclusions and explanations;
- developing and using models; and

- obtaining, evaluating, and communicating information.

"Understand" refers to the application of scientific knowledge including the ability to:

- apply understanding of key science concepts and the nature of science;
- apply information and principles to new problems or situations, recognizing what information is required for a particular situation, using the information to explain new phenomena, and determining when there are exceptions;
- think critically, problem-solve, and make decisions;
- make connections with Crosscutting Concepts to allow for deeper understanding. The Crosscutting Concepts are cause and effect; energy and matter; patterns; scale, proportion, and quantity; stability and change; structure and function; and systems and system models. These concepts provide a context through which the standards can be unified throughout the year.

Therefore, the use of "investigate and understand" allows each content standard to become the basis for a broad range of teaching objectives, which school divisions will develop and refine to meet the intent of the 2025 Expanded High School Science *Standards of Learning*

K-12 Safety

Safe learning environments are critical when implementing the 2025 Expanded High School Science *Standards of Learning*. Teachers must be certain that students know how to follow safety guidelines, demonstrate appropriate laboratory safety techniques, and use equipment safely while working individually and in groups.

Safety must be given the highest priority in implementing the K-12 instructional program for science. Correct and safe techniques, as well as the wise selection of experiments, resources, materials, and field experiences appropriate to age levels, must be carefully considered with regard to the safety precautions for every instructional activity. Safe science classrooms require thorough planning, careful management, and constant monitoring of student activities. Class enrollment should not exceed the designed capacity of the room.

Teachers must be knowledgeable of the properties, use, and proper disposal of all chemicals that may be judged as hazardous before their use in an instructional activity. Such information is referenced through Safety Data Sheets (SDS), which conform to the requirements of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). The identified precautions involving the use of goggles, gloves, aprons, and fume hoods must be followed as prescribed.

The following sources offer further guidance on science safety:

- public health departments' and school divisions' protocols and chemical hygiene plans.
- Occupational Safety and Health Administration;
- International Science and Engineering Fair rules;

- Virginia Department of Education (VDOE) Science Safety Handbook on the VDOE Science Instruction webpage; and
- American Chemical Society (ACS) resources: Safety in the Elementary Science Classroom, Chemical Safety for Teachers and their Supervisors, and Guidelines for Chemical Laboratory Safety on the ACS webpage.

The 2025 Expanded High School Science *Standards of Learning* are informed by the NRC Framework for K-12 Science Education (https://nap.nationalacademies.org/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts) and the Next Generation Science Standards (https://www.nextgenscience.org/).

2025 Environmental Science

Environmental Science examines the mutual relationships between organisms and their environment. Students learn about photosynthesis, recycling and regeneration, ecosystems, population and growth studies, pollution, and conservation of natural resources as they study the relationships among plants, animals, and humans. Instruction should provide opportunities for field experiences and investigations of local ecological systems. The scientific and engineering practices are used as students examine scientific explanations, conduct experiments, analyze and communicate information, gather and use information in scientific literature, and use their science knowledge to solve problems.

ENV.1 The student will demonstrate an understanding of scientific and engineering practices by

a) asking questions and defining problems
   - ask questions that arise from careful observation of phenomena and/or organisms, from examining models and theories, and/or to seek additional information
   - determine which questions can be investigated within the scope of the school laboratory or field
   - make hypotheses that specify what happens to a dependent variable when an independent variable is manipulated
   - generate hypotheses based on research and scientific principles
   - define design problems that involve the development of a process or system with multiple components and criteria

b) planning and carrying out investigations
   - plan and conduct observational and experimental investigations; identify variables, constants, and controls where appropriate
   - plan and conduct investigations or test design solutions in a safe and ethical manner including considerations of environmental, social, and personal effects
   - select and use appropriate tools and technology to collect and record data
   - determine appropriate sample size and techniques

c) interpreting, analyzing, and evaluating data
   - construct and interpret data tables showing independent and dependent variables, repeated trials, and means
   - construct, analyze, and interpret graphical displays of data and consider limitations of data analysis
   - use data to build and revise models, to support an explanation for phenomena, or test a solution to problems
   - apply mathematical concepts and processes
   - analyze data using tools, technologies, and/or models to make valid and reliable scientific claims or determine an optimal design solution

d) constructing and critiquing conclusions and explanations

- construct and revise explanations based on valid and reliable evidence obtained from a variety of sources including models, theories, simulations, peer review, and students' own investigations
- make quantitative and/or qualitative claims based on data
- apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and design solutions
- compare and evaluate competing arguments or design solutions in light of currently accepted explanations and new scientific evidence
- make and support a claim using empirical evidence and scientific reasoning
- evaluate a claim by applying scientific reasoning, theory, and/or models to link evidence to assess the extent to which the reasoning and data support the explanation or conclusion.
- differentiate among a scientific hypothesis, theory, and law

e) developing and using models
- evaluate the merits and limitations of models
- develop, revise, and/or use models based on evidence to illustrate or predict relationships, to support explanations, predict phenomena, analyze systems, and/or solve problems

f) obtaining, evaluating, and communicating information
- compare, integrate, and evaluate sources of information presented in different media or formats to address a scientific question or solve a problem
- gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and credibility of each source
- communicate scientific and/or technical information about phenomena and/or a design process in multiple formats

ENV.2 The student will investigate and understand that matter and energy move within and among Earth's systems.

Demonstration of the essential knowledge and practices includes:

a) Make, support, and evaluate a claim about how Earth is a system composed of interacting components.
b) Explain the importance of the properties and characteristics of water in supporting life processes and Earth systems.
c) Develop and use a model to explain how biogeochemical processes support life and demonstrate the conservation of matter and energy.
d) Develop and use a model of Earth's energy budget to predict how fluctuations and changes in the budget might affect Earth's ability to sustain life.

ENV.3 The student will investigate and understand that processes and systems lead to changes on Earth's surface.

Demonstration of the essential knowledge and practices includes:

a) Plan and conduct an investigation on the effect of processes on Earth's surface.

b) Develop and use a model to explain how processes of the rock cycle change Earth's surface.
c) Make, support, and evaluate a claim about how natural processes and human activities have changed Earth's surface.

ENV.4 The student will investigate and understand that ecosystems are in a state of dynamic equilibrium that is affected by complex biotic and abiotic interactions.

Demonstration of the essential knowledge and practices includes:

a) Compare biotic and abiotic factors in terrestrial and aquatic ecosystems.
b) Describe the ecological role that an organism plays in supporting the overall sustainability of the ecosystem.
c) Make, support, and evaluate a claim about the ecological roles of different categories of species in maintaining or disrupting ecosystem equilibrium.
d) Predict the effect caused by the introduction of an invasive species on the equilibrium of an ecosystem.
e) Develop and use models to predict the effects of energy and matter transfer in ecosystems.
f) Make, support, and evaluate a claim about how energy and matter is conserved in ecosystems.
g) Make, support, and evaluate a claim about how environmental pressures may lead to shifts in ecosystem equilibrium.
h) Explain how ecosystems change over time through succession and how this affects ecosystem dynamics.
i) Predict the effect of natural processes and human activities on Virginia's biodiversity and ecosystem equilibrium.

ENV.5 The student will investigate and understand that changes in population affect biodiversity and ecosystem success.

Demonstration of the essential knowledge and practices includes:

a) Analyze and interpret population growth curves to identify changes in population size.
b) Make, support, and evaluate a claim about the relationship among limiting factors, population size, and carrying capacity.
c) Make, support, and evaluate a claim about the importance of genetic variation on the biodiversity of an ecosystem.
d) Develop and use a model to explain how species diversity is affected by environmental pressures.
e) Explain how human population growth changed over time as a result of various factors and predict the effect of continued growth on the environment.

ENV.6 The student will investigate and understand that Earth's resources are finite and should be conserved.

Demonstration of the essential knowledge and practices includes:

a) Make, support, and evaluate a claim about how sustainable and unsustainable natural resources affect organisms.

b) Compare geologic and chemical processes that are responsible for filtering, cycling, and storing Earth's freshwater resources.
c) Debate advantages and disadvantages of a sustainable practice in a community, in a home, and as an individual.
d) Make, support, and evaluate a claim about how human activities affect Earth's resources.
e) Compare environmental effects related to the various energy sources in Virginia.

ENV.7 The student will investigate and understand that pollutants have physical, chemical, and biological consequences at the local, regional, and global level.

Demonstration of the essential knowledge and practices includes:

a) Use data to identify a land, water, or atmospheric pollutant in the local community and determine possible sources and effects on the environment.
b) Debate advantages and disadvantages of solutions to safely reduce, eliminate, or remediate a land, water, or atmospheric pollutant.
c) Compare the benefits and limitations of remediation methods used with land, water, and atmospheric pollutants.
d) Research a clean-up plan for a designated Environmental Protection Agency Superfund site.

ENV.8 The student will investigate and understand that natural events and human activities affect global climate change.

Demonstration of the essential knowledge and practices includes:

a) Make, support, and evaluate a claim about how human activities affect global climate change.
b) Compare the effects of natural events and human activities on global climate change.
c) Develop and use a model to explain how changes in global temperature affect a specific ecosystem.
d) Make, support, and evaluate a claim about how climate change affects Virginia communities.
e) Research ways to mitigate greenhouse gas emissions and propose solutions to reduce emissions in the school, home, and community.

ENV.9 The student will investigate and understand that individual and collective actions influence environmental sustainability and policy at local, national, and global levels.

Demonstration of the essential knowledge and practices includes:

a) Make, support, and evaluate a claim about how consumer, corporation, and government choices can affect the environment.
b) Compare the priorities of multiple stakeholders involved in an environmental issue that affects global and/or local ecosystem health.
c) Debate advantages and disadvantages of possible solutions to an environmental problem.
d) Research solutions that reduce effects of human activities on natural systems and propose solutions for school, home, and community to reduce these effects.
e) Explain the roles individuals and communities as well as local, national, and global policies play in mitigating the negative effects of human activities on the climate.