

Grade Four Science Standards of Learning for Virginia Public Schools – January 2010

Introduction

The *Science Standards of Learning* for Virginia Public Schools identify academic content for essential components of the science curriculum at different grade levels. Standards are identified for kindergarten through grade five, for middle school, and for a core set of high school courses — Earth Science, Biology, Chemistry, and Physics. Throughout a student’s science schooling from kindergarten through grade six, content strands, or topics are included. The Standards of Learning in each strand progress in complexity as they are studied at various grade levels in grades K-6, and are represented indirectly throughout the high school courses. These strands are

- Scientific Investigation, Reasoning, and Logic;
- Force, Motion, and Energy;
- Matter;
- Life Processes;
- Living Systems;
- Interrelationships in Earth/Space Systems;
- Earth Patterns, Cycles, and Change; and
- Earth Resources.

Five key components of the science standards that are critical to implementation and necessary for student success in achieving science literacy are 1) Goals; 2) K-12 Safety; 3) Instructional Technology; 4) Investigate and Understand; and 5) Application. It is imperative to science instruction that the local curriculum consider and address how these components are incorporated in the design of the kindergarten through high school science program.

Goals

The purposes of scientific investigation and discovery are to satisfy humankind’s quest for knowledge and understanding and to preserve and enhance the quality of the human experience. Therefore, as a result of science instruction, students will be able to achieve the following objectives:

1. Develop and use an experimental design in scientific inquiry.
2. Use the language of science to communicate understanding.
3. Investigate phenomena using technology.
4. Apply scientific concepts, skills, and processes to everyday experiences.

5. Experience the richness and excitement of scientific discovery of the natural world through the collaborative quest for knowledge and understanding.
6. Make informed decisions regarding contemporary issues, taking into account the following:
 - public policy and legislation;
 - economic costs/benefits;
 - validation from scientific data and the use of scientific reasoning and logic;
 - respect for living things;
 - personal responsibility; and
 - history of scientific discovery.
7. Develop scientific dispositions and habits of mind including:
 - curiosity;
 - demand for verification;
 - respect for logic and rational thinking;
 - consideration of premises and consequences;
 - respect for historical contributions;
 - attention to accuracy and precision; and
 - patience and persistence.
8. Develop an understanding of the interrelationship of science with technology, engineering and mathematics.
9. Explore science-related careers and interests.

K-12 Safety

In implementing the *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 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 prior to their use in an instructional activity. Such information is referenced through Materials Safety Data Sheets (MSDS). The identified precautions involving the use of goggles, gloves, aprons, and fume hoods must be followed as prescribed.

While no comprehensive list exists to cover all situations, the following should be reviewed to avoid potential safety problems. Appropriate safety procedures should be used in the following situations:

- observing wildlife; handling living and preserved organisms; and coming in contact with natural hazards, such as poison ivy, ticks, mushrooms, insects, spiders, and snakes;
- engaging in field activities in, near, or over bodies of water;
- handling glass tubing and other glassware, sharp objects, and labware;
- handling natural gas burners, Bunsen burners, and other sources of flame/heat;
- working in or with direct sunlight (sunburn and eye damage);
- using extreme temperatures and cryogenic materials;
- handling hazardous chemicals including toxins, carcinogens, and flammable and explosive materials;
- producing acid/base neutralization reactions/dilutions;
- producing toxic gases;
- generating/working with high pressures;
- working with biological cultures including their appropriate disposal and recombinant DNA;
- handling power equipment/motors;
- working with high voltage/exposed wiring; and
- working with laser beam, UV, and other radiation.

The use of human body fluids or tissues is generally prohibited for classroom lab activities. Further guidance from the following sources may be referenced:

- OSHA (Occupational Safety and Health Administration);
- ISEF (International Science and Engineering Fair) rules; and
- public health departments' and school divisions' protocols.

Instructional Technology

The use of current and emerging technologies is essential to the K-12 science instructional program. Specifically, technology must accomplish the following:

- Assist in improving every student's functional literacy. This includes improved communication through reading/information retrieval (the use of

telecommunications), writing (word processing), organization and analysis of data (databases, spreadsheets, and graphics programs), presentation of one's ideas (presentation software), and resource management (project management software).

- Be readily available and regularly used as an integral and ongoing part of the delivery and assessment of instruction.
- Include instrumentation oriented toward the instruction and learning of science concepts, skills, and processes. Technology, however, should not be limited to traditional instruments of science, such as microscopes, labware, and data-collecting apparatus, but should also include computers, robotics, video-microscopes, graphing calculators, probeware, geospatial technologies, online communication, software and appropriate hardware, as well as other emerging technologies.
- Be reflected in the “instructional strategies” generally developed at the school division level.

In most cases, the application of technology in science should remain “transparent” unless it is the actual focus of the instruction. One must expect students to “do as a scientist does” and not simply hear about science if they are truly expected to explore, explain, and apply scientific concepts, skills, and processes.

As computer/technology skills are essential components of every student's education, it is important that teaching these skills is a shared responsibility of teachers of all disciplines and grade levels.

Investigate and Understand

Many of the standards in the *Science Standards of Learning* begin with the phrase “Students will investigate and understand.” This phrase was chosen to communicate the range of rigorous science skills and knowledge levels embedded in each standard. Limiting a standard to one observable behavior, such as “describe” or “explain,” would have narrowed the interpretation of what was intended to be a rich, highly rigorous, and inclusive content standard.

“Investigate” refers to scientific methodology and implies systematic use of the following inquiry skills:

- observing;
- classifying and sequencing;
- communicating;
- measuring;
- predicting;
- hypothesizing;

- inferring;
- defining, controlling, and manipulating variables in experimentation;
- designing, constructing, and interpreting models; and
- interpreting, analyzing, and evaluating data.

“Understand” refers to various levels of knowledge application. In the *Science Standards of Learning*, these knowledge levels include the ability to:

- recall or recognize important information, key definitions, terminology, and facts;
- explain the information in one’s own words, comprehend how the information is related to other key facts, and suggest additional interpretations of its meaning or importance;
- apply the facts 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;
- analyze the underlying details of important facts and principles, recognizing the key relations and patterns that are not always readily visible;
- arrange and combine important facts, principles, and other information to produce a new idea, plan, procedure, or product; and
- make judgments about information in terms of its accuracy, precision, consistency, or effectiveness.

Therefore, the use of “investigate and understand” allows each content standard to become the basis for a broad range of teaching objectives, which the school division will develop and refine to meet the intent of the *Science Standards of Learning*.

Application

Science provides the key to understanding the natural world. The application of science to relevant topics provides a context for students to build their knowledge and make connections across content and subject areas. This includes applications of science among technology, engineering, and mathematics, as well as within other science disciplines. Various strategies can be used to facilitate these applications and to promote a better understanding of the interrelated nature of these four areas.

Grade Four

The fourth-grade standards stress the importance of using information, analyzing data, and validating experimental results. Defining variables in experimentation is emphasized, and making simple predictions from picture, bar, and basic line graphs is underscored. Questioning and hypothesizing become more detailed at this level. Students are introduced to basic principles of electricity and to the concept of motion. Students explore basic information about our solar system and investigate the interactions among Earth, the moon, and the sun. Students explore basic plant anatomy, plant adaptations, and investigate relationships among plants and animals and their environments. In examining weather phenomena and conditions, students identify various factors, make predictions based on data, and evaluate the results. The importance of natural resources in Virginia is emphasized.

Scientific Investigation, Reasoning, and Logic

- 4.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
- a) distinctions are made among observations, conclusions, inferences, and predictions;
 - b) objects or events are classified and arranged according to characteristics or properties;
 - c) appropriate instruments are selected and used to measure length, mass, volume, and temperature in metric units;
 - d) appropriate instruments are selected and used to measure elapsed time;
 - e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources;
 - f) independent and dependent variables are identified;
 - g) constants in an experimental situation are identified;
 - h) hypotheses are developed as cause and effect relationships;
 - i) data are collected, recorded, analyzed, and displayed using bar and basic line graphs;
 - j) numerical data that are contradictory or unusual in experimental results are recognized;
 - k) data are communicated with simple graphs, pictures, written statements, and numbers;
 - l) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and
 - m) current applications are used to reinforce science concepts.

Force, Motion, and Energy

- 4.2 The student will investigate and understand characteristics and interactions of moving objects. Key concepts include
- a) motion is described by an object's direction and speed;
 - b) changes in motion are related to force and mass;
 - c) friction is a force that opposes motion; and
 - d) moving objects have kinetic energy.

- 4.3 The student will investigate and understand the characteristics of electricity. Key concepts include
- a) conductors and insulators;
 - b) basic circuits;
 - c) static electricity;
 - d) the ability of electrical energy to be transformed into light and motion, and to produce heat;
 - e) simple electromagnets and magnetism; and
 - f) historical contributions in understanding electricity.

Life Processes

- 4.4 The student will investigate and understand basic plant anatomy and life processes. Key concepts include
- a) the structures of typical plants and the function of each structure;
 - b) processes and structures involved with plant reproduction;
 - c) photosynthesis; and
 - d) adaptations allow plants to satisfy life needs and respond to the environment.

Living Systems

- 4.5 The student will investigate and understand how plants and animals, including humans, in an ecosystem interact with one another and with the nonliving components in the ecosystem. Key concepts include
- a) plant and animal adaptations;
 - b) organization of populations, communities, and ecosystems and how they interrelate;
 - c) flow of energy through food webs;
 - d) habitats and niches;
 - e) changes in an organism's niche at various stages in its life cycle; and
 - f) influences of human activity on ecosystems.

Interrelationships in Earth/Space Systems

- 4.6 The student will investigate and understand how weather conditions and phenomena occur and can be predicted. Key concepts include
- a) weather phenomena;
 - b) weather measurements and meteorological tools; and
 - c) use of weather measurements and weather phenomena to make weather predictions.

Earth Patterns, Cycles, and Change

- 4.7 The student will investigate and understand the organization of the solar system. Key concepts include
- a) the planets in the solar system;
 - b) the order of the planets in the solar system; and
 - c) the relative sizes of the planets.

- 4.8 The student will investigate and understand the relationships among Earth, the moon, and the sun. Key concepts include
- a) the motions of Earth, the moon, and the sun;
 - b) the causes for Earth's seasons;
 - c) the causes for the phases of the moon;
 - d) the relative size, position, age, and makeup of Earth, the moon, and the sun; and
 - e) historical contributions in understanding the Earth-moon-sun system.

Earth Resources

- 4.9 The student will investigate and understand important Virginia natural resources. Key concepts include
- a) watersheds and water resources;
 - b) animals and plants;
 - c) minerals, rocks, ores, and energy sources; and
 - d) forests, soil, and land.

Grade Five Science Standards of Learning for Virginia Public Schools – January 2010

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Application

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Grade Five

The fifth-grade standards emphasize the importance of selecting appropriate instruments for measuring and recording observations. The organization, analysis, and application of data continue to be an important focus of classroom inquiry. Science skills from preceding grades, including questioning, using and validating evidence, and systematic experimentation, are reinforced at this level. Students are introduced to more detailed concepts of sound and light and the tools used for studying them. Key concepts of matter, including those about atoms, molecules, elements, and compounds, are studied, and the properties of matter are defined in greater detail. The cellular makeup of organisms and the distinguishing characteristics of groups of organisms are stressed. Students learn about the characteristics of the oceans and Earth's changing surface.

The fifth-grade standards focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

Scientific Investigation, Reasoning, and Logic

- 5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
- a) items such as rocks, minerals, and organisms are identified using various classification keys;
 - b) estimates are made and accurate measurements of length, mass, volume, and temperature are made in metric units using proper tools;
 - c) estimates are made and accurate measurements of elapsed time are made using proper tools;
 - d) hypotheses are formed from testable questions;
 - e) independent and dependent variables are identified;
 - f) constants in an experimental situation are identified;
 - g) data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements;
 - h) predictions are made using patterns from data collected, and simple graphical data are generated;
 - i) inferences are made and conclusions are drawn;
 - j) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and
 - k) current applications are used to reinforce science concepts.

Force, Motion, and Energy

- 5.2 The student will investigate and understand how sound is created and transmitted, and how it is used. Key concepts include
- a) compression waves;
 - b) vibration, compression, wavelength, frequency, amplitude;
 - c) the ability of different media (solids, liquids, and gases) to transmit sound; and
 - d) uses and applications of sound waves.
- 5.3 The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include
- a) transverse waves;
 - b) the visible spectrum;
 - c) opaque, transparent, and translucent;
 - d) reflection of light from reflective surfaces; and
 - e) refraction of light through water and prisms.

Matter

- 5.4 The student will investigate and understand that matter is anything that has mass and takes up space; and occurs as a solid, liquid, or gas. Key concepts include
- a) distinguishing properties of each phase of matter;
 - b) the effect of temperature on the phases of matter;
 - c) atoms and elements;
 - d) molecules and compounds; and
 - e) mixtures including solutions.

Living Systems

- 5.5 The student will investigate and understand that organisms are made of one or more cells and have distinguishing characteristics that play a vital role in the organism's ability to survive and thrive in its environment. Key concepts include
- a) basic cell structures and functions;
 - b) classification of organisms using physical characteristics, body structures, and behavior of the organism; and
 - c) traits of organisms that allow them to survive in their environment.

Interrelationships in Earth/Space Systems

- 5.6 The student will investigate and understand characteristics of the ocean environment. Key concepts include
- a) geological characteristics;
 - b) physical characteristics; and
 - c) ecological characteristics.

Earth Patterns, Cycles, and Change

- 5.7 The student will investigate and understand how Earth's surface is constantly changing. Key concepts include
- a) identification of rock types;
 - b) the rock cycle and how transformations between rocks occur;
 - c) Earth history and fossil evidence;
 - d) the basic structure of Earth's interior;
 - e) changes in Earth's crust due to plate tectonics;
 - f) weathering, erosion, and deposition; and
 - g) human impact.