

# **Science Standards of Learning for Virginia Public Schools**

**Adopted in January 2003 by the  
Board of Education**

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## **Introduction**

The Science Standards of Learning identify academic content for essential components of the science curriculum at different grade levels for Virginia's public schools. Standards are identified for kindergarten through grade five, for the middle school, and for a core set of high school courses including Earth Science, Biology, Chemistry, and Physics. Throughout a student's science schooling from kindergarten through grade six, specific content strands or topics are included. These content 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 Resources. The Standards of Learning in each strand progress in complexity at each grade level K-6 and are represented indirectly throughout the high school courses.

The Standards of Learning are not intended to encompass the entire science curriculum for a given grade level or course or to prescribe how the content should be taught. Teachers are encouraged to go beyond the standards and to select instructional strategies and assessment methods appropriate for their students.

Four key components of the science standards critical to implementation and necessary for student success in achieving science literacy are described below. It is imperative to science instruction that the local curriculum consider and address how these 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. Explore science-related careers and interests.

## K-12 Safety

In implementing the Science Standards of Learning, students must 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 contact with natural hazards such as poison ivy, ticks, mushrooms, insects, spiders, and snakes;
- Field activities in, near, or over bodies of water;
- Handling of glass tubing, sharp objects, glassware, and labware;
- Natural gas burners, bunsen burners, and other sources of flame/heat;
- Hazards associated with direct sunlight (sunburn and eye damage);
- Use of extreme temperatures and cryogenic materials;
- Hazardous chemicals including toxins, carcinogens, flammable and explosive materials;
- Acid/base neutralization reactions/dilutions;
- Production of toxic gases or situations where high pressures are generated;
- Biological cultures, their appropriate disposal, and recombinant DNA;
- Power equipment/motors;
- High voltage/exposed wiring; and
- 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 taken into account.

- OSHA (Occupational Safety and Health Administration)
- ISEF (International Science and Engineering Fair Rules)
- Public health departments and local school division protocols.

## **The Role of Instructional Technology in Science Education**

The use of current and emerging technologies is essential to the K-12 science instructional program.

Specifically, technology must

- 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), selling one's idea (presentation software), and resource management (project management software).
- Be readily available and used regularly as an integral and ongoing part in 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, interactive-optical laser discs, video-microscopes, graphing calculators, CD-ROMs, probeware, global positioning systems (GPS), online telecommunication, software and appropriate hardware, as well as other emerging technologies.
- Be reflected in the "instructional strategies" generally developed at the local 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 these skills are 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, explaining new phenomena with the information, 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 information, facts, and principles to produce a new idea, plan, procedure, or product; and
- Make judgments about information in terms of 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 local school division will develop and refine to meet the intent of the Science Standards of Learning.

## **Kindergarten**

The kindergarten standards stress the use of basic science skills to explore common materials, objects, and living things. Emphasis is placed on using the senses to gather information. Students are expected to develop skills in posing simple questions, measuring, sorting, classifying, and communicating information about the natural world. The science skills are an important focus as students learn about life processes and properties of familiar materials such as magnets and water. Through phenomena including shadows, patterns of weather, and plant growth, students are introduced to the concept of change. The significance of natural resources and conservation is introduced in the kindergarten standards.

### **Scientific Investigation, Reasoning, and Logic**

- K.1 The student will conduct investigations in which
- a) basic properties of objects are identified by direct observation;
  - b) observations are made from multiple positions to achieve different perspectives;
  - c) objects are described both pictorially and verbally;
  - d) a set of objects is sequenced according to size;
  - e) a set of objects is separated into two groups based on a single physical attribute;
  - f) nonstandard units are used to measure common objects;
  - g) a question is developed from one or more observations;
  - h) picture graphs are constructed using 10 or fewer units;
  - i) an unseen member in a sequence of objects is predicted; and
  - j) unusual or unexpected results in an activity are recognized.
- K.2 Students will investigate and understand that humans have senses that allow one to seek, find, take in, and react or respond to information in order to learn about one's surroundings. Key concepts include:
- a) five senses and corresponding sensing organ (taste-tongue, touch-skin, smell-nose, hearing-ears, and sight-eyes); and
  - b) sensory descriptors (sweet, sour, bitter, salty, rough/smooth, hard/soft, cold, warm, hot, loud/soft, high/low, bright/dull)

### **Force, Motion, and Energy**

- K.3 The student will investigate and understand that magnets have an effect on some materials, make some things move without touching them, and have useful applications. Key concepts include
- a) attraction/nonattraction, push/pull, attract/repel, and metal/nonmetal; and
  - b) useful applications (refrigerator magnet, can opener, magnetized screwdriver, and magnetic games).

## **Matter**

- K.4 The student will investigate and understand that the position, motion, and physical properties of an object can be described. Key concepts include
- a) colors (red, orange, yellow, green, blue, purple), white, and black;
  - b) shapes (circle, triangle, square, and rectangle) and forms (flexible/stiff, straight/curved);
  - c) textures (rough/smooth) and feel (hard/soft);
  - d) relative size and weight (big/little, large/small, heavy/light, wide/thin, long/short); and
  - e) position (over/under, in/out, above/below, left/right) and speed (fast/slow).
- K.5 The student will investigate and understand that water flows and has properties that can be observed and tested. Key concepts include
- a) water occurs in different states (solid, liquid, gas);
  - b) the natural flow of water is downhill; and
  - c) some materials float in water while others sink.

## **Life Processes**

- K.6 The student will investigate and understand basic needs and life processes of plants and animals. Key concepts include
- a) living things change as they grow and need food, water, and air to survive;
  - b) plants and animals live and die (go through a life cycle); and
  - c) offspring of plants and animals are similar but not identical to their parents and one another.

## **Interrelationships in Earth/Space Systems**

- K.7 The student will investigate and understand that shadows occur when light is blocked by an object. Key concepts include
- a) shadows occur in nature when sunlight is blocked by an object; and
  - b) shadows can be produced by blocking artificial light sources.

## **Earth Patterns, Cycles, and Change**

- K.8 The student will investigate and understand simple patterns in his/her daily life. Key concepts include
- a) weather observations;
  - b) the shapes and forms of many common natural objects including seeds, cones, and leaves;
  - c) animal and plant growth; and

d) home and school routines.

- K.9 The student will investigate and understand that change occurs over time, and rates may be fast or slow. Key concepts include
- a) natural and human-made things may change over time; and
  - b) changes can be noted and measured.

### **Resources**

- K.10 The student will investigate and understand that materials can be reused, recycled, and conserved. Key concepts include
- a) materials and objects can be used over and over again;
  - b) everyday materials can be recycled; and
  - c) water and energy conservation at home and in school helps preserve resources for future use.

## **Grade One**

The first-grade standards continue to stress basic science skills in understanding familiar objects and events. Students are expected to begin conducting simple experiments and be responsible for some of the planning. Students are introduced to the concept of classifying plants and animals based on simple characteristics. Emphasis is placed on the relationships among objects and their interactions with one another. Students are expected to know the basic relationships between the sun and Earth and between seasonal changes and plant and animal activities. Students also will begin to develop an understanding of moving objects, simple solutions, and important natural resources.

### **Scientific Investigation, Reasoning, and Logic**

- 1.1 The student will conduct investigations in which
- a) differences in physical properties are observed using the senses;
  - b) simple tools are used to enhance observations;
  - c) objects or events are classified and arranged according to attributes or properties;
  - d) observations and data are communicated orally and with simple graphs, pictures, written statements, and numbers;
  - e) length, mass, and volume are measured using standard and nonstandard units;
  - f) predictions are based on patterns of observation rather than random guesses;
  - g) simple experiments are conducted to answer questions; and
  - h) inferences are made and conclusions are drawn about familiar objects and events.

### **Force, Motion, and Energy**

- 1.2 The student will investigate and understand that moving objects exhibit different kinds of motion. Key concepts include
- a) objects may have straight, circular, and back and forth motions;
  - b) objects may vibrate and produce sound;
  - c) pushes or pulls can change the movement of an object; and
  - d) the motion of objects may be observed in toys and in playground activities.

### **Matter**

- 1.3 The student will investigate and understand how different common materials interact with water. Key concepts include
- a) some liquids will separate when mixed with water, others will not;
  - b) some common solids will dissolve in water, others will not; and
  - c) some substances will dissolve more readily in hot water than in cold water.

## **Life Processes**

- 1.4 The student will investigate and understand that plants have life needs and functional parts and can be classified according to certain characteristics. Key concepts include
- a) needs (food, air, water, light, and a place to grow);
  - b) parts (seeds, roots, stems, leaves, blossoms, fruits); and
  - c) characteristics (edible/nonedible, flowering/nonflowering, evergreen/deciduous).
- 1.5 The student will investigate and understand that animals, including people, have life needs and specific physical characteristics and can be classified according to certain characteristics. Key concepts include
- a) life needs (air, food, water, and a suitable place to live);
  - b) physical characteristics (body coverings, body shape, appendages, and methods of movement); and
  - c) other characteristics (wild/tame, water homes/land homes).

## **Interrelationships in Earth/Space Systems**

- 1.6 The student will investigate and understand the basic relationships between the sun and the Earth. Key concepts include
- a) the sun is the source of heat and light that warms the land, air, and water; and
  - b) night and day are caused by the rotation of the Earth.

## **Earth Patterns, Cycles, and Change**

- 1.7 The student will investigate and understand the relationship of seasonal change and weather to the activities and life processes of plants and animals. Key concepts include how temperature, light, and precipitation bring about changes in
- a) plants (growth, budding, falling leaves, and wilting);
  - b) animals (behaviors, hibernation, migration, body covering, and habitat); and
  - c) people (dress, recreation, and work).

## **Resources**

- 1.8 The student will investigate and understand that natural resources are limited. Key concepts include
- a) identification of natural resources (plants and animals, water, air, land, minerals, forests, and soil);
  - b) factors that affect air and water quality; and
  - c) recycling, reusing, and reducing consumption of natural resources.

## **Grade Two**

The second-grade standards continue to focus on using a broad range of science skills in understanding the natural world. Making detailed observations, drawing conclusions, and recognizing unusual or unexpected data are skills needed to be able to use and validate information. Measurement in both English and metric units is stressed. The idea of living systems is introduced through habitats and the interdependence of living and nonliving things. The concept of change is explored in states of matter, life cycles, weather patterns, and seasonal effects on plants and animals.

### **Scientific Investigation, Reasoning, and Logic**

- 2.1 The student will conduct investigations in which
- a) observation is differentiated from personal interpretation, and conclusions are drawn based on observations;
  - b) observations are repeated to ensure accuracy;
  - c) two or more attributes are used to classify items;
  - d) conditions that influence a change are defined;
  - e) length, volume, mass, and temperature measurements are made in metric (centimeters, meters, liters, degrees Celsius, grams, kilograms) and standard English units (inches, feet, yards, cups, pints, quarts, gallons, degrees Fahrenheit, ounces, pounds);
  - f) pictures and bar graphs are constructed using numbered axes;
  - g) unexpected or unusual quantitative data are recognized; and
  - h) simple physical models are constructed.

### **Force, Motion, and Energy**

- 2.2 The student will investigate and understand that natural and artificial magnets have certain characteristics and attract specific types of metals. Key concepts include
- a) magnetism, iron, magnetic/nonmagnetic, poles, attract/repel; and
  - b) important applications including the magnetic compass.

### **Matter**

- 2.3 The student will investigate and understand basic properties of solids, liquids, and gases. Key concepts include
- a) mass and volume; and
  - b) processes involved with changes in matter from one state to another (condensation, evaporation, melting, and freezing).

## **Life Processes**

- 2.4 The student will investigate and understand that plants and animals undergo a series of orderly changes in their life cycles. Key concepts include
- a) some animals (frogs and butterflies) undergo distinct stages during their lives while others generally resemble their parents; and
  - b) flowering plants undergo many changes from the formation of the flower to the development of the fruit.

## **Living Systems**

- 2.5 The student will investigate and understand that living things are part of a system. Key concepts include
- a) living organisms are interdependent with their living and nonliving surroundings; and
  - b) habitats change over time due to many influences.

## **Interrelationships in Earth/Space Systems**

- 2.6 The student will investigate and understand basic types, changes, and patterns of weather. Key concepts include
- a) temperature, wind, precipitation, drought, flood, and storms; and
  - b) the uses and importance of measuring and recording weather data.

## **Earth Patterns, Cycles, and Change**

- 2.7 The student will investigate and understand that weather and seasonal changes affect plants, animals, and their surroundings. Key concepts include
- a) effects on growth and behavior of living things (migration, hibernation, camouflage, adaptation, dormancy); and
  - b) weathering and erosion of the land surface.

## **Resources**

- 2.8 The student will investigate and understand that plants produce oxygen and food, are a source of useful products, and provide benefits in nature. Key concepts include
- a) important plant products (fiber, cotton, oil, spices, lumber, rubber, medicines, and paper);

- b) the availability of plant products affects the development of a geographic area; and
- c) plants provide homes and food for many animals and prevent soil from washing away.

## Grade Three

The third-grade standards place increasing emphasis on conducting investigations. Students are expected to be able to develop questions, formulate simple hypotheses, make predictions, gather data, and use the metric system with greater precision. Using information to make inferences and draw conclusions becomes more important. In the area of physical science, the standards focus on simple and compound machines, energy, and a basic understanding of matter. Behavioral and physical adaptations are examined in relation to the life needs of animals. The notion of living systems is further explored in aquatic and terrestrial food chains and diversity in environments. Patterns in the natural world are demonstrated in terms of the phases of the moon, tides, seasonal changes, the water cycle, and animal life cycles. Geological concepts are introduced through the investigation of the components of soil.

### Scientific Investigation, Reasoning, and Logic

- 3.1 The student will plan and conduct investigations in which
- a) predictions and observations are made;
  - b) objects with similar characteristics are classified into at least two sets and two subsets;
  - c) questions are developed to formulate hypotheses;
  - d) volume is measured to the nearest milliliter and liter;
  - e) length is measured to the nearest centimeter;
  - f) mass is measured to the nearest gram;
  - g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
  - h) temperature is measured to the nearest degree Celsius;
  - i) time is measured to the nearest minute;
  - j) inferences are made and conclusions are drawn; and
  - k) natural events are sequenced chronologically.

### Force, Motion, and Energy

- 3.2 The student will investigate and understand simple machines and their uses. Key concepts include
- a) types of simple machines (lever, screw, pulley, wheel and axle, inclined plane, and wedge);
  - b) how simple machines function;
  - c) compound machines (scissors, wheelbarrow, and bicycle); and
  - d) examples of simple and compound machines found in the school, home, and work environment.

## **Matter**

- 3.3 The student will investigate and understand that objects are made of materials that can be described by their physical properties. Key concepts include
- a) objects are made of one or more materials;
  - b) materials are composed of parts that are too small to be seen without magnification; and
  - c) physical properties remain the same as the material is reduced in size.

## **Life Processes**

- 3.4 The student will investigate and understand that behavioral and physical adaptations allow animals to respond to life needs. Key concepts include
- a) methods of gathering and storing food, finding shelter, defending themselves, and rearing young; and
  - b) hibernation, migration, camouflage, mimicry, instinct, and learned behavior.

## **Living Systems**

- 3.5 The student will investigate and understand relationships among organisms in aquatic and terrestrial food chains. Key concepts include
- a) producer, consumer, decomposer;
  - b) herbivore, carnivore, omnivore; and
  - c) predator - prey.
- 3.6 The student will investigate and understand that environments support a diversity of plants and animals that share limited resources. Key concepts include
- a) water-related environments (pond, marshland, swamp, stream, river, and ocean environments);
  - b) dry-land environments (desert, grassland, rain forest, and forest environments); and
  - c) population and community.

## **Interrelationships in Earth/Space Systems**

- 3.7 The student will investigate and understand the major components of soil, its origin, and importance to plants and animals including humans. Key concepts include
- a) soil provides the support and nutrients necessary for plant growth;
  - b) topsoil is a natural product of subsoil and bedrock;
  - c) rock, clay, silt, sand, and humus are components of soils; and
  - d) soil is a natural resource and should be conserved.

## **Earth Patterns, Cycles, and Change**

- 3.8 The student will investigate and understand basic patterns and cycles occurring in nature. Key concepts include
- a) patterns of natural events (day and night, seasonal changes, phases of the moon, and tides); and
  - b) animal and plant life cycles.
- 3.9 The student will investigate and understand the water cycle and its relationship to life on Earth. Key concepts include
- a) the energy from the sun drives the water cycle;
  - b) processes involved in the water cycle (evaporation, condensation, precipitation);
  - c) water is essential for living things; and
  - d) water supply and water conservation.

## **Resources**

- 3.10 The student will investigate and understand that natural events and human influences can affect the survival of species. Key concepts include
- a) the interdependency of plants and animals;
  - b) human effects on the quality of air, water, and habitat;
  - c) the effects of fire, flood, disease, and erosion on organisms; and
  - d) conservation and resource renewal.
- 3.11 The student will investigate and understand different sources of energy. Key concepts include
- a) the sun's ability to produce light and heat energy;
  - b) sources of energy (sunlight, water, wind);
  - c) fossil fuels (coal, oil, natural gas) and wood; and
  - d) renewable and nonrenewable energy resources.

## **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. Relationships are investigated in the interactions among the Earth, moon, and sun and 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 plan and conduct investigations in which
- a) distinctions are made among observations, conclusions, inferences, and predictions;
  - b) hypotheses are formulated based on cause and effect relationships;
  - c) variables that must be held constant in an experimental situation are defined;
  - d) appropriate instruments are selected to measure linear distance, volume, mass, and temperature;
  - e) appropriate metric measures are used to collect, record, and report data;
  - f) data are displayed using bar and basic line graphs;
  - g) numerical data that are contradictory or unusual in experimental results are recognized; and
  - h) predictions are made based on data from picture graphs, bar graphs, and basic line graphs.

### **Force, Motion, and Energy**

- 4.2 The student will investigate and understand characteristics and interaction of moving objects. Key concepts include
- a) motion is described by an object's direction and speed;
  - b) forces cause changes in motion;
  - 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 (open/closed, parallel/series);
  - c) static electricity;
  - d) the ability of electrical energy to be transformed into heat, light, and mechanical energy;

- 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 (leaves, stems, roots, and flowers);
  - b) processes and structures involved with reproduction (pollination, stamen, pistil, sepal, embryo, spore, and seed);
  - c) photosynthesis (sunlight, chlorophyll, water, carbon dioxide, oxygen, and sugar); and
  - d) dormancy.

### **Living Systems**

- 4.5 The student will investigate and understand how plants and animals in an ecosystem interact with one another and the nonliving environment. Key concepts include
- a) behavioral and structural adaptations;
  - b) organization of communities;
  - c) flow of energy through food webs;
  - d) habitats and niches;
  - e) life cycles; and
  - f) influence 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 measurements and meteorological tools (air pressure-barometer, wind speed-anemometer, rainfall-rain gauge, and temperature-thermometer); and
  - b) weather phenomena (fronts, clouds, and storms).

### **Earth Patterns, Cycles, and Change**

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

## Resources

4.8 The student will investigate and understand important Virginia natural resources.

Key concepts include

- a) watershed and water resources;
- b) animals and plants;
- c) minerals, rocks, ores, and energy sources; and
- d) forests, soil, and land.

## **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 include atoms, molecules, elements, and compounds, 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 will learn about the characteristics of the oceans and the 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 plan and conduct investigations in which
- a) rocks, minerals, and organisms are identified using a classification key;
  - b) estimations of length, mass, and volume are made;
  - c) appropriate instruments are selected and used for making quantitative observations of length, mass, volume, and elapsed time;
  - d) accurate measurements are made using basic tools (thermometer, meter stick, balance, graduated cylinder);
  - e) data are collected, recorded, and reported using the appropriate graphical representation (graphs, charts, diagrams);
  - f) predictions are made using patterns, and simple graphical data are extrapolated;
  - g) manipulated and responding variables are identified; and
  - h) an understanding of the nature of science is developed and reinforced.

### **Force, Motion, and Energy**

- 5.2 The student will investigate and understand how sound is transmitted and is used as a means of communication. Key concepts include
- a) frequency, waves, wavelength, vibration;

- b) the ability of different media (solids, liquids, and gases) to transmit sound; and
- c) uses and applications (voice, sonar, animal sounds, and musical instruments).

- 5.3 The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include
- a) the visible spectrum and light waves;
  - b) refraction of light through water and prisms;
  - c) reflection of light from reflective surfaces (mirrors);
  - d) opaque, transparent, and translucent; and
  - e) historical contributions in understanding light.

### **Matter**

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

### **Living Systems**

- 5.5 The student will investigate and understand that organisms are made of cells and have distinguishing characteristics. Key concepts include
- a) basic cell structures and functions;
  - b) kingdoms of living things;
  - c) vascular and nonvascular plants; and
  - d) vertebrates and invertebrates.

### **Interrelationships in Earth/Space Systems**

- 5.6 The student will investigate and understand characteristics of the ocean environment. Key concepts include
- a) geological characteristics (continental shelf, slope, rise);
  - b) physical characteristics (depth, salinity, major currents); and
  - c) biological characteristics (ecosystems).

### **Earth Patterns, Cycles, and Change**

- 5.7 The student will investigate and understand how the Earth's surface is constantly changing. Key concepts include
- a) the rock cycle including the identification of rock types;

- b) Earth history and fossil evidence;
- c) the basic structure of the Earth's interior;
- d) plate tectonics (earthquakes and volcanoes);
- e) weathering and erosion; and
- f) human impact.