GRADE-LEVEL EXPECTATIONS (GLE) HANDBOOK

SCIENCE
GRADES 5–8

LOUISIANA DEPARTMENT OF EDUCATION

CECIL J. PICARD
STATE SUPERINTENDENT OF EDUCATION

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LOUISIANA
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GRADE-LEVEL EXPECTATIONS HANDBOOK OVERVIEW

INTRODUCTION

In 1997, rigorous K–12 content standards were approved for mathematics, English language arts, science, social studies, foreign languages, and the arts. In conjunction with the development of these content standards, the Louisiana Department of Education (LDE) developed standards-based tests in English language arts, mathematics, science and social studies for grades 4, 8, 10, and 11. These tests have served as the basis for Louisiana's School and District Accountability System for several years. The development of Grade-Level Expectations (GLEs) in 2003 in English language arts, mathematics, science and social studies was a continuation of Louisiana's effort to expand and extend the content standards. GLEs identify what all students should know or be able to do by the end of a given grade level from prekindergarten through grade 12 in these four content areas.

PURPOSES OF THE GLE HANDBOOKS

The Louisiana Grade-Level Expectations handbooks include grade-specific information about the GLEs. Each handbook includes introductory information for each content area contained within the handbook, a glossary, and tables that map the relationship between the standards and/or strands, benchmarks, and GLEs. Each handbook also correlates with one of fourteen GLE posters.

GRADE-LEVEL EXPECTATIONS DEVELOPMENT GUIDELINES

Each grade-level expectation is meant to further define a content standard and benchmark(s). There is a progression of specificity; the standards represent broad statements, benchmarks are more specific, and GLEs provide the most detail. Grade-level expectations have been developed from prekindergarten through grade 12.

GLEs do not represent the entire curriculum for a given grade or course. Rather, they represent the core content that should be mastered by the end of a given year by all students. For mastery to be achieved at a given level, it may be necessary for those skills to be introduced at an earlier grade. Similarly, skills will need to be maintained after mastery has occurred.

The GLEs were developed with the following goals in mind:

- to articulate learning from PreK–12
- to be appropriate for the developmental or grade level of students
- to move from the concrete to the abstract
- to attend to prerequisite skills and understandings
- to be specific, but not so specific as to be too small in "grain size" compared with other GLEs for a particular content area

The GLEs were developed with an effort to avoid including:

- statements of curricular activities or instructional strategies
- value-laden concepts and understandings

SUMMARY OF GLE DEVELOPMENT PROCESS

In December 2002, the LDE selected Data Recognition Corporation (DRC) as the contractor for the Grade-Level Expectations Project. The steps in the process of developing the Grade-Level Expectations for English language arts, mathematics, science, and social studies are described below.

1. **Identifying National Consultants.** National consultants representing each content area were selected to provide a national perspective to the GLE project and to assist the LDE and DRC with various steps in the GLE development process.

2. **Conducting Teacher Committee Meetings.** In March and April of 2003, content-area development committees, comprised of approximately 120 Louisiana classroom teachers, administrators, special populations teachers, and resource teachers chosen for their knowledge of standards and curriculum, were convened to assist with the development of the GLEs for English language arts, mathematics, science, and social studies.

3. **Completing Initial drafts.** The draft GLEs for the four content areas were completed and prepared for further review.

4. **Convening Focus Groups.** Two eighty-member groups of educators, nominated by their districts, reviewed the draft GLEs for horizontal and vertical alignments with the standards for English language arts, mathematics, science, and social studies and provided additional input on these initial drafts to the LDE.

5. **Conducting an Online/Electronic Public Review.** An online/electronic public review and feedback system was developed for the GLEs and made available on the LDE Web site. The purpose of this review was to solicit a broad range of feedback on the GLEs from parents, teachers, and other stakeholders.

6. **Completing an External Review.** With assistance from the staff of the Council of Chief State School Officers (CCSSO), twelve content specialists (three per content area) from other states or from universities or educational organizations across the nation were invited to serve on the review committee. In addition, the LDE also invited the national consultants from each content area to participate in the review meeting to answer questions about the development of the GLEs. External review committee members reviewed the GLE documents prior to the meetings, met with national consultants and LDE staff, and provided specific feedback on the GLEs via a written report.

7. **Conducting Final Committee Meeting.** The public comments and suggestions from the online public review were tabulated, and the additional comments and feedback from the external review committee meeting were compiled for sharing with committee members during the third and final GLE development committee meeting. The outcome of the third meeting of content-area committees consisted of suggestions for final edits that would be incorporated into the documents for presentation to the Louisiana State Board of Elementary and Secondary Education.

8. **Obtaining SBESE Board Approval of the GLEs.** In October 2003, the LDE staff presented the GLEs to the Louisiana State Board of Elementary and Secondary Education for review and approval.

9. **Conducting Preworkshops and GLE Awareness Workshops.** Two preworkshops for district supervisors in early December 2003 and fifteen GLE awareness workshops for local school personnel in late January 2004 have been conducted to inform educators about the grade-level expectations and their future role as it relates to curriculum and assessment

CONCLUSION

Louisiana's content standards and benchmarks have guided the Louisiana education reform program for several years. As an extension of the content standards and benchmarks, the GLEs provide a link among instruction, curriculum, and assessment. The primary goal is a common understanding among parents, students, teachers, and the general public about what is expected of Louisiana students as they progress from grade to grade.

SCIENCE INTRODUCTION

GENERAL DEVELOPMENT PRINCIPLES

The content described by the Grade-Level Expectations (GLEs) does not represent the entire science curriculum for a grade or course. The GLEs indicate core content to be mastered by the end of a given grade. Science content can be added and enriched as appropriate for a district program, school, or student. For mastery to be attained, most content must be introduced earlier than the grade identified for mastery. Once a particular skill has been identified as a GLE, the skill should be reinforced in subsequent years, but it is not repeated in the list of expectations for subsequent years.

ELEMENTARY: PREKINDERGARTEN–GRADE 4

Students at the prekindergarten (PreK) through grade 4 levels are learning to observe by using their senses, describing properties of substances using appropriate terminology, and comparing, sorting, classifying, and reading about the natural world. Science activities and investigations can be used to engage students in reading, expository writing, measuring, calculating, graphing, and communicating.

MIDDLE SCHOOL: GRADES 5–8

To develop a deeper understanding of concepts, science content focus areas have been identified for grades 5–8. They are listed in Table 1.

Table 1. Middle School Science Focus Areas

Grade	Focus Area
5	Integrated Science
6	Physical Science
7	Life Science
8	Earth and Space Science

In addition to the designated focus areas, the Science as Inquiry (SI) and Science and the Environment (SE) strands are integrated into each of the middle school grades. Other content may be integrated locally within school districts. Additionally, districts not teaching middle school science in the same order as the focus areas may need to realign their curriculum to meet *i*LEAP assessment requirements.

HIGH SCHOOL: GRADES 9–12

In high school, GLEs were developed for six science courses, one each at ninth- and tenth-grade levels and four for the eleventh- and twelfth-grade levels, with the following recommendations in mind (Table 2):

Table 2. High School Courses

Strand	Course(s)	Recommended Grades
Physical Science	Physical Science	9
	Chemistry I	11–12
	Physics I	11–12
Life Science	Biology I	10
Earth and Space Science	Earth Science	11–12
Science and the Environment	Environmental Science	11–12

Students may meet the state's high school graduation requirements in science in a variety of ways. Both personal preference and district course offerings affect which courses are taken and may determine the order in which courses are taken.

Chemistry and Physics are advanced Physical Science courses. GLEs for these courses are based on the Physical Science benchmarks but require higher-level skills and understandings. Prerequisite GLEs for Chemistry and Physics can be found in the Physical Science course recommended for grade 9.

STANDARDS/BENCHMARKS/GLES

The organization of the science GLEs aligns with the *Louisiana Science Framework* (1997). The science GLEs address benchmarks from all five content strands outlined in the framework document.

Additional resources used to facilitate the development of the science GLEs include the *National Science Education Standards* (NSES, 1996), the National Assessment of Educational Progress *Science Framework* (NAEP, 1999), and the various Project 2061 publications of the American Association for the Advancement of Science. These national standards are reflected in the *Louisiana Science Framework* and the GLEs.

The five Louisiana science content standards are broad goals for what all students in Louisiana should know and be able to do in science. In the *Louisiana Science Framework*, strands are based on the five science standards. That is, each strand represents one of the five standards. The strands and their respective abbreviated codes are Science as Inquiry (SI), Physical Science (PS), Life Science (LS), Earth and Space Science (ESS), and Science and the Environment (SE). There is one process strand, Science as Inquiry, and four content strands. This organization into strands does not imply that science must be taught in separate isolated units. In fact, teachers are encouraged to teach integrated, interdisciplinary units of study.

Codes at the end of each GLE are used to identify a developmental profile indicator from the *Louisiana Standards for Programs Serving Four-Year-Old Children* (Table 3) and/or benchmarks from the *Louisiana Science Framework* (Table 4). A GLE may apply to more than one benchmark and, as a result, a GLE may have more than one code.

Developmental Profile Indicator Code: The first part of the code is always PK, which means prekindergarten. The second part, or term, indicates the domain and content area (i.e., Cognitive Science). The third term indicates the skill area, or strand, (i.e., PS, LS, ES) and skill number (e.g., 1, 2).

Table 3. Explanation of Developmental Profile Indicator Codes

Code(s)	Explanation
PK-CS-L4	Prekindergarten, Cognitive Science, Life Science, Skill 4
PK-CS-P3	Prekindergarten, Cognitive Science, Physical Science, Skill 3
PK-CS-ES1	Prekindergarten, Cognitive Science, Earth and Space Science, Skill 1

Benchmark Codes: The first term in the benchmark code refers to the strand (i.e., SI, PS, LS, ESS, SE). The second term refers to the grade cluster (i.e., E for elementary, M for middle school, and H for high school). The third term refers to the substrand and benchmark number (e.g., A1, B2, C3).

For most grade clusters, strands are divided into substrands or major topical areas. (The SE strand has no substrands at the PreK–4 and 5–8 grade levels.) Science GLEs have been developed and are organized based on this secondary breakdown. Substrands are indicated by the letters in the benchmark code designations.

Table 4. Explanation of Benchmark Codes

Code(s)	Explanation
SI-E-A5	SI strand, Elementary level, substrand A, benchmark 5
PS-M-B4	PS strand, Middle School level, substrand B, benchmark 4
SE-H-A6 LS-H-D1	SE strand, High School level, substrand A, benchmark 6 *and* LS strand, High School level, substrand D, benchmark 1

SCIENCE INTRODUCTION

The SI standard states: *The students will **do** science by engaging in partial and full inquiries that are within their developmental capabilities*. The GLEs for the SI strand of the science framework are to be embedded in all science courses at every grade level and cannot be considered in isolation from the other strands. The processes and skills in the SI strand are to be integrated with the science content of the other four strands.

Each of the following GLE listings by grade opens with a summary describing the focal emphases of that grade. These emphases serve to shape and mold the program for that individual grade level. Careful articulation of these GLEs in a program will assure Louisiana a future marked by significant growth in students' abilities to learn, apply, and appreciate science concepts in all aspects of their lives.

FIFTH GRADE INTRODUCTION

Fifth Grade

The focus of fifth-grade science is to further develop understanding of fundamental concepts from each of the science strands. The emphasis is on developing inquiry skills and acquiring more depth in content knowledge. For example, in the Physical Science (PS) strand, students compare physical and chemical properties of materials. In the Earth and Space Science (ESS) strand, they demonstrate the results of constructive and destructive forces using models or illustrations.

SAMPLE PAGE AND KEY FOR SCIENCE

Strand/ Standard

Science As Inquiry: The students will do science by engaging in partial and full inquiries that are within their developmental capabilities.

Substrand

A. The Abilities Necessary to do Scientific Inquiry

Benchmarks	Grade-Level Expectations
SI-E-A1: asking appropriate questions about organisms and events in the environment	1. Ask questions about objects and events in the environment (e.g., plants, rocks, storms) (SI-E-A1) 2. Pose questions that can be answered by using students' own observations, scientific knowledge, and testable scientific investigations (SI-E-A1)
SI-E-A2: planning and/or designing and conducting a scientific investigation	3. Use observations to design and conduct simple investigations or experiments to answer testable questions (SI-E-A2) 4. Predict and anticipate possible outcomes (SI-E-A2) 5. Identify variables to ensure that only one experimental variable is tested at a time (SI-E-A2) 6. Use a variety of methods and materials and multiple trials to investigate ideas (observe, measure, accurately record data) (SI-E-A2)
SI-E-A3: communicating that observations are made with one's senses	7. Use the five senses to describe observations (SI-E-A3)
SI-E-A4: employing equipment and tools to gather data and extend the sensory observations	8. Measure and record length, temperature, mass, volume, and area in both metric system and U.S. system units (SI-E-A4) 9. Select and use developmentally appropriate equipment and tools (e.g., magnifying lenses, microscopes, graduated cylinders) and units of measurement to observe and collect data (SI-E-A4)

Benchmarks

Grade-Level Expectations (GLEs)

FIFTH GRADE

SCIENCE

Science As Inquiry: The students will do science by engaging in partial and full inquiries that are within their developmental capabilities.

A. The Abilities Necessary to do Scientific Inquiry

Benchmarks	Grade-Level Expectations
SI-M-A1: identifying questions that can be used to design a scientific investigation	1. Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1) 2. Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1) 3. Use a variety of sources to answer questions (SI-M-A1)
SI-M-A2: designing and conducting a scientific investigation	4. Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2) 5. Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
SI-M-A3: using mathematics and appropriate tools and techniques to gather, analyze, and interpret data	6. Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3) 7. Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3) 8. Use consistency and precision in data collection, analysis, and reporting (SI-M-A3) 9. Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)

SI-M-A4: developing descriptions, explanations, and graphs using data	10. Identify the difference between description and explanation (SI-M-A4) 11. Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4) 12. Use data and information gathered to develop an explanation of experimental results (SI-M-A4) 13. Identify patterns in data to explain natural events (SI-M-A4)
SI-M-A5: developing models and predictions using the relationships between data and explanations	14. Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5) 15. Identify and explain the limitations of models used to represent the natural world (SI-M-A5) 16. Use evidence to make inferences and predict trends (SI-M-A5)
SI-M-A6: comparing alternative explanations and predictions	17. Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6) 18. Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6)
SI-M-A7: communicating scientific procedures, information, and explanations	19. Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7) 20. Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7) 21. Distinguish between *observations* and *inferences* (SI-M-A7) 22. Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
SI-M-A8: utilizing safety procedures during scientific investigations	23. Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8) 24. Provide appropriate care and utilize safe practices and ethical treatment when animals are involved in scientific field and laboratory research (SI-M-A8)

B. Understanding Scientific Inquiry	
SI-M-B1: recognizing that different kinds of questions guide different kinds of scientific investigations	25. Compare and critique scientific investigations (SI-M-B1) 26. Use and describe alternate methods for investigating different types of testable questions (SI-M-B1) 27. Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
SI-M-B2: communicating that current scientific knowledge guides scientific investigations	28. Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
SI-M-B3: understanding that mathematics, technology, and scientific techniques used in an experiment can limit or enhance the accuracy of scientific knowledge	29. Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3) 30. Describe why all questions cannot be answered with present technologies (SI-M-B3) 31. Recognize that there is an acceptable range of variation in collected data (SI-M-B3) 32. Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3)
SI-M-B4: using data and logical arguments to propose, modify, or elaborate on principles and models	33. Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
SI-M-B5: understanding that scientific knowledge is enhanced through peer review, alternative explanations, and constructive criticism	34. Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5) 35. Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5) 36. Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5) 37. Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
SI-M-B6: communicating that scientific investigations can result in new ideas, new methods or procedures, and new technologies	38. Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)

SI-M-B7: understanding that scientific development/technology is driven by societal needs and funding	39. Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7) 40. Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
Physical Science: Students will develop an understanding of the characteristics and interrelationships of matter and energy in the physical world.	
A. Properties And Changes Of Properties In Matter	
Benchmarks	**Grade-Level Expectations**
PS-M-A1: investigating, measuring, and communicating the properties of different substances which are independent of the amount of the substance	1. Measure a variety of objects in metric system units (PS-M-A1) 2. Compare the physical properties of large and small quantities of the same type of matter (PS-M-A1)
PS-M-A2: understanding that all matter is made up of particles called atoms and that atoms of different elements are different	3. Describe the structure of atoms and the electrical charge of protons, neutrons, and electrons (PS-M-A2)
PS-M-A3: grouping substances according to similar properties and/or behaviors	4. Identify the physical and chemical properties of various substances and group substances according to their observable and measurable properties (e.g., conduction, magnetism, light transmission) (PS-M-A3)
PS-M-A4: understanding that atoms and molecules are perpetually in motion	
PS-M-A5: investigating the relationships among temperature, molecular motion, phase changes, and physical properties of matter	5. Describe the properties and behavior of water in its solid, liquid, and gaseous phases (states) (PS-M-A5)
PS-M-A6: investigating chemical reactions between different substances to discover that new substances formed may have new physical properties and do have new chemical properties	6. Describe new substances formed from common chemical reactions (e.g., burning paper produces ash) (PS-M-A6)

PS-M-A7: understanding that during a chemical reaction in a closed system, the mass of the products is equal to that of the reactants	
PS-M-A8: discovering and recording how factors such as temperature influence chemical reactions	
PS-M-A9: identifying elements and compounds found in common foods, clothing, household materials, and automobiles	
B. Motions and Forces	
PS-M-B1: describing and graphing the motions of objects	7. Compare, calculate, and graph the average speeds of objects in motion using both metric system and U.S. system units (PS-M-B1)
PS-M-B2: recognizing different forces and describing their effects (gravity, electrical, magnetic)	
PS-M-B3: understanding that, when an object is not being subjected to a force, it will continue to move at a constant speed and in a straight line	8. Explain that gravity accelerates all falling objects at the same rate in the absence of air resistance (PS-M-B3)
PS-M-B4: describing how forces acting on an object will reinforce or cancel one another, depending upon their direction and magnitude	
PS-M-B5: understanding that unbalanced forces will cause changes in the speed or direction of an object's motion	9. Demonstrate a change in speed or direction of an object's motion with the use of unbalanced forces (PS-M-B5)
C. Transformations of Energy	
PS-M-C1: identifying and comparing the characteristics of different types of energy	10. Compare potential and kinetic energy and give examples of each (PS-M-C1) 11. Classify energy resources as *renewable*, *non-renewable*, or *inexhaustible* (PS-M-C1)
PS-M-C2: understanding the different kinds of energy transformations and the fact that energy can be neither destroyed nor created	

PS-M-C3: understanding that the sun is a major source of energy and that energy arrives at the Earth's surface as light with a range of wavelengths	12. Identify the Sun as Earth's primary energy source and give examples (e.g., photosynthesis, water cycle) to support that conclusion (PS-M-C3)
PS-M-C4: observing and describing the interactions of light and matter (reflection, refraction, absorption, transmission, scattering)	13. Investigate how changes in the position of a light source and an object alter the size and shape of the shadow (PS-M-C4)
PS-M-C5: investigating and describing the movement of heat and the effects of heat in objects and systems	
PS-M-C6: describing the types of energy that can be involved, converted, or released in electrical circuits	14. Identify other types of energy produced through the use of electricity (e.g., heat, light, mechanical) (PS-M-C6)
PS-M-C7: understanding that energy is involved in chemical reactions	
PS-M-C8: comparing the uses of different energy resources and their effects upon the environment	
Life Science: The students will become aware of the characteristics and life cycles of organisms and understand their relationships to each other and to their environment.	
A. Structure and Function in Living Systems	
Benchmarks	**Grade-Level Expectations**
LS-M-A1: describing the observable components and functions of a cell, such as the cell membrane, nucleus, and movement of molecules into and out of cells	15. Identify the cell as the basic unit of living things (LS-M-A1) 16. Observe, identify, and describe the basic components of cells and their functions (e.g., cell wall, cell membrane, cytoplasm, nucleus) (LS-M-A1)
LS-M-A2: comparing and contrasting the basic structures and functions of different plant and animal cells	17. Compare plant and animal cells and label cell components (LS-M-A2)

LS-M-A3: observing and analyzing the growth and development of selected organisms, including a seed plant, an insect with complete metamorphosis, and an amphibian	18. Describe the metamorphosis of an amphibian (e.g., frog) (LS-M-A3)
LS-M-A4: describing the basic processes of photosynthesis and respiration and their importance to life	19. Describe the processes of photosynthesis and respiration in green plants (LS-M-A4)
LS-M-A5: investigating human body systems and their functions (including circulatory, digestive, skeletal, respiratory)	20. Describe the levels of structural organization in living things (e.g., cells, tissues, organs, organ systems) (LS-M-A5)
LS-M-A6: describing how the human body changes with age and listing factors that affect the length and quality of life	
LS-M-A7: describing communicable and noncommunicable diseases	21. Identify diseases caused by germs and how they can be transmitted from person to person (LS-M-A7)
B. Reproduction and Heredity	
There are no Grade-Level Expectations for Benchmarks in Grade 5 for this substrand.	
C. Populations and Ecosystems	
LS-M-C1: constructing and using classification systems based on the structure of organisms	22. Develop and use a simple dichotomous key to classify common plants and animals (LS-M-C1)
LS-M-C2: modeling and interpreting food chains and food webs	23. Construct food chains that could be found in ponds, marshes, oceans, forests, or meadows (LS-M-C2) 24. Describe the roles of producers, consumers, and decomposers in a food chain (LS-M-C2) 25. Compare food chains and food webs (LS-M-C2)
LS-M-C3: investigating major ecosystems and recognizing physical properties and organisms within each	26. Identify and describe ecosystems of local importance (LS-M-C3) 27. Compare common traits of organisms within major ecosystems (LS-M-C3)
LS-M-C4: explaining the interaction and interdependence of nonliving and living components within ecosystems	28. Explain and give examples of predator/prey relationships (LS-M-C4)

D. Adaptations of Organisms	
LS-M-D1: describing the importance of plant and animal adaptation, including local examples	29. Describe adaptations of plants and animals that enable them to thrive in local and other natural environments (LS-M-D1)
LS-M-D2: explaining how some members of a species survive under changed environmental conditions	
Earth and Space Science: The students will develop an understanding of the properties of earth materials, the structure of the Earth system, the Earth's history, and the Earth's place in the universe.	
A. Structure of the Earth	
Benchmarks	**Grade-Level Expectations**
ESS-M-A1: understanding that the Earth is layered by density with an inner and outer core, a mantle, and a thin outer crust	
ESS-M-A2: understanding that the Earth's crust and solid upper mantle are dividing plates that move in response to convection currents (energy transfers) in the mantle	
ESS-M-A3: investigating the characteristics of earthquakes and volcanos and identifying zones where they may occur	
ESS-M-A4: investigating how soils are formed from weathered rock and decomposed organic material	30. Identify organic and inorganic matter in soil samples with the aid of a hand lens or microscope (ESS-M-A4)
ESS-M-A5: identifying the characteristics and uses of minerals and rocks and recognizing that rocks are mixtures of minerals	31. Identify common rocks and minerals and explain their uses and economic significance (ESS-M-A5)
ESS-M-A6: explaining the processes involved in the rock cycle	

ESS-M-A7: modeling how landforms result from the interaction of constructive and destructive forces	32. Demonstrate the results of constructive and destructive forces using models or illustrations (ESS-M-A7) 33. Identify the processes that prevent or cause erosion (ESS-M-A7)
ESS-M-A8: identifying the man-made and natural causes of coastal erosion and the steps taken to combat it	
ESS-M-A9: compare and contrast topographic features of the ocean floor to those formed above sea level	
ESS-M-A10: explaining (illustrating) how water circulates—on and through the crust, in the oceans, and in the atmosphere—in the water cycle	See GLE #46.
ESS-M-A11: understanding that the atmosphere interacts with the hydrosphere to affect weather and climate conditions	34. Identify the components of the hydrosphere (ESS-M-A11) 35. Identify the atmosphere as a mixture of gases, water vapor, and particulate matter (ESS-M-A11) 36. 36. Identify, describe, and compare climate zones (e.g., polar, temperate, tropical) (ESS-M-A11)
ESS-M-A12: predicting weather patterns through use of a weather map	37. Identify typical weather map symbols and the type of weather they represent (ESS-M-A12)
B. Earth History	
ESS-M-B1: investigating how fossils show the development of life over time	
ESS-M-B2: devising a model that demonstrates supporting evidence that the Earth has existed for a vast period of time	
ESS-M-B3: understanding that earth processes such as erosion and weathering affect the Earth today and are similar to those which occurred in the past	38. Estimate the range of time over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years) (ESS-M-B3)

C. Earth In The Solar System	
ESS-M-C1: identifying the characteristics of the sun and other stars	39. Identify the physical characteristics of the Sun (ESS-M-C1) 40. Describe the significance of Polaris as the North Star (ESS-M-C1) 41. Explain why the Moon, Sun, and stars appear to move from east to west across the sky (ESS-M-C1)
ESS-M-C2: comparing and contrasting the celestial bodies in our solar system	42. Differentiate among moons, asteroids, comets, meteoroids, meteors, and meteorites (ESS-M-C2) 43. Describe the characteristics of the inner and outer planets (ESS-M-C2)
ESS-M-C3: investigating the force of gravity and the ways gravity governs motion in the solar system and objects on Earth	
ESS-M-C4: modeling the motions of the Earth-moon-sun system to explain day and night, a year, eclipses, moon phases, and tides	44. Explain rotation and revolution by using models or illustrations (ESS-M-C4)
ESS-M-C5: modeling the position of the Earth in relationship to other objects in the solar system	45. Identify Earth's position in the solar system (ESS-M-C5)
ESS-M-C6: modeling and describing how radiant energy from the sun affects phenomena on the Earth's surface, such as winds, ocean currents, and the water cycle	46. Identify and explain the interaction of the processes of the water cycle (ESS-M-C6) (ESS-M-A10)
ESS-M-C7: modeling and explaining how seasons result from variations in amount of the sun's energy hitting the surface due to the tilt of Earth's rotation on its axis and the length of the day	
ESS-M-C8: understanding that space exploration is an active area of scientific and technological research and development	47. Identify and explain advances in technology that have enabled the exploration of space (ESS-M-C8)

Science and the Environment: In learning environmental science, students will develop an appreciation of the natural environment, learn the importance of environmental quality, and acquire a sense of stewardship. As consumers and citizens, they will be able to recognize how our personal, professional, and political actions affect the natural world.

Benchmarks	Grade-Level Expectations
SE-M-A1: demonstrating knowledge that an ecosystem includes living and nonliving factors and that humans are an integral part of ecosystems	
SE-M-A2: demonstrating an understanding of how carrying capacity and limiting factors affect plant and animal populations	48. Determine the ability of an ecosystem to support a population (carrying capacity) by identifying the resources needed by that population (SE-M-A2)
SE-M-A3: defining the concept of pollutant and describing the effects of various pollutants on ecosystems	49. Identify and give examples of pollutants found in water, air, and soil (SE-M-A3)
SE-M-A4: understanding that human actions can create risks and consequences in the environment	50. Describe the consequences of several types of human activities on local ecosystems (e.g., polluting streams, regulating hunting, introducing nonnative species) (SE-M-A4)
SE-M-A5: tracing the flow of energy through an ecosystem and demonstrating a knowledge of the roles of producers, consumers, and decomposers in the ecosystem	
SE-E-A6: distinguishing between renewable and nonrenewable resources and understanding that nonrenewable natural resources are not replenished through the natural cycles and thus are strictly limited in quantity	
SE-M-A7: demonstrating knowledge of the natural cycles, such as the carbon cycle, nitrogen cycle, water cycle, and oxygen cycle	51. Describe naturally occurring cycles and identify where they are found (e.g., carbon, nitrogen, water, oxygen) (SE-M-A7)

SE-M-A8: investigating and analyzing how technology affects the physical, chemical, and biological factors in an ecosystem	
SE-M-A9: demonstrating relationships of characteristics of soil types to agricultural practices and productivity	
SE-M-A10: identifying types of soil erosion and preventive measures	

SIXTH GRADE INTRODUCTION

Sixth Grade

The focus at the sixth-grade level is on physical science concepts. The content explored at this grade level includes the effects of forces on the motions of objects, forms of energy, and characteristics and outcomes of energy transformations. Selected Science and the Environment (SE) concepts are integrated with Physical Science content.

SIXTH GRADE

SCIENCE

Science As Inquiry: The students will do science by engaging in partial and full inquiries that are within their developmental capabilities.

A. The Abilities Necessary to do Scientific Inquiry

Benchmarks	Grade-Level Expectations
SI-M-A1: identifying questions that can be used to design a scientific investigation	1. Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1) 2. Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1) 3. Use a variety of sources to answer questions (SI-M-A1)
SI-M-A2: designing and conducting a scientific investigation	4. Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2) 5. Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
SI-M-A3: using mathematics and appropriate tools and techniques to gather, analyze, and interpret data	6. Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3) 7. Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3) 8. Use consistency and precision in data collection, analysis, and reporting (SI-M-A3) 9. Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)

SI-M-A4: developing descriptions, explanations, and graphs using data	10. Identify the difference between description and explanation (SI-M-A4) 11. Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4) 12. Use data and information gathered to develop an explanation of experimental results (SI-M-A4) 13. Identify patterns in data to explain natural events (SI-M-A4)
SI-M-A5: developing models and predictions using the relationships between data and explanations	14. Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5) 15. Identify and explain the limitations of models used to represent the natural world (SI-M-A5) 16. Use evidence to make inferences and predict trends (SI-M-A5)
SI-M-A6: comparing alternative explanations and predictions	17. Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6) 18. Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6)
SI-M-A7: communicating scientific procedures, information, and explanations	19. Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7) 20. Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7) 21. Distinguish between *observations* and *inferences* (SI-M-A7) 22. Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
SI-M-A8: utilizing safety procedures during scientific investigations	23. Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8) 24. Provide appropriate care and utilize safe practices and ethical treatment when animals are involved in scientific field and laboratory research (SI-M-A8)

B. Understanding Scientific Inquiry	
SI-M-B1: recognizing that different kinds of questions guide different kinds of scientific investigations	25. Compare and critique scientific investigations (SI-M-B1) 26. Use and describe alternate methods for investigating different types of testable questions (SI-M-B1) 27. Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
SI-M-B2: communicating that current scientific knowledge guides scientific investigations	28. Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
SI-M-B3: understanding that mathematics, technology, and scientific techniques used in an experiment can limit or enhance the accuracy of scientific knowledge	29. Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3) 30. Describe why all questions cannot be answered with present technologies (SI-M-B3) 31. Recognize that there is an acceptable range of variation in collected data (SI-M-B3) 32. Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3)
SI-M-B4: using data and logical arguments to propose, modify, or elaborate on principles and models	33. Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
SI-M-B5: understanding that scientific knowledge is enhanced through peer review, alternative explanations, and constructive criticism	34. Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5) 35. Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5) 36. Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5) 37. Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
SI-M-B6: communicating that scientific investigations can result in new ideas, new methods or procedures, and new technologies	38. Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)

SI-M-B7: understanding that scientific development/technology is driven by societal needs and funding	39. Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7) 40. Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
Physical Science: Students will develop an understanding of the characteristics and interrelationships of matter and energy in the physical world.	
A. Properties And Changes Of Properties In Matter	
Benchmarks	**Grade-Level Expectations**
PS-M-A1: investigating, measuring, and communicating the properties of different substances which are independent of the amount of the substance	1. Measure and record the volume and mass of substances in metric system units (PS-M-A1) 2. Calculate the density of large and small quantities of a variety of substances (e.g., aluminum foil, water, copper, clay, rock) (PS-M-A1)
PS-M-A2: understanding that all matter is made up of particles called atoms and that atoms of different elements are different	3. Construct models that replicate atomic structure for selected common elements from the periodic table (PS-M-A2)
PS-M-A3: grouping substances according to similar properties and/or behaviors	4. Differentiate between the physical and chemical properties of selected substances (PS-M-A3) 5. Compare physical and chemical changes (PS-M-A3)
PS-M-A4: understanding that atoms and molecules are perpetually in motion	6. Draw or model the movement of atoms in solid, liquid, and gaseous states (PS-M-A4) 7. Simulate how atoms and molecules have kinetic energy exhibited by constant motion (PS-M-A4)
PS-M-A5: investigating the relationships among temperature, molecular motion, phase changes, and physical properties of matter	8. Determine the temperatures at which water changes physical phases (e.g., freezing point, melting point, boiling point) (PS-M-A5)

PS-M-A6: investigating chemical reactions between different substances to discover that new substances formed may have new physical properties and do have new chemical properties	9. Describe the properties of reactants and products of chemical reactions observed in the lab (PS-M-A6)
PS-M-A7: understanding that during a chemical reaction in a closed system, the mass of the products is equal to that of the reactants	10. Identify the average atomic masses of given elements using the periodic table (PS-M-A7) 11. Compare the masses of reactants and products of a chemical reaction (PS-M-A7)
PS-M-A8: discovering and recording how factors such as temperature influence chemical reactions	12. Determine the effect of particle size of the same reactants on the rate of chemical reactions during a lab activity (e.g., powdered vs. solid forms) (PS-M-A8)
PS-M-A9: identifying elements and compounds found in common foods, clothing, household materials, and automobiles	13. Use a variety of resources to identify elements and compounds in common substances (PS-M-A9)
B. Motions and Forces	
PS-M-B1: describing and graphing the motions of objects	14. Construct and analyze graphs that represent one-dimensional motion (i.e., motion in a straight line) and predict the future positions and speed of a moving object (PS-M-B1) 15. Explain why velocity is expressed in both speed and direction (PS-M-B1) 16. Compare line graphs of acceleration, constant speed, and deceleration (PS-M-B1)
PS-M-B2: recognizing different forces and describing their effects (gravity, electrical, magnetic)	17. Describe and demonstrate that friction is a force that acts whenever two surfaces or objects move past one another (PS-M-B2) 18. Explain how the resistance of materials affects the rate of electrical flow (PS-M-B2)
PS-M-B3: understanding that, when an object is not being subjected to a force, it will continue to move at a constant speed and in a straight line	19. Identify forces acting on all objects (PS-M-B3) Also see GLE #22.
PS-M-B4: describing how forces acting on an object will reinforce or cancel one another, depending upon their direction and magnitude	20. Draw and label a diagram to represent forces acting on an object (PS-M-B4) 21. Determine the magnitude and direction of unbalanced (i.e., net) forces acting on an object (PS-M-B4)

PS-M-B5: understanding that unbalanced forces will cause changes in the speed or direction of an object's motion	22. Demonstrate that an object will remain at rest or move at a constant speed and in a straight line if it is not subjected to an unbalanced force (PS-M-B5) (PS-M-B3) 23. Predict the direction of a force applied to an object and how it will change the speed and direction of the object (PS-M-B5)
C. Transformations of Energy	
PS-M-C1: identifying and comparing the characteristics of different types of energy	24. Describe and give examples of how all forms of energy may be classified as potential or kinetic energy (PS-M-C1) 25. Compare forms of energy (e.g., light, heat, sound, electrical, nuclear, mechanical) (PS-M-C1) 26. Describe and summarize observations of the transmission, reflection, and absorption of sound, light, and heat energy (PS-M-C1)
PS-M-C2: understanding the different kinds of energy transformations and the fact that energy can be neither destroyed nor created	27. Explain the relationship between work input and work output by using simple machines (PS-M-C2) 28. Explain the law of conservation of energy (PS-M-C2) 29. Compare and/or investigate the relationships among work, power, and efficiency (PS-M-C2) 30. Trace energy transformations in a simple system (e.g., flashlight) (PS-M-C2)
PS-M-C3: understanding that the sun is a major source of energy and that energy arrives at the Earth's surface as light with a range of wavelengths	31. Compare types of electromagnetic waves (PS-M-C3)

PS-M-C4: observing and describing the interactions of light and matter (reflection, refraction, absorption, transmission, scattering)	32. Identify and illustrate key characteristics of waves (e.g., wavelength, frequency, amplitude) (PS-M-C4) 33. Predict the direction in which light will refract when it passes from one transparent material to another (e.g., from air to water, from prism to air) (PS-M-C4) 34. Apply the law of reflection and law of refraction to demonstrate everyday phenomena (e.g., how light is reflected from tinted windows, how light is refracted by cameras, telescopes, eyeglasses) (PS-M-C4) 35. Determine through experimentation whether light is reflected, transmitted, and/or absorbed by a given object or material (PS-M-C4) 36. Explain the relationship between an object's color and the wavelength of light reflected or transmitted to the viewer's eyes (PS-M-C4)
PS-M-C5: investigating and describing the movement of heat and the effects of heat in objects and systems	37. Compare how heat is transferred by conduction, convection, and radiation (PS-M-C5) 38. Identify conditions under which thermal energy tends to flow from a system of higher energy to a system of lower energy (PS-M-C5)
PS-M-C6: describing the types of energy that can be involved, converted, or released in electrical circuits	39. Describe how electricity can be produced from other types of energy (e.g., magnetism, solar, mechanical) (PS-M-C6)
PS-M-C7: understanding that energy is involved in chemical reactions	40. Identify heat energy gains and losses during exothermic and endothermic chemical reactions (PS-M-C7)
PS-M-C8: comparing the uses of different energy resources and their effects upon the environment	41. Identify risks associated with the production and use of coal, petroleum, hydroelectricity, nuclear energy, and other energy forms (PS-M-C8)

STANDARDS, BENCHMARKS, AND GRADE-LEVEL EXPECTATIONS

Life Science: The students will become aware of the characteristics and life cycles of organisms and understand their relationships to each other and to their environment.
There are no Grade-Level Expectations for Benchmarks in Grade Six for this strand.
Earth and Space Science: The students will develop an understanding of the properties of earth materials, the structure of the Earth system, the Earth's history, and the Earth's place in the universe.
There are no Grade-Level Expectations for Benchmarks in Grade Six for this strand.
Science and the Environment: In learning environmental science, students will develop an appreciation of the natural environment, learn the importance of environmental quality, and acquire a sense of stewardship. As consumers and citizens, they will be able to recognize how our personal, professional, and political actions affect the natural world.

Benchmarks	**Grade-Level Expectations**
SE-M-A1: demonstrating knowledge that an ecosystem includes living and nonliving factors and that humans are an integral part of ecosystems	
SE-M-A2: demonstrating an understanding of how carrying capacity and limiting factors affect plant and animal populations	
SE-M-A3: defining the concept of pollutant and describing the effects of various pollutants on ecosystems	

SE-M-A4: understanding that human actions can create risks and consequences in the environment	
SE-M-A5: tracing the flow of energy through an ecosystem and demonstrating a knowledge of the roles of producers, consumers, and decomposers in the ecosystem	
SE-E-A6: distinguishing between renewable and nonrenewable resources and understanding that nonrenewable natural resources are not replenished through the natural cycles and thus are strictly limited in quantity	42. Identify energy types from their source to their use and determine if the energy types are renewable, nonrenewable, or inexhaustible (SE-M-A6) 43. Explain how the use of different energy resources affects the environment and the economy (SE-M-A6) 44. Explain how an inexhaustible resource can be harnessed for energy production (SE-M-A6) 45. Describe methods for sustaining renewable resources (SE-M-A6) 46. Identify ways people can reuse, recycle, and reduce the use of resources to improve and protect the quality of life (SE-M-A6)
SE-M-A7: demonstrating knowledge of the natural cycles, such as the carbon cycle, nitrogen cycle, water cycle, and oxygen cycle	
SE-M-A8: investigating and analyzing how technology affects the physical, chemical, and biological factors in an ecosystem	47. Illustrate how various technologies influence resource use in an ecosystem (e.g., forestry management, soil conservation, fishery improvement) (SE-M-A8)
SE-M-A9: demonstrating relationships of characteristics of soil types to agricultural practices and productivity	
SE-M-A10: identifying types of soil erosion and preventive measures	

SEVENTH GRADE INTRODUCTION

Seventh Grade

The focus at the seventh-grade level is on Life Science (LS) concepts and the living components of the environment. Students further develop inquiry skills and content knowledge through observations and investigations designed to expand understandings of living systems. The content emphasized includes structures and functions of living things, reproduction and heredity, populations and ecosystems, and adaptations. For example, students learn that plants and animals obtain energy in different ways and that they have different structures adapted for obtaining this energy.

SEVENTH GRADE

SCIENCE

Science As Inquiry: The students will <u>do</u> science by engaging in partial and full inquiries that are within their developmental capabilities.

A. The Abilities Necessary to do Scientific Inquiry

Benchmarks	Grade-Level Expectations
SI-M-A1: identifying questions that can be used to design a scientific investigation	1. Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1) 2. Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1) 3. Use a variety of sources to answer questions (SI-M-A1)
SI-M-A2: designing and conducting a scientific investigation	4. Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2) 5. Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
SI-M-A3: using mathematics and appropriate tools and techniques to gather, analyze, and interpret data	6. Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3) 7. Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3) 8. Use consistency and precision in data collection, analysis, and reporting (SI-M-A3) 9. Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)

SI-M-A4: developing descriptions, explanations, and graphs using data	10. Identify the difference between description and explanation (SI-M-A4) 11. Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4) 12. Use data and information gathered to develop an explanation of experimental results (SI-M-A4) 13. Identify patterns in data to explain natural events (SI-M-A4)
SI-M-A5: developing models and predictions using the relationships between data and explanations	14. Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5) 15. Identify and explain the limitations of models used to represent the natural world (SI-M-A5) 16. Use evidence to make inferences and predict trends (SI-M-A5)
SI-M-A6: comparing alternative explanations and predictions	17. Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6) 18. Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6)
SI-M-A7: communicating scientific procedures, information, and explanations	19. Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7) 20. Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7) 21. Distinguish between *observations* and *inferences* (SI-M-A7) 22. Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
SI-M-A8: utilizing safety procedures during scientific investigations	23. Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8) 24. Provide appropriate care and utilize safe practices and ethical treatment when animals are involved in scientific field and laboratory research (SI-M-A8)

B. Understanding Scientific Inquiry	
SI-M-B1: recognizing that different kinds of questions guide different kinds of scientific investigations	25. Compare and critique scientific investigations (SI-M-B1) 26. Use and describe alternate methods for investigating different types of testable questions (SI-M-B1) 27. Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
SI-M-B2: communicating that current scientific knowledge guides scientific investigations	28. Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
SI-M-B3: understanding that mathematics, technology, and scientific techniques used in an experiment can limit or enhance the accuracy of scientific knowledge	29. Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3) 30. Describe why all questions cannot be answered with present technologies (SI-M-B3) 31. Recognize that there is an acceptable range of variation in collected data (SI-M-B3) 32. Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3)
SI-M-B4: using data and logical arguments to propose, modify, or elaborate on principles and models	33. Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
SI-M-B5: understanding that scientific knowledge is enhanced through peer review, alternative explanations, and constructive criticism	34. Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5) 35. Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5) 36. Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5) 37. Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
SI-M-B6: communicating that scientific investigations can result in new ideas, new methods or procedures, and new technologies	38. Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)

SI-M-B7: understanding that scientific development/technology is driven by societal needs and funding	39. Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7) 40. Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
Physical Science: Students will develop an understanding of the characteristics and interrelationships of matter and energy in the physical world.	
A. Properties And Changes Of Properties In Matter	
Benchmarks	**Grade-Level Expectations**
PS-M-A1: investigating, measuring, and communicating the properties of different substances which are independent of the amount of the substance	
PS-M-A2: understanding that all matter is made up of particles called atoms and that atoms of different elements are different	
PS-M-A3: grouping substances according to similar properties and/or behaviors	
PS-M-A4: understanding that atoms and molecules are perpetually in motion	
PS-M-A5: investigating the relationships among temperature, molecular motion, phase changes, and physical properties of matter	
PS-M-A6: investigating chemical reactions between different substances to discover that new substances formed may have new physical properties and do have new chemical properties	
PS-M-A7: understanding that during a chemical reaction in a closed system, the mass of the products is equal to that of the reactants	

PS-M-A8: discovering and recording how factors such as temperature influence chemical reactions	
PS-M-A9: identifying elements and compounds found in common foods, clothing, household materials, and automobiles	1. Identify the elements most often found in living organisms (e.g., C, N, H, O, P, S, Ca, Fe) (PS-M-A9)
B. Motions and Forces	
There are no Grade-Level Expectations for Benchmarks in Grade 7 for this substrand.	
C. Transformations of Energy	
There are no Grade-Level Expectations for Benchmarks in Grade 7 for this substrand.	
Life Science: The students will become aware of the characteristics and life cycles of organisms and understand their relationships to each other and to their environment.	
A. Structure and Function in Living Systems	
Benchmarks	**Grade-Level Expectations**
LS-M-A1: describing the observable components and functions of a cell, such as the cell membrane, nucleus, and movement of molecules into and out of cells	2. Compare the basic structures and functions of different types of cells (LS-M-A1) 3. Illustrate and demonstrate osmosis and diffusion in cells (LS-M-A1)
LS-M-A2: comparing and contrasting the basic structures and functions of different plant and animal cells	4. Compare functions of plant and animal cell structures (i.e., organelles) (LS-M-A2)
LS-M-A3: observing and analyzing the growth and development of selected organisms, including a seed plant, an insect with complete metamorphosis, and an amphibian	5. Compare complete and incomplete metamorphosis in insects (e.g., butterflies, mealworms, grasshoppers) (LS-M-A3) 6. Compare the life cycles of a variety of organisms, including non-flowering and flowering plants, reptiles, birds, amphibians, and mammals (LS-M-A3)

LS-M-A4: describing the basic processes of photosynthesis and respiration and their importance to life	7. Construct a word equation that illustrates the processes of photosynthesis and respiration (LS-M-A4) 8. Distinguish between *aerobic* respiration and *anaerobic* respiration (LS-M-A4)
LS-M-A5: investigating human body systems and their functions (including circulatory, digestive, skeletal, respiratory)	9. Relate structural features of organs to their functions in major systems (LS-M-A5) 10. Describe the way major organ systems in the human body interact to sustain life (LS-M-A5)
LS-M-A6: describing how the human body changes with age and listing factors that affect the length and quality of life	11. Describe the growth and development of humans from infancy to old age (LS-M-A6) 12. Explain how external factors and genetics can influence the quality and length of human life (e.g., nutrition, smoking, drug use, exercise) (LS-M-A6)
LS-M-A7: describing communicable and noncommunicable diseases	13. Identify and describe common communicable and noncommunicable diseases and the methods by which they are transmitted, treated, and prevented (LS-M-A7)
B. Reproduction and Heredity	
LS-M-B1: describing the importance of body cell division (mitosis) and sex cell production (meiosis)	14. Differentiate between sexual and asexual reproduction (LS-M-B1) 15. Contrast the processes of mitosis and meiosis in relation to growth, repair, reproduction, and heredity (LS-M-B1)
LS-M-B2: describing the role of chromosomes and genes in heredity	16. Explain why chromosomes in body cells exist in pairs (LS-M-B2) 17. Explain the relationship of genes to chromosomes and genotypes to phenotypes (LS-M-B2) 18. Recognize genetic errors caused by changes in chromosomes (LS-M-B2)
LS-M-B3: describing how heredity allows parents to pass certain traits to offspring	19. Apply the basic laws of Mendelian genetics to solve simple monohybrid crosses, using a Punnett square (LS-M-B3) 20. Explain the differences among the inheritance of dominant, recessive, and incomplete dominant traits (LS-M-B3) 21. Use a Punnett square to demonstrate how sex-linked traits are inherited (LS-M-B3) 22. Give examples of the importance of selective breeding (e.g., domestic animals, livestock, horticulture) (LS-M-B3)

C. Populations and Ecosystems	
LS-M-C1: constructing and using classification systems based on the structure of organisms	23. Classify organisms based on structural characteristics, using a dichotomous key (LS-M-C1)
LS-M-C2: modeling and interpreting food chains and food webs	24. Analyze food webs to determine energy transfer among organisms (LS-M-C2)
LS-M-C3: investigating major ecosystems and recognizing physical properties and organisms within each	25. Locate and describe the major biomes of the world (LS-M-C3) 26. Describe and compare the levels of organization of living things within an ecosystem (LS-M-C3)
LS-M-C4: explaining the interaction and interdependence of nonliving and living components within ecosystems	27. Identify the various relationships among plants and animals (e.g., mutualistic, parasitic, producer/consumer) (LS-M-C4) 28. Differentiate between ecosystem components of habitat and niche (LS-M-C4) 29. Predict the impact changes in a species' population have on an ecosystem (LS-M-C4)
D. Adaptations of Organisms	
LS-M-D1: describing the importance of plant and animal adaptation, including local examples	30. Differentiate between structural and behavioral adaptations in a variety of organisms (LS-M-D1) 31. Describe and evaluate the impact of introducing nonnative species into an ecosystem (LS-M-D1)
LS-M-D2: explaining how some members of a species survive under changed environmental conditions	32. Describe changes that can occur in various ecosystems and relate the changes to the ability of an organism to survive (LS-M-D2) 33. Illustrate how variations in individual organisms within a population determine the success of the population (LS-M-D2) 34. Explain how environmental factors impact survival of a population (LS-M-D2)

Earth and Space Science: The students will develop an understanding of the properties of earth materials, the structure of the Earth system, the Earth's history, and the Earth's place in the universe.

There are no Grade-Level Expectations for Benchmarks in Grade 7 for this strand.

Science and the Environment: In learning environmental science, students will develop an appreciation of the natural environment, learn the importance of environmental quality, and acquire a sense of stewardship. As consumers and citizens, they will be able to recognize how our personal, professional, and political actions affect the natural world.

Benchmarks	Grade-Level Expectations
SE-M-A1: demonstrating knowledge that an ecosystem includes living and nonliving factors and that humans are an integral part of ecosystems	35. Identify resources humans derive from ecosystems (SE-M-A1) 36. Distinguish the essential roles played by biotic and abiotic components in various ecosystems (SE-M-A1)
SE-M-A2: demonstrating an understanding of how carrying capacity and limiting factors affect plant and animal populations	37. Identify and describe the effects of limiting factors on a given population (SE-M-A2) 38. Evaluate the carrying capacity of an ecosystem (SE-M-A2)
SE-M-A3: defining the concept of pollutant and describing the effects of various pollutants on ecosystems	
SE-M-A4: understanding that human actions can create risks and consequences in the environment	39. Analyze the consequences of human activities on ecosystems (SE-M-A4)
SE-M-A5: tracing the flow of energy through an ecosystem and demonstrating a knowledge of the roles of producers, consumers, and decomposers in the ecosystem	40. Construct or draw food webs for various ecosystems (SE-M-A5)

SE-E-A6: distinguishing between renewable and nonrenewable resources and understanding that nonrenewable natural resources are not replenished through the natural cycles and thus are strictly limited in quantity	
SE-M-A7: demonstrating knowledge of the natural cycles, such as the carbon cycle, nitrogen cycle, water cycle, and oxygen cycle	41. Describe the nitrogen cycle and explain why it is important for the survival of organisms (SE-M-A7) 42. Describe how photosynthesis and respiration relate to the carbon cycle (SE-M-A7)
SE-M-A8: investigating and analyzing how technology affects the physical, chemical, and biological factors in an ecosystem	43. Identify and analyze the environmental impact of humans' use of technology (e.g., energy production, agriculture, transportation, human habitation) (SE-M-A8)
SE-M-A9: demonstrating relationships of characteristics of soil types to agricultural practices and productivity	
SE-M-A10: identifying types of soil erosion and preventive measures	

EIGHTH GRADE INTRODUCTION

Eighth Grade

The focus at the eighth-grade level is on Earth and Space Science (ESS) concepts. Students develop additional inquiry skills through observations and investigations designed to expand comprehension of Earth and space as well as related physical and environmental science topics. Earth and Space Science topics include exploring the structure of Earth, Earth history, and Earth's place in the solar system.

EIGHTH GRADE

SCIENCE

Science As Inquiry: The students will do science by engaging in partial and full inquiries that are within their developmental capabilities.

A. The Abilities Necessary to do Scientific Inquiry

Benchmarks	Grade-Level Expectations
SI-M-A1: identifying questions that can be used to design a scientific investigation	1. Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1) 2. Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1) 3. Use a variety of sources to answer questions (SI-M-A1)
SI-M-A2: designing and conducting a scientific investigation	4. Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2) 5. Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
SI-M-A3: using mathematics and appropriate tools and techniques to gather, analyze, and interpret data	6. Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3) 7. Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3) 8. Use consistency and precision in data collection, analysis, and reporting (SI-M-A3) 9. Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)

SI-M-A4: developing descriptions, explanations, and graphs using data	10. Identify the difference between description and explanation (SI-M-A4) 11. Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4) 12. Use data and information gathered to develop an explanation of experimental results (SI-M-A4) 13. Identify patterns in data to explain natural events (SI-M-A4)
SI-M-A5: developing models and predictions using the relationships between data and explanations	14. Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5) 15. Identify and explain the limitations of models used to represent the natural world (SI-M-A5) 16. Use evidence to make inferences and predict trends (SI-M-A5)
SI-M-A6: comparing alternative explanations and predictions	17. Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6) 18. Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6)
SI-M-A7: communicating scientific procedures, information, and explanations	19. Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7) 20. Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7) 21. Distinguish between *observations* and *inferences* (SI-M-A7) 22. Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
SI-M-A8: utilizing safety procedures during scientific investigations	23. Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8) 24. Provide appropriate care and utilize safe practices and ethical treatment when animals are involved in scientific field and laboratory research (SI-M-A8)

B. Understanding Scientific Inquiry	
SI-M-B1: recognizing that different kinds of questions guide different kinds of scientific investigations	25. Compare and critique scientific investigations (SI-M-B1) 26. Use and describe alternate methods for investigating different types of testable questions (SI-M-B1) 27. Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
SI-M-B2: communicating that current scientific knowledge guides scientific investigations	28. Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
SI-M-B3: understanding that mathematics, technology, and scientific techniques used in an experiment can limit or enhance the accuracy of scientific knowledge	29. Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3) 30. Describe why all questions cannot be answered with present technologies (SI-M-B3) 31. Recognize that there is an acceptable range of variation in collected data (SI-M-B3) 32. Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3)
SI-M-B4: using data and logical arguments to propose, modify, or elaborate on principles and models	33. Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
SI-M-B5: understanding that scientific knowledge is enhanced through peer review, alternative explanations, and constructive criticism	34. Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5) 35. Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5) 36. Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5) 37. Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
SI-M-B6: communicating that scientific investigations can result in new ideas, new methods or procedures, and new technologies	38. Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)

SI-M-B7: understanding that scientific development/technology is driven by societal needs and funding	39. Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7) 40. Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
Physical Science: Students will develop an understanding of the characteristics and interrelationships of matter and energy in the physical world.	
A. Properties And Changes Of Properties In Matter	
Benchmarks	**Grade-Level Expectations**
PS-M-A1: investigating, measuring, and communicating the properties of different substances which are independent of the amount of the substance	
PS-M-A2: understanding that all matter is made up of particles called atoms and that atoms of different elements are different	1. Determine that all atoms of the same element are similar to but different from atoms of other elements (PS-M-A2) 2. Recognize that elements with the same number of protons may or may not have the same charge (PS-M-A2) 3. Define ions and describe them in terms of the number of protons, electrons, and their charges (PS-M-A2)
PS-M-A3: grouping substances according to similar properties and/or behaviors	
PS-M-A4: understanding that atoms and molecules are perpetually in motion	
PS-M-A5: investigating the relationships among temperature, molecular motion, phase changes, and physical properties of matter	

PS-M-A6: investigating chemical reactions between different substances to discover that new substances formed may have new physical properties and do have new chemical properties	
PS-M-A7: understanding that during a chemical reaction in a closed system, the mass of the products is equal to that of the reactants	
PS-M-A8: discovering and recording how factors such as temperature influence chemical reactions	
PS-M-A9: identifying elements and compounds found in common foods, clothing, household materials, and automobiles	
B. Motions and Forces	
PS-M-B1: describing and graphing the motions of objects	
PS-M-B2: recognizing different forces and describing their effects (gravity, electrical, magnetic)	4. Demonstrate that Earth has a magnetic field by using magnets and compasses (PS-M-B2) 5. Define gravity and describe the relationship among the force of gravity, the mass of objects, and the distance between objects (PS-M-B2) 6. Predict how the gravitational attraction between two masses will increase or decrease when changes are made in the masses or in the distance between the objects (PS-M-B2)
PS-M-B3: understanding that, when an object is not being subjected to a force, it will continue to move at a constant speed and in a straight line	
PS-M-B4: describing how forces acting on an object will reinforce or cancel one another, depending upon their direction and magnitude	
PS-M-B5: understanding that unbalanced forces will cause changes in the speed or direction of an object's motion	7. Explain the relationships among force, mass, and acceleration (PS-M-B5)

C. Transformations of Energy	
There are no Grade-level Expectations for Benchmarks in Grade 8 for this substrand.	
Life Science: The students will become aware of the characteristics and life cycles of organisms and understand their relationships to each other and to their environment.	
There are no Grade-Level Expectations for Benchmarks in Grade Eight for this standard.	
Earth and Space Science: The students will develop an understanding of the properties of earth materials, the structure of the Earth system, the Earth's history, and the Earth's place in the universe.	
A. Structure of the Earth	
Benchmarks	**Grade-Level Expectations**
ESS-M-A1: understanding that the Earth is layered by density with an inner and outer core, a mantle, and a thin outer crust	8. Identify and describe the four density layers of Earth (ESS-M-A1)
ESS-M-A2: understanding that the Earth's crust and solid upper mantle are dividing plates that move in response to convection currents (energy transfers) in the mantle	9. Explain the historical development of the theories of plate tectonics, including continental drift and sea-floor spreading (ESS-M-A2) 10. Illustrate the movement of convection currents (ESS-M-A2) 11. Illustrate the movements of lithospheric plates as stated in the plate tectonics theory (ESS-M-A2)
ESS-M-A3: investigating the characteristics of earthquakes and volcanos and identifying zones where they may occur	12. Identify the edges of plate boundaries as likely areas of earthquakes and volcanic action (ESS-M-A3) 13. Describe the processes responsible for earthquakes and volcanoes and identify the effects of these processes (e.g., faulting, folding) (ESS-M-A3)

ESS-M-A4: investigating how soils are formed from weathered rock and decomposed organic material	14. Distinguish between chemical and mechanical (physical) weathering and identify the role of weathering agents (e.g., wind, water, ice, gravity) (ESS-M-A4) 15. Illustrate the role of organic processes in soil formation (ESS-M-A4)
ESS-M-A5: identifying the characteristics and uses of minerals and rocks and recognizing that rocks are mixtures of minerals	16. Compare the physical characteristics of rock and mineral specimens to observe that a rock is a mixture of minerals (ESS-M-A5) 17. Describe the properties of minerals (e.g., color, luster, hardness, streak) (ESS-M-A5)
ESS-M-A6: explaining the processes involved in the rock cycle	18. Describe how sedimentary, igneous, and metamorphic rocks form and change in the rock cycle (ESS-M-A6)
ESS-M-A7: modeling how landforms result from the interaction of constructive and destructive forces	19. Determine the results of constructive and destructive forces upon landform development with the aid of geologic maps of Louisiana (ESS-M-A7)
ESS-M-A8: identifying the man-made and natural causes of coastal erosion and the steps taken to combat it	20. Describe how humans' actions and natural processes have modified coastal regions in Louisiana and other locations (ESS-M-A8)
ESS-M-A9: compare and contrast topographic features of the ocean floor to those formed above sea level	21. Read and interpret topographic maps (ESS-M-A9) 22. Compare ocean floor topography to continental topography by using topographic maps (ESS-M-A9)
ESS-M-A10: explaining (illustrating) how water circulates—on and through the crust, in the oceans, and in the atmosphere—in the water cycle	23. Explain the processes of evaporation, condensation, precipitation, infiltration, transpiration, and sublimation as they relate to the water cycle (ESS-M-A10) 24. Investigate and explain how given factors affect the rate of water movement in the water cycle (e.g., climate, type of rock, ground cover) (ESS-M-A10)
ESS-M-A11: understanding that the atmosphere interacts with the hydrosphere to affect weather and climate conditions	25. Explain and give examples of how climatic conditions on Earth are affected by the proximity of water (ESS-M-A11) 26. Describe and illustrate the layers of Earth's atmosphere (ESS-M-A11)

ESS-M-A12: predicting weather patterns through use of a weather map	27. Identify different air masses, jet streams, global wind patterns, and other atmospheric phenomena and describe how they relate to weather events, such as El Niño and La Niña (ESS-M-A12) 28. Use historical data to plot the movement of hurricanes and explain events or conditions that affected their paths (ESS-M-A12) 29. Make predictions about future weather conditions based on collected weather data (ESS-M-A12)
B. Earth History	
ESS-M-B1: investigating how fossils show the development of life over time	30. Interpret a geologic timeline (ESS-M-B1) 31. Compare fossils from different geologic eras and areas of Earth to show that life changes over time (ESS-M-B1)
ESS-M-B2: devising a model that demonstrates supporting evidence that the Earth has existed for a vast period of time	32. Interpret a timeline starting with the birth of the solar system to the present day (ESS-M-B2) 33. Use historical data to draw conclusions about the age of Earth (e.g., half-life, rock strata) (ESS-M-B2)
ESS-M-B3: understanding that earth processes such as erosion and weathering affect the Earth today and are similar to those which occurred in the past	34. Apply geological principles to determine the relative ages of rock layers (e.g., original horizontality, superposition, cross-cutting relationships) (ESS-M-B3) 35. Describe how processes seen today are similar to those in the past (e.g., weathering, erosion, lithospheric plate movement) (ESS-M-B3)
C. Earth In The Solar System	
ESS-M-C1: identifying the characteristics of the sun and other stars	36. Describe the life cycle of a star and predict the next likely stage of the Sun (ESS-M-C1) 37. Use a Hertzsprung-Russell diagram and other data to compare the approximate mass, size, luminosity, temperature, structure, and composition of the Sun to other stars (ESS-M-C1)

ESS-M-C2: comparing and contrasting the celestial bodies in our solar system	38. Use data to compare the planets in terms of orbit, size, composition, density, rotation, revolution, and atmosphere (ESS-M-C2)
ESS-M-C3: investigating the force of gravity and the ways gravity governs motion in the solar system and objects on Earth	39. Relate Newton's laws of gravity to the motions of celestial bodies and objects on Earth (ESS-M-C3)
ESS-M-C4: modeling the motions of the Earth-moon-sun system to explain day and night, a year, eclipses, moon phases, and tides	40. Identify and illustrate the relative positions of Earth, the Moon, and the Sun during eclipses and phases of the Moon (ESS-M-C4) 41. Describe the effects of the Moon on tides (ESS-M-C4)
ESS-M-C5: modeling the position of the Earth in relationship to other objects in the solar system	42. Interpret a scale model of the solar system (ESS-M-C5)
ESS-M-C6: modeling and describing how radiant energy from the sun affects phenomena on the Earth's surface, such as winds, ocean currents, and the water cycle	43. Identify the processes involved in the creation of land and sea breezes (ESS-M-C6) 44. Describe how unequal heating of Earth's surface affects movement of air masses and water in the atmosphere and hydrosphere (ESS-M-C6)
ESS-M-C7: modeling and explaining how seasons result from variations in amount of the sun's energy hitting the surface due to the tilt of Earth's rotation on its axis and the length of the day	45. Explain how seasonal changes are caused by the tilt of Earth as it rotates on its axis and revolves around the Sun (ESS-M-C7) 46. Illustrate and explain how the angle at which sunlight strikes Earth produces changes in the seasons and length of daylight (ESS-M-C7) 47. Compare the relative distances from Earth to the Sun on the first day of summer and the first day of winter (ESS-M-C7)
ESS-M-C8: understanding that space exploration is an active area of scientific and technological research and development	48. Communicate ways that information from space exploration and technological research have advanced understanding about Earth, the solar system, and the universe (ESS-M-C8) 49. Identify practical applications of technological advances resulting from space exploration and scientific and technological research (ESS-M-C8)

STANDARDS, BENCHMARKS, AND GRADE-LEVEL EXPECTATIONS

Science and the Environment: In learning environmental science, students will develop an appreciation of the natural environment, learn the importance of environmental quality, and acquire a sense of stewardship. As consumers and citizens, they will be able to recognize how our personal, professional, and political actions affect the natural world.

Benchmarks	Grade-Level Expectations
SE-M-A1: demonstrating knowledge that an ecosystem includes living and nonliving factors and that humans are an integral part of ecosystems	
SE-M-A2: demonstrating an understanding of how carrying capacity and limiting factors affect plant and animal populations	
SE-M-A3: defining the concept of pollutant and describing the effects of various pollutants on ecosystems	50. Illustrate possible point and non-point source contributions to pollution and natural or human-induced pathways of a pollutant in an ecosystem (SE-M-A3)
SE-M-A4: understanding that human actions can create risks and consequences in the environment	51. Analyze the consequences of human activities on global Earth systems (SE-M-A4)
SE-M-A5: tracing the flow of energy through an ecosystem and demonstrating a knowledge of the roles of producers, consumers, and decomposers in the ecosystem	
SE-E-A6: distinguishing between renewable and nonrenewable resources and understanding that nonrenewable natural resources are not replenished through the natural cycles and thus are strictly limited in quantity:	
SE-M-A7: demonstrating knowledge of the natural cycles, such as the carbon cycle, nitrogen cycle, water cycle, and oxygen cycle	
SE-M-A8: investigating and analyzing how technology affects the physical, chemical, and biological factors in an ecosystem	

SE-M-A9: demonstrating relationships of characteristics of soil types to agricultural practices and productivity	52. Describe the relationship between plant type and soil compatibility (SE-M-A9)
SE-M-A10: identifying types of soil erosion and preventive measures	53. Distinguish among several examples of erosion (e.g., stream bank, topsoil, coastal) and describe common preventive measures (SE-M-A10)

GLOSSARY

SCIENCE GLOSSARY

Acceleration — The change in velocity per unit time; it is a vector quantity, as are velocity and position. The metric units of acceleration are meters per second squared or m/s^2.

Aerobic Respiration — Process of respiration that involves the release of energy from glucose or another organic compound in the presence of oxygen. The basic word equation that summarizes aerobic respiration is (glucose + oxygen $\rightarrow$ carbon dioxide + water + energy). The balanced chemical equation is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O +$ energy. The energy produced is captured in adenosine triphosphate (ATP) molecules.

Anaerobic Respiration — Process of cellular respiration in which a cell obtains energy from inorganic molecules in the absence of oxygen.

Biome — A biome is a group of ecosystems that covers a large geographic area, related by having a similar type of vegetation, and governed by a similar climate. Examples of biomes are arctic tundra, coniferous forest, temperate forest, grassland, desert, tropical rain forest, and ocean.

Biosphere — Thin layer of Earth's surface where life exists; it includes all living organisms and all organic matter.

Bohr Model — Simplified, schematic model of the atom proposed by Niels Bohr in 1915 and more familiarly known as the planetary model. In the Bohr model, neutrons and protons occupy a dense central nucleus and the electrons orbit the nucleus.

Cardinal Directions — The four basic points (top or north, bottom or south, left side or west, and right side or east) on a compass.

Carrying Capacity — The maximum number of individuals of a species or population that an ecosystem can support without being degraded or destroyed over time.

Celestial — Of or related to the sky or universe, as the planets and stars.

Centripetal Force — Force acting on a body in curvilinear motion that pulls the object toward the center of curvature or axis of rotation.

GLOSSARY

Circuit Closed path followed by an electrical current.

Closed System A complex unity of diverse parts that is isolated so that it experiences no interactions to the outside environment; a closed-loop system.

Communicable Disease Disease that is transmittable between persons or species; contagious disease.

Compression Waves Waves which travel back and forth in the same direction as the waves wave motion; an example of compression waves is sound waves; also known as longitudinal waves.

Conductor Substance or medium that transmits heat, light, sound, or especially, an electrical charge.

Consistency Repeatability or reproducibility of measurements.

Continental Drift The movement of continents as described by the German geologist and meteorologist Alfred Wegener in 1915. A theory that proposed the continents had once been joined together and have slowly drifted apart by an unknown mechanism. Essentially this theory has been replaced by advances in plate tectonics, which built on the original theory of continental drift.

Constants/Controls Those factors (variables) that are kept unchanged or are restricted during a controlled experiment.

Control/Control Group A group of subjects or objects in a scientific experiment or group investigation that does not receive the treatment being tested.

Controlled Experiment An experiment in which all but one of the variable factors are experiment kept the same in order to observe the results of changing one factor, the independent variable.

Coulomb's Law Principle stating that electrostatic force is proportional to the product of the charges and inversely proportional to the square of the distance between them. Charles A. Coulomb, a French scientist, was the first to quantitatively measure the electrical attraction and repulsion between charged objects.

GLOSSARY

Covalent Compound	A compound in which bonded atoms share electrons; it is formed compound when two nonmetals bond to each other.
Data	Numerical or descriptive, factual information, especially that which is derived from scientific observations or experiments, organized for analysis.
Dependent Variable	A variable whose value is determined by the changes made in the variable independent variable. Those factors observed for changes in value as a result of adjustments made in the independent variable.
Dichotomous Key	Tool that can be used to correctly identify organisms or objects in the natural world (e.g., trees, flowers, rocks, minerals) through a series of divergent choices between two descriptions.
Dimensional Analysis	Problem-solving method based on the fact that any number or analysis mathematical expression can be multiplied by one without changing its value; also called factor-label method or unit factor method.
Doppler Effect	Apparent change in the wavelength of radiation caused by the relative motion of a source and the observer. As the source and/or the observer draw closer together, the observed frequency is higher than the emitted frequency and decrease as they move apart.
Electromagnetic Waves	Waves that involve varying electrical and magnetic fields at right angles to each other and the direction of wave propagation (direction of travel of the waves). Examples of these waves that together comprise the electromagnetic spectrum are light (visible, infrared, and ultraviolet) waves, microwaves, x-rays, gamma rays, and radio waves.
Electrostatic Forces	Forces between electrically-charged objects at rest, as measured and expressed by Coulomb's law.
Empirical	Based entirely on experimental evidence and observation rather than theory.
Endothermic Chemical Reactions	Chemical reactions such as photosynthesis that absorb energy in chemical order to proceed and cannot occur spontaneously; these types of reactions reactions are characterized by positive heat flow (i.e., into the reaction) and an increase in enthalpy.

GLOSSARY

Eukaryotic Cells	Cells that contain membrane-bound nuclei and organelles.
Exothermic Chemical Reactions	Chemical reactions that release energy in the form of heat, light, or chemical sound. In the laboratory, these reactions produce heat and may reactions be flammable or explosive.
Genotype	Combination of two alleles that an organism inherits for a certain trait; genetic makeup of an organism.
Guiding Questions	Questions that begin a process of thinking and questioning leading to discovery through exploration and manipulation of data.
Habitat	Specific environment or part of an ecosystem where an organism lives (e.g., woods, desert).
Hertzsprung-Russell (HR) Diagram	A two-dimensional plot of the observed stars used to group them by spectral class, relative luminosity (compared to Sun = 1), diagram absolute magnitude or degree of brightness on a logarithmic scale, and effective temperature (Kelvin).
Homeostasis	The maintenance of the internal environment in a system within tolerable limits; the resistance to change and the maintenance of equilibrium, or constant conditions, in a system.
Hybridization	1. Cross-mating between two closely related species. 2. Concept dictating the nature of bonding and resulting molecular shapes of carbon compounds.
Hypothesis	Rational explanation of a single event or phenomenon based upon what has been observed but not proven. A tentative explanation for the cause of an observed phenomenon.
Independent Variable	Manipulated variable in a scientific experiment or investigation that determines the changes in the dependent variables.
Inertia	The tendency of a body at rest to remain at rest, or if moving in a straight line, to continue moving in a straight line, unless acted on by an outside force.

GLOSSARY

Inexhaustible Resources — Apparently endless resources such as the Sun, wind, or internal resources heat of Earth.

Inference — Process of drawing a conclusion or making a logical judgment based on prior conclusions or evidence but without direct observation.

Inorganic Matter — Matter not involving or relating to living organisms or the products of organic life.

Inquiry — Systematic process of using knowledge and skills to acquire and/or apply new knowledge and skills.

Ion — An atom or group of atoms that has acquired a net positive or negative electrical charge by gaining or losing one or more electrons.

Ionic Compound — A compound in which bonded atoms transfer electrons from one to the other; it is usually formed when metals bond to nonmetals.

Kinetic Energy — The energy of motion of an object, as expressed in the equation, $KE = ½ * m * v^2$, where m equals the mass of the object and v equals the speed of the object.

Lewis Dot Structures — Symbolic representations in atoms and simple ions showing structures valence electrons as dots placed around the symbol of the element, *and* structures illustrating covalent compounds or polyatomic ions showing valence electrons arranged among the atoms symbols in the molecule to illustrate the bonding of the atoms.

Lithospheric Plate — One of the movable sections of Earth's crust and upper mantle.

Medium — Substance, for example water or glass, through which something else, such as sound or light, is transmitted or carried.

Metamorphosis — Process of change of organisms through various stages in their life cycles. May be complete, involving the four stages of egg, larva, pupa, and adult, as in butterflies and moths, or incomplete, as in the gradual development of many insects and crustaceans.

GLOSSARY

Metric System Units of Measurement	Decimal system of weights and measurements that includes units of Standard International or SI units measurement.
Meiosis	Process of cellular division in which the number of chromosomes in each daughter cell is reduced by half the number in the parent cell. This cellular division process produces gametes.
Mitosis	Process of cellular division in which a cell's chromosomes are divided into two identical sets prior to cytoplasmic division. This process produces two identical daughter cells.
Model	Simulation of a real object that has explanatory power but that typically differs in size, scale, and/or detail; examples include plan, scheme, structure, or mathematical equation.
Molality	Number of moles of solute dissolved in one kilogram of solvent.
Molarity	Number of moles of solute dissolved in a liter of solution.
Nebular Hypothesis	Hypothesis for the origin of the solar system that proposes that hypothesis that the Sun and planets formed from the same cloud of gas and dust in interstellar space.
Niche	The role an organism carries out in its habitat.
Noncommunicable Disease	Disease that is not transmittable between persons or species; disease non-contagious disease.
Nonpoint-source	Sources of pollution that do not result from a single point or pollution source, for example, erosion of soil materials from multiple farms and construction sites that are carried and deposited in an adjacent stream as opposed to specific points of discharge.
Nonstandard Tools	Objects or instruments such as pieces of string, rows of blocks, tools fingers, hands, or pencils used for measurement; examples do not include standard and systematic means of measurement such as scales, rulers, clocks, and thermometers.

GLOSSARY

Normality	Concentration of a solution expressed in gram equivalent weights of solute per liter; it is particularly useful in titration calculations.
Null Hypothesis	Statistical hypothesis, often the reverse of what the experimenter actually believes, that is used to determine if the results obtained can be rejected merely on the basis of chance factors.
Organic Matter	Matter that is of, related to, or derived from living organisms.
Phenotype	The expression of an organism's traits as a result of its genetic makeup; outward appearance of an organism.
Pitch	Relative quality of highness or lowness of sound that is primarily dependent on the frequency of the waves produced by its source.
Plate Tectonics	Theory that Earth's outer shell consists of individual plates which interact in various ways and produce earthquakes, volcanoes, and mountain building.
Point-source Pollution	Pollution originating from a single source such as a discharge pipe from a sewage plant or chemical factory.
Potable Water	Water fit for human consumption.
Potential Energy	Energy that is stored in an object as a result of its vertical position.
Precision	The relative degree of exactness and reproducibility between measurements or estimates.
Prokaryotic Cells	Cells that lack an organized, membrane bound nucleus.
Punnett Square	Chart or grid system used to compute and visualize all possible genotypes of a genetic cross.
Refract	To deflect or bend from a straight path, as when a light wave changes direction as it passes from one medium into another of different density.

GLOSSARY

Revolution	The motion of a body or object around another body or object, for example, the revolution of Earth around the Sun.
Rotation	The spinning of a planet such as Earth or other object on its axis.
Rules of Evidence	Criteria used to examine and evaluate experimental results; examples include testability, reliability, application of standards and controls, error rate, subjection to peer review, and acceptance in the scientific community.
Scalar Quantity	A quantity that is completely specified by its magnitude and has no direction in space; examples are mass, length, volume, temperature, and speed.
Scientific Evidence	Evidence in which theories are validated against physical observations and not judged simply on the basis of their logical compatibility with available data; includes criteria such as testability, reliability, application of standards and controls, error rate, subjection to peer review, and acceptance in the scientific community.
Sea-floor Spreading	It is the process of producing new sea floor crust on the ocean floor between two diverging tectonic plates.
Standard International (SI) Units of Measurement	More complete, coherent version of the metric system of International measurement; basic units of the SI system include the centimeter (SI) units of or meter, gram or kilogram, and second. measurement
Standard Tools	Instruments such as meter sticks, pan balances, graduated cylinders, or thermometers used for systematic measurement.
Statistical Significance	A test performed to determine if the null hypothesis can be significance rejected, and if so, then the effect in the sample is found to be statistically significant.
Stoichiometry	Quantitative relationship between chemical substances in a reaction.
Superposition	Principle in geology which states that in any undisturbed sequence of sedimentary rocks each bed is older than the layers above and younger than the layers found below.

GLOSSARY

Sustainability	Capacity of continuing and maintaining a population and growth with minimal long-term effects on natural resources and the environment. *Sustainable* means that a process can be continued indefinitely without depleting the energy and resources upon which it depends.
Sustainable Development	Development that provides benefits now without sacrificing or development depleting resources or causing environmental impacts that will affect future generations.
Symbolic Representation	Ways in which science ideas such as chemical elements, formulas, representation ions, and equations are expressed; other examples include numbers in scientific notation illustrations, fractions, graphs, or spreadsheets.
Terrestrial	Relating to Earth or earthlike, its environments, or its inhabitants.
Testable Question/ a Hypothesis/Investigation	A query that can be answered through experimentation or research; hypothesis that makes predictions about the compatibility or investigation noncompatibility of observable evidence; an investigation or experiment to answer a testable question or hypothesis.
Scientific Theory	Explanation of a set of related observations or events based upon theory hypotheses that have verified through multiple investigations. Scientific theories differs from the general use of the word theory because this term applies to well tested and widely accepted ideas that explain certain observable facts.
Translucent	Transmitting light with sufficient diffusion so as to prevent distinct perception of images.
Transverse Waves	Waves in which the motion is up and down or at right angles to the direction of propagation or the direction in which the waves are traveling. Examples include radio waves, light waves, heat waves, and water waves.
U.S. System Units of Measurement	Principal and customary system of weights and measurements of measurement used in the U.S.A.; although the names of the units are the same as in the British system, the sizes of some units differ.
Valence Electron	Orbital electrons in the outermost shell of an atom that largely determine its properties and that are capable of forming chemical bonds with other atoms.

GLOSSARY

Validity	Degree to which an experimenter is measuring what s/he thinks; more generally refers to the strength of conclusions, inferences, propositions.
Vector Quantity	Quantity that is not complete unless both a magnitude and a direction are specified; an example is velocity.
Velocity	Vector quantity specifying both the speed and direction of a body or an object in motion.
Zygote	Fertilized egg resulting from the joining of two haploid gametes.