

## Table of Contents

<b>DOMAIN I.</b>	<b>SCIENTIFIC INQUIRY AND PROCESS</b>	
<b>COMPETENCY 1.0</b>	<b>UNDERSTANDING HOW TO MANAGE LEARNING ACTIVITIES TO ENSURE THE SAFETY OF ALL STUDENTS</b>	<b>1</b>
Skill 1.1	Understands safety regulations and guidelines for science facilities and science instruction	1
Skill 1.2	Knows procedures for and sources of information regarding the appropriate handling, use, disposal, care, and maintenance of chemicals, materials, specimens, and equipment	2
Skill 1.3	Knows procedures for the safe handling and ethical care and treatment of organisms and specimens	3
<b>COMPETENCY 2.0</b>	<b>UNDERSTANDING THE CORRECT USE OF TOOLS, MATERIALS, EQUIPMENT, AND TECHNOLOGIES</b>	<b>5</b>
Skill 2.1	Selects and safely uses appropriate tools, technologies, materials, and equipment needed for instructional activities	5
Skill 2.2	Understands concepts of precision, accuracy, and error with regard to reading and recording numerical data from a scientific instrument	7
Skill 2.3	Understands how to gather, organize, display, and communicate data in a variety of ways	8
Skill 2.4	Understand the international system of measurement and performs unit conversions within measurement systems	9
<b>COMPETENCY 3.0</b>	<b>UNDERSTANDING THE PROCESS OF SCIENTIFIC INQUIRY AND THE HISTORY AND NATURE OF SCIENCE</b>	<b>10</b>
Skill 3.1	Understands the characteristics of various types of scientific investigations	10
Skill 3.2	Understands how to design, conduct, and communicate the results of a variety of scientific investigations	11

Skill 3.3	Understands the historical development of science and the contributions that diverse cultures and individuals of both genders have made to scientific knowledge .....	11
Skill 3.4	Understands the roles that logical reasoning, verifiable evidence, prediction, and peer review play in the process of generating and evaluating scientific knowledge.....	14
Skill 3.5	Understands principles of scientific ethics .....	14
Skill 3.6	Develops, analyzes, and evaluates different explanations for a given scientific result.....	15
Skill 3.7	Demonstrates an understanding of potential sources of error in inquiry based investigation.....	16
Skill 3.8	Demonstrates an understanding of how to communicate and defend the results of an inquiry-based investigation .....	16
<b>COMPETENCY 4.0</b>	<b>UNDERSTANDING HOW SCIENCE IMPACTS THE DAILY LIVES OF STUDENTS AND INTERACTS WITH AND INFLUENCES PERSONAL AND SOCIETAL DECISIONS.....</b>	<b>17</b>
Skill 4.1	Understands that decisions about the use of science are based on factors such as ethical standards, economics, and personal and societal needs .....	17
Skill 4.2	Applies scientific principles and the theory of probability to analyze the advantages of, disadvantages of, or alternatives to a give decision or course of action .....	18
Skill 4.3	Applies scientific principles and the processes to analyze factors that influence personal choices concerning fitness and health, including physiological and psychological effect and risks associated with the use of substances and substance abuse.....	18
Skill 4.4	Understand concepts, characteristics, and issues related to changes in populations and human population growth .....	19
Skill 4.5	Understand the types and uses of natural resources and the effects of human consumption of the renewal and depletion of resources ....	20
Skill 4.6	Understands the role science can play in helping resolve personal, societal, and global challenges .....	21

**COMPETENCY 5.0 UNDERSTANDING THE UNIFYING CONCEPTS AND PROCESSES THAT ARE COMMON TO ALL SCIENCES .....23**

- Skill 5.1 Understands how the following concepts and processes provide and unifying explanatory framework across the science disciplines: systems, order, and organization; evidence, models, and explanation; change, constancy, and measurements; evolution and equilibrium; and form and function ..... 23
- Skill 5.2 Demonstrates an understanding of how patterns in observations and data can be used to make explanations and predictions ..... 24
- Skill 5.3 Analyzes interactions and interrelationships between systems and subsystems ..... 25
- Skill 5.4 Analyzes unifying concepts to explore similarities in a variety of natural phenomena ..... 26
- Skill 5.5 Understands how properties and patterns of systems can be described in terms of space, time, energy, and matter ..... 27
- Skill 5.6 Understands how change and constancy occur in systems ..... 28
- Skill 5.7 Understands the complementary nature of form and function in a given system ..... 29
- Skill 5.8 Understands how models are used to represent the natural world and how to evaluate the strengths and limitations of a variety of scientific models (e.g., physical, conceptual, mathematical) ..... 30

**DOMAIN II. THE PHYSICAL SCIENCES**

**COMPETENCY 6.0 UNDERSTANDING FORCES AND MOTION AND THEIR RELATIONSHIPS ..... 31**

- Skill 6.1 Demonstrates an understanding of properties of universal forces ..... 31
- Skill 6.2 Understand how to measure, graph, and describe changes in motion using concepts of displacement, velocity, and acceleration ..... 31
- Skill 6.3 Understands the vector nature of force ..... 33
- Skill 6.4 Identifies the forces acting on an object and applies Newton’s laws to describe the motion of an object ..... 33

Skill 6.5 Analyzes the relationship between force and motion in a variety of situations..... 34

**COMPETENCY 7.0 UNDERSTANDING PHYSICAL PROPERTIES OF AND CHANGES IN MATTER ..... 36**

Skill 7.1 Describes the physical properties of substances (e.g., density, boiling point, solubility, thermal and electrical conductivity) ..... 36

Skill 7.2 Describes the physical properties and molecular structure of solids, liquids, and gases ..... 38

Skill 7.3 Describes the relationship between the molecular structure of materials and their physical properties..... 38

Skill 7.4 Relates the physical properties of an element to its placement in the periodic table ..... 40

Skill 7.5 Distinguishes between physical and chemical changes in matter ..... 43

Skill 7.6 Applies knowledge of physical properties of and changes in matter to processes and situations that occur in life and earth/space science..... 43

**COMPETENCY 8.0 UNDERSTANDING CHEMICAL PROPERTIES AND CHANGES IN MATTER ..... 44**

Skill 8.1 Describes the structure and components of the atom ..... 44

Skill 8.2 Distinguishes among elements, mixtures, and compounds and describes their properties..... 46

Skill 8.3 Relates the chemical properties of an element to its placement in the periodic table..... 48

Skill 8.4 Describes chemical bonds and chemical formulas ..... 49

Skill 8.5 Analyzes chemical reactions and their associated chemical equations ..... 51

Skill 8.6 Explains the importance of a variety of chemical reactions that occur in daily life ..... 52

Skill 8.7 Understands applications of chemical properties of matter in physical, life, and earth/space science and technology ..... 56

**COMPETENCY 9.0 UNDERSTANDING ENERGY AND INTERACTIONS  
BETWEEN MATTER AND ENERGY ..... 58**

Skill 9.1 Describes concepts of work, power, and potential and kinetic energy ..... 58

Skill 9.2 Understands the concept of heat energy and the difference between heat and temperature ..... 59

Skill 9.3 Understands the principles of electricity and magnetism and their applications ..... 61

Skill 9.4 Applies knowledge of properties of light to describe the function of optical systems and phenomena ..... 65

Skill 9.5 Demonstrates an understanding of the properties, production, and transmission of sound ..... 67

Skill 9.6 Applies knowledge of properties and characteristics of waves to describe a variety of waves ..... 68

**COMPETENCY 10.0 UNDERSTANDING ENERGY TRANSFORMATIONS  
AND THE CONSERVATION OF MATTER AND  
ENERGY ..... 71**

Skill 10.1 Describes the processes that generate energy in the sun and other stars ..... 71

Skill 10.2 Applies the law of conservation of matter to analyze a variety of situations ..... 71

Skill 10.3 Describes sources of electrical energy and processes of energy transformation for human uses ..... 72

Skill 10.4 Understands exothermic and endothermic chemical reactions and their applications ..... 73

Skill 10.5 Applies knowledge of the transfer of energy in a variety of situations (e.g., the production of heat, light, sound, and magnetic effects by electrical energy; the process of photosynthesis; weather processes; food webs; food/energy pyramids) ..... 73

Skill 10.6 Applies the law of conservation of energy to analyze a variety of physical phenomena ..... 74

Skill 10.7 Understands applications of energy transformations and the

conservation of matter and energy in life and earth/space science.....	75
--	----

**DOMAIN III. THE LIFE SCIENCES**

**COMPETENCY 11.0 UNDERSTANDING THE STRUCTURE AND FUNCTION OF LIVING THINGS ..... 76**

Skill 11.1	Describes characteristics of organisms from the major taxonomic groups.....	76
Skill 11.2	Analyzes how structure complements function in cells.....	78
Skill 11.3	Analyzes how structure complements function in tissues, organs, organ systems, and organisms .....	80
Skill 11.4	Identifies human body systems and describes their functions.....	81
Skill 11.5	Describes how organisms obtain and use energy and matter .....	89
Skill 11.6	Applies chemical properties to describe the structure and function of the basic chemical components or living things .....	91

**COMPETENCY 12.0 UNDERSTANDING REPRODUCTION AND THE MECHANISMS OF HEREDITY ..... 95**

Skill 12.1	Compares and contrasts sexual and asexual reproduction .....	95
Skill 12.2	Understands the organization of heredity material.....	95
Skill 12.3	Describes how an inherited trait can be determined by one or many genes and how more than one trait can be influenced by a single gene .....	97
Skill 12.4	Distinguishes between dominant and recessive traits and predict the probable outcomes of genetic combinations.....	98
Skill 12.5	Evaluates the influence of environmental and genetic factors on the traits of an organism .....	99
Skill 12.6	Describes current applications of genetic research.....	100

**COMPETENCY 13.0 UNDERSTANDING ADAPTATION OF ORGANISMS AND THE THEORY OF EVOLUTION..... 101**

- Skill 13.1 Describes similarities and differences among various types of organisms and methods of classifying organisms..... 101
- Skill 13.2 Describes traits in a population of species that enhance its survival and reproductive success ..... 103
- Skill 13.3 Describes how populations and species change through time ..... 104
- Skill 13.4 Applies knowledge of the mechanisms and processes of biological evolution (e.g., variation, mutation, environmental factors, natural selection) ..... 105
- Skill 13.5 Describes evidence that supports the theory of evolution on life on Earth ..... 106

**COMPETENCY 14.0 UNDERSTANDING REGULATORY MECHANISMS AND BEHAVIOR..... 109**

- Skill 14.1 Describes how organisms respond to internal and external stimuli ..... 109
- Skill 14.2 Applies knowledge of structures and physiological processes that maintain stable internal conditions..... 110
- Skill 14.3 Demonstrates an understanding of feedback mechanisms that allow organisms to maintain stable internal conditions ..... 111
- Skill 14.4 Understands how evolutionary history affects behavior ..... 112

**COMPETENCY 15.0 UNDERSTANDING THE RELATIONSHIP BETWEEN ORGANISMS AND THE ENVIRONMENT ..... 113**

- Skill 15.1 Identifies the abiotic and biotic components of an ecosystem ..... 113
- Skill 15.2 Analyzes the interrelationships among producers, consumers, and decomposers in an ecosystem ..... 113
- Skill 15.3 Identifies factors that influence the size and growth of population in an ecosystem..... 114
- Skill 15.4 Analyzes adaptive characteristics that result in a population's or species' unique niche in an ecosystem..... 115

Skill 15.5	Describes and analyzes energy flow through various types of ecosystems .....	116
Skill 15.6	Knows how populations and species modify and affect ecosystems .....	117

**DOMAIN IV. EARTH AND SPACE SCIENCE**

**COMPETENCY 16.0 UNDERSTANDING THE STRUCTURE AND FUNCTION OF EARTH SYSTEMS .....** 119

Skill 16.1	Understands the structure of Earth and analyzes constructive and destructive processes that produce geological change.....	119
Skill 16.2	Understands the form and function of surface and subsurface water .....	122
Skill 16.3	Applies knowledge of the composition and structure of the atmosphere and its properties .....	124
Skill 16.4	Demonstrates an understanding of the interactions that occur among the biosphere, geosphere, hydrosphere, and atmosphere.....	125
Skill 16.5	Applies knowledge of how human activity and natural processes, both gradual and catastrophic, can alter earth systems.....	126
Skill 16.6	Identifies the sources of energy in earth systems and describes mechanisms of energy transfer.....	127

**COMPETENCY 17.0 UNDERSTANDING CYCLES IN THE EARTH'S SYSTEMS .....** 128

Skill 17.1	Understands the rock cycle and how rocks, minerals, and soils are formed.....	128
Skill 17.2	Understands the water cycle and its relationship to earth systems .....	130
Skill 17.3	Understand the nutrient cycle and its relationship to earth systems ..	130
Skill 17.4	Applies knowledge of how human and natural processes affect earth systems .....	131
Skill 17.5	Understands the dynamic interactions that occur among the various cycles in the biosphere, geosphere, hydrosphere, and atmosphere .....	131

<b>COMPETENCY 18.0</b>	<b>UNDERSTANDING THE ROLE OF ENERGY IN WEATHER AND CLIMATE</b> .....	132
Skill 18.1	Understand the elements of weather and how they are measured ....	132
Skill 18.2	Compares and contrasts weather and climate .....	132
Skill 18.3	Analyzes weather charts and data to make weather predictions .....	133
Skill 18.4	Applies knowledge of how transfers of energy among earth systems affect weather and climate .....	134
Skill 18.5	Analyzes how Earth’s position, orientation, and surface features affect weather and climate .....	135
<b>COMPETENCY 19.0</b>	<b>UNDERSTANDING THE CHARACTERISTICS OF THE SOLAR SYSTEM AND THE UNIVERSE</b> .....	137
Skill 19.1	Understand the properties and characteristics of celestial objects ....	137
Skill 19.2	Applies knowledge of the earth-moon-sun system and the interactions among them.....	138
Skill 19.3	Identifies properties of the components of the solar system.....	139
Skill 19.4	Recognizes characteristics of stars and galaxies and their distribution in the universe .....	141
Skill 19.5	Demonstrates an understanding of scientific theories of the origin of the universe .....	142
<b>COMPETENCY 20.0</b>	<b>UNDERSTANDING THE HISTORY OF THE EARTH SYSTEM</b> .....	144
Skill 20.1	Understands the scope of the geologic time scale and its relationship to geologic processes.....	144
Skill 20.2	Demonstrates an understanding of theories about the earth’s origin and geologic history .....	145
Skill 20.3	Demonstrates an understanding of how tectonic forces have shaped landforms over time.....	147
Skill 20.4	Understands the formation of fossils and the importance of the fossil record in explaining the earth’s history .....	148

**DOMAIN V. SCIENCE LEARNING, INSTRUCTION, AND ASSESSMENT**

**COMPETENCY 21.0 THEORETICAL AND PRACTICAL KNOWLEDGE ABOUT TEACHING SCIENCE AND HOW STUDENTS LEARN SCIENCE ..... 149**

Skill 21.1 Understands how the developmental characteristics, prior knowledge, and experience, and attitudes of students influence science learning ..... 149

Skill 21.2 Selects and adapts science curricula, content, instructional materials, and activities to meet the interests, knowledge, understanding, abilities, experiences, and needs of all students, including English Language Learners ..... 151

Skill 21.3 Understands how to use situations from students' daily lives to develop instructional materials that investigate how science can be used to make informed decisions ..... 152

Skill 21.4 Understands common misconceptions in science and effective ways to address these misconceptions..... 152

Skill 21.5 Understands the rationale for the use of active learning and inquiry processes for students..... 153

Skill 21.6 Understands questioning strategies designed to elicit higher-level thinking and how to use them to move students from concrete to more abstract understanding ..... 154

Skill 21.7 Understands the importance of planning activities that are inclusive and accommodate the needs of all students..... 156

Skill 21.8 Understands how to sequence learning activities in a way that allows students to build upon their prior knowledge and challenges them to expand their understanding of science ..... 156

**COMPETENCY 22.0 UNDERSTANDING THE PROCESS OF SCIENTIFIC INQUIRY AND ITS ROLE IN SCIENCE INSTRUCTION .. 158**

Skill 22.1 Plans and implement instruction that provides opportunities for all students to engage in non-experimental and experimental inquiry investigations ..... 158

Skill 22.2 Focuses inquiry-based instruction on questions and issues relevant to students and uses strategies to assist students with generating, refining, and focusing scientific questions and hypotheses..... 159

Skill 22.3	Instructs students in the safe and proper use of a variety of grade-appropriate tools, equipment, resources, technology, and techniques to access, gather, store, retrieve, organize, and analyze data.....	160
Skill 22.4	Knows how to guide students in making systematic observations and measurements .....	163
Skill 22.5	Knows how to promote the use of critical-thinking skills, logical reasoning, and scientific problem solving to reach conclusions based on evidence.....	166
Skill 22.6	Knows how to teach students to develop, analyze, and evaluate different explanations for a given scientific investigation.....	167
Skill 22.7	Knows how to teach students to demonstrate an understanding of potential sources or error in inquiry-based investigation .....	168
Skill 22.8	Knows how to teach students to demonstrate an understanding of how to communicate and defend the results of an inquiry-based investigation.....	168
<b>COMPETENCY 23.0 VARIED AND APPROPRIATE ASSESSMENTS AND ASSESSMENT PRACTICES TO MONITOR SCIENCE LEARNING IN LABORATORY, FIELD, AND CLASSROOM SETTINGS .....</b>		<b>169</b>
Skill 23.1	Understands the relationship among science curriculum, assessment, and instruction and bases instruction on information gathered through assessment of students' strengths and needs.....	169
Skill 23.2	Understands the importance of monitoring and assessing students' understanding of science concepts and skills on an ongoing basis .....	169
Skill 23.3	Understands the importance of carefully selecting or designing formative and summative assessments for the specific decisions they are intended to inform .....	170
Skill 23.4	Selects or designs and administers a variety of appropriate assessment methods to monitor students understanding and progress.....	171
Skill 23.5	Uses formal and informal assessments of student performance and products to evaluate student participation in and understanding of the inquiry process.....	173

Skill 23.6	Understands the importance of sharing evaluation criteria and assessment results with students .....	174
<b>Sample Test</b>	.....	175
<b>Answer Key</b>	.....	203
<b>Rigor Table</b>	.....	204
<b>Sample Questions with Rationale</b>	.....	205