

Science Rationale

Students are naturally curious about the world and their place in it. Sustaining this curiosity and giving it a scientific foundation must be a high priority in Arizona schools. Students need to be actively involved in scientific investigations, develop a rational and objective framework for solving problems, and understand the concepts that unify the scientific disciplines. All students must recognize how developments in science impact their personal, societal, and physical environment and how scientific knowledge is developed, organized and interrelated. Scientifically and technologically literate people know how to apply the methods of science and technology for personal and professional growth and are able to use these skills for advancing community well-being.

Science is not a blueprint for rote memorization, and students should not simply be shown results. Science is a process of gathering and evaluating information, looking for patterns, and then devising and testing possible explanations. Knowledge of the history and nature of science and continuous opportunities to conduct scientific inquiries provide a complement to learning the sciences and understanding their relationships to other disciplines.

Students need to recognize the diversity and complexity of the life forms found on earth in order to understand the network of interrelationships among organisms and between living and non-living things. They must also understand how organisms emerge and adapt in order to survive. Students need to have knowledge of the properties and makeup of matter, the transfer and transformation of different forms of energy, and the results of matter and energy interactions. Students must understand the composition of the earth, the function of its resources, the impact of weather, and earth's relationship to other planets in the solar system. Even students who plan no further science study benefit from this information for it makes them better able to appreciate their world and to understand the many scientific and technological issues that face them.

Broad unifying concepts and processes provide a solid base for understanding the specific discipline-oriented concepts presented in several of the standards. The application of these concepts and processes provide students with productive and

insightful ways of considering and integrating a range of basic ideas that explain the natural and designed world. Some unifying concepts and processes include

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- systems, order and organization
- evidence, models and explanation
- change, constancy and measurement
- evolution and equilibrium
- form and function

Because the understanding and abilities associated with major conceptual and procedural schemes need to be developed over an entire education, the unifying concepts and processes transcend disciplinary boundaries.

The science standards are set with the expectation that science-related activities occur at all grade levels—from initial explorations in kindergarten through increasingly organized and focused science investigations in higher grades—and that science is taught in conjunction with all subject areas. The methods and thought processes of science have application well beyond the bounds of science and can support the broader goals of all subject areas.

The developers of the Arizona science standards relied heavily on the very thoughtful and carefully crafted content standards found in the *National Science Education Standards*. These standards should serve as the basis for interpreting and teaching the standards outlined in this document.

SCIENCE STANDARDS

STANDARD 1: SCIENCE AS INQUIRY

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Students understand and use the processes of scientific investigation and scientific ways of knowing. They are able to design, conduct, describe and evaluate these investigations. They are able to understand and apply concepts that unify scientific disciplines.

READINESS (Kindergarten)

Students know and are able to do the following:

- **1SC-R1. Identify and use safe procedures in all science activities**

PO 1. Demonstrate safe procedures (e.g., use and care of simple technology, materials and organisms) and behavior in all science inquiry

- **1SC-R2. Ask questions about the natural world (e.g., How do trees grow? Why is the sky blue? Where does rain come from?)**

PO 1. Formulate questions about objects, organisms, events and relationships in the natural world

- **1SC-R3. Categorize objects, organisms and events in different ways**

PO 1. Organize (e.g., sort, classify, sequence) objects, organisms and events by different characteristics

- **1SC-R4. State simple hypotheses about cause-and-effect relationships in the environment**

PO 1. Formulate a question that relates to the environment

PO 2. Predict the results of an observable cause-and-effect relationship

- **1SC-R5. Perform simple measurements and comparisons**

PO 1. Perform simple measurements using appropriate devices

PO 2. Compare objects according to their measurements

- **1SC-R6. Communicate observations and comparisons through various means such as pictographs, pictures, models and words**

PO 1. Describe observations with pictographs, pictures, models and words

PO 2. Describe similarities and differences of observations

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- **1SC-R7. Observe and describe changes in a simple system (e.g., a plant terrarium)**

PO 1. Describe changes observed in a simple system (e.g., ant farm, plant terrarium, aquarium)

FOUNDATIONS (Grades 1-3)

Students know and are able to do all of the above and the following:

- **1SC-F1. Plan, design, conduct and report on the conclusions of basic experiments**

With appropriate guidance:

PO 1. Plan an experiment

PO 2. Design an experiment

PO 3. Predict the results of an experiment

PO 4. Conduct an experiment and record data

PO 5. Report, through various means, the conclusions of an experiment

- **1SC-F2. Construct models (e.g., a volcano, a paper airplane, a solar system) that illustrate simple concepts and compare those models to what they represent**

With appropriate guidance:

PO 1. Construct physical models (e.g., a volcano, a paper airplane, a solar system) illustrating simple concepts

PO 2. Compare a physical model to what it represents

- **1SC-F3. Identify and record changes and patterns of changes in a familiar system**

PO 1. Describe changes and patterns of changes in a familiar system

PO 2. Record changes and patterns of changes in a familiar system

- **1SC-F4. Describe relationships among parts of a familiar system (e.g., a bicycle, a park, a clock)**

PO 1. Identify parts of a familiar system

PO 2. Explain the relationships among parts of a system

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ESSENTIALS (Grades 4-8)

Students know and are able to do all of the above and the following:

- **1SC-E1. Identify a question, formulate a hypothesis, control and manipulate variables, devise experiments, predict outcomes, compare and analyze results, and defend conclusions**

(Grades 4-5)

- PO 1. Distinguish between a question and a hypothesis
- PO 2. Describe the functions of variables in an investigation
- PO 3. Predict an outcome based on experimental data
- PO 4. Draw a conclusion based on a set of experimental data

(Grades 6-8)

- PO 1. Design an experiment using a scientific method
- PO 2. Conduct an experiment using a scientific method
- PO 3. Analyze the results of an experiment
- PO 4. Defend conclusions drawn from the analysis

- **1SC-E2. Create a model (e.g., a computer simulation, a stream table) to predict change**

(Grades 4-5)

- PO 1. Design a model to illustrate a system

(Grades 6-8)

- PO 1. Construct a model that demonstrates change within a system
- PO 2. Describe variables that cause change
- PO 3. Explain cause and effect of variables within a system

- **1SC-E3. Organize and present data gathered from their own experiences, using appropriate mathematical analyses and graphical representations**

(Grades 4-5)

- PO 1. Organize gathered data into an appropriate format
- PO 2. Construct a representation of data (e.g., bar graph, line graph, frequency table, Venn diagram)

(Grades 6-8)

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- PO 1. Construct a representation of data (e.g., histogram, stem-and-leaf plot, scatter plot, circle graph, flow chart)
- PO 2. Interpret patterns in collected data

- **1SC-E4. Identify and refine questions from previous investigations**

(Grades 4-5)

- PO 1. Identify questions from previous investigations
- PO 2. Refine questions from previous investigations

(Grades 6-8)

- PO 1. Analyze the results of previous investigations
- PO 2. Refine hypotheses from a previous investigation

- **1SC-E5. Analyze the processes, parts and subsystems of a bicycle, a clock or other mechanical or electrical device**

(Grades 4-5)

- PO 1. Identify the parts of a subsystem within a system
- PO 2. Describe the functions of the parts of a subsystem
- PO 3. State cause-and-effect relationships among components in mechanical or electrical devices

(Grades 6-8)

- PO 1. Explain the interaction among parts within mechanical or electrical devices
- PO 2. Analyze the processes that operate within a mechanical or electrical device

- **1SC-E6. Analyze scientific reports from magazines, television or other media**

(Grades 4-5)

- PO 1. Analyze the reliability of scientific information from a variety of sources
- PO 2. Use evidence to support or refute a conclusion drawn from a scientific report

(Grades 6-8)

- PO 1. Evaluate information for accuracy, logic, bias and impact

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PROFICIENCY - (Grades 9-12)

Students know and are able to do all of the above and the following:

- **1SC-P1. Propose solutions to practical and theoretical problems by synthesizing and evaluating information gained from scientific investigations**

PO 1. Evaluate scientific information for relevance to a given problem

PO 2. Propose solutions to a problem, based on information gained from scientific investigations

- **1SC-P2. Compare observations of the real world to observations of a constructed model (e.g., an aquarium, a terrarium, a volcano)**

PO 1. Assess the capability of a model to represent a “real world” scenario

- **1SC-P3. Analyze and evaluate reports of scientific studies**

PO 1. Analyze reports of scientific studies for elements of experimental design

PO 2. Compare conclusions to original hypotheses

PO 3. Evaluate validity of conclusions

- **1SC-P4. Create and defend a written plan of action for a scientific investigation**

PO 1. Design an appropriate protocol (written plan of action) for the investigation of a scientific problem

PO 2. Justify the protocol in terms of the elements of experimental design

- **1SC-P5. Apply the concepts of equilibrium, form and function to a variety of phenomena**

PO 1. Predict the effects of various factors on the equilibrium of a system

PO 2. Explain how the relationships between form and function are evident in natural and designed systems

PO 3. Describe how present form and function of an object, organism or system could have evolved from prior form and function

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- **1SC-P6. Identify and refine a researchable question, conduct the experiment, collect and analyze data, share and discuss findings**

PO 1. Construct a researchable question

PO 2. Employ a research design that incorporates a scientific method to carry out an experiment

PO 3. Analyze experimental data

PO 4. Communicate experimental findings to others

DISTINCTION (Honors)

Students know and are able to do all of the above and the following:

- **1SC-D1. Design and complete an advanced scientific investigation, either individually or as part of a team, and formally report results to peers, teachers and others**
- **1SC-D2. Apply the concepts of emergent properties, feedback, subsystems, equilibria, and unpredictability to a complex system (e.g., weather, the brain)**
- **1SC-D3. Interview science professionals (e.g., scientists, philosophers of science) to understand how they view science and formally report results to peers, teachers and others**

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SCIENCE STANDARDS

STANDARD 2: HISTORY AND NATURE OF SCIENCE

Students understand the nature of scientific ways of thinking. Students understand that scientific investigation grows from the contributions of many people.

READINESS (Kindergarten)

Students know and are able to do the following:

- **2SC-R1. Understand that all people can and do participate in science**

PO 1. Give examples of how diverse people (e.g. children, weathermen, cooks, healthcare workers, gardeners) participate in science

FOUNDATIONS (Grades 1-3)

Students know and are able to do all of the above and the following:

- **2SC-F1. Recognize that scientific contributions have been made by all kinds of people everywhere in the world**

PO 1. Describe how people and cultures, past and present, have made important contributions to scientific knowledge

- **2SC-F2. Understand that scientific inquiry has produced much knowledge about the world, that much is still unknown, and that some things will always be unknown**

PO 1. Describe the results of scientific inquiry in the world (e.g., a timeline of inventions, progression from simple to mechanized tools, understanding weather patterns)

PO 2. Explain how inquiry develops into further exploration of the unknown

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- **2SC-F3. Understand that science involves asking and answering questions and comparing the results to what is already known**

PO 1. Explain how asking and answering questions are part of the process of a scientific investigation

PO 2. Compare prior knowledge to the results of a scientific investigation

ESSENTIALS (Grades 4-8)

Students know and are able to do all of the above and the following:

- **2SC-E1. Identify major milestones in science that have revolutionized the thinking of the time**

(Grades 4-5)

PO 1. Describe major scientific contributions

(Grades 6-8)

PO 1. Describe the effects of major scientific events on society

PO 2. Describe a recent scientific event that has impacted the quality of life

- **2SC-E2. Describe how science and technology are interrelated**

(Grades 4-5)

PO 1. Describe how science has helped technology change over time

PO 2. Describe how technology has helped science change over time

(Grades 6-8)

PO 1. Describe a technological discovery that influences science

PO 2. Describe a scientific discovery that influences technology

PO 3. Determine scientific processes involved in a technological advancement

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- **2SC-E3. Provide different explanations for a phenomenon; defend and refute the explanations**

(Grades 4-5)

- PO 1. Propose several possible explanations for a scientific phenomenon
- PO 2. Provide evidence to defend an explanation for a scientific phenomenon
- PO 3. Provide evidence to refute an explanation for a scientific phenomenon

(Grades 6-8)

- PO 1. Analyze different theories to explain a phenomenon
- PO 2. Defend or refute the explanation of a phenomenon

- **2SC-E4. Identify characteristics of scientific ways of thinking**

(Grades 4-5)

- PO 1. Describe a variety of ways scientists generate ideas

(Grades 6-8)

- PO 1. Describe the following scientific processes: observing, communicating, comparing, organizing, relating, inferring and applying

- **2SC-E5. Explain how scientific theory, hypothesis generation and experimentation are interrelated**

(Grades 4-5)

- PO 1. Explain the role of a hypothesis in scientific inquiry
- PO 2. Explain the role of experimentation in scientific inquiry
- PO 3. Describe how a scientific theory can be developed and modified

(Grades 6-8)

- PO 1. Describe the relationship between theory and hypotheses
- PO 2. Describe how experimental procedures can be formulated to test a hypothesis
- PO 3. Explain how experimental results may affect a hypothesis and a theory

- **2SC-E6. Demonstrate how Science is an ongoing process of gathering and evaluating information, assessing evidence for and against theories and**

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hypotheses, looking for patterns, and then devising and testing possible explanations.

(Grades 4-5)

PO 1. Explain how a scientific theory has changed over time

PO 2. Explain how a hypothesis has changed over time

(Grades 6-8)

PO 1. Compare and contrast the evidence of a hypothesis

PO 2. Compare and contrast the evidence of a theory

PO 3. Analyze a hypothesis

PO 4. Analyze a theory

PROFICIENCY (Grades 9-12)

Students know and are able to do all of the above and the following:

- **2SC-P1. Identify and describe key factors (e.g., technology, competitiveness, world events, personalities, societal views) that affect the development and acceptance of scientific thought**

PO 1. Define key factors that affect the development of scientific thought

PO 2. Describe how different key factors affect the development and acceptance of scientific thought

- **2SC-P2. Explain how scientific innovations can challenge accepted ideas**

PO 1. Describe how an accepted idea could be challenged by scientific innovation

- **2SC-P3. Explain the impact on society of major scientific developments (e.g., germ theory, molecular biology, relativity)**

PO 1. Describe the benefits, limitations, and consequences of major scientific developments in pure and applied science

PO 2. Explain how major scientific developments in pure and applied science have affected, or could affect, society

- **2SC-P4. Trace the development and consequences of an invention, theory or discovery to demonstrate the dynamic nature of science**

PO 1. Trace the development of a selected invention, theory or discovery from its

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inception to modern day

PO 2. Explain the progression of changes in the invention, theory or discovery

PO 3. Describe the impact of the invention, theory or discovery on further scientific thought

- **2SC-P5. Explain how theory, law and fact are developed in science to answer a specific question**

PO 1. Define theory, law and fact

PO 2. Describe the relationships among theories, laws and facts

PO 3. Explain how theories, laws and facts are used to answer specific questions

- **2SC-P6. Analyze evidence that supports past and current scientific theories about a specific topic**

PO 1. Distinguish between evidence which supports a given scientific theory (e.g., model of the atom, plate tectonics, natural selection) and evidence which does not support the theory

DISTINCTION (Honors)

Students know and are able to do all of the above and the following:

- **2SC-D1. Conduct a detailed case study of the societal response to a major scientific finding or theory (e.g., theories of Einstein, Galileo, Copernicus)**

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STANDARD 3: PERSONAL AND SOCIAL PERSPECTIVES IN SCIENCE AND TECHNOLOGY

Students understand the impact of science on human activity and the environment and are proficient in the uses of technology as they relate to science.

READINESS (Kindergarten)

Students know and are able to do the following:

- **3SC-R1. Distinguish between natural and man-made objects**

PO 1. Identify natural objects

PO 2. Identify man-made objects

PO 3. Describe differences between natural and man-made objects

- **3SC-R2. Use simple technology (e.g., scales, balances, magnifiers, computers)**

PO 1. Demonstrate the proper use of simple technology

FOUNDATIONS (Grades 1-3)

Students know and are able to do all of the above and the following:

- **3SC-F1. Identify occupations that require the application of science and technology**

PO 1. Describe occupations that require the application of science and technology

- **3SC-F2. Use scientific findings to propose and evaluate solutions to problems (e.g., water pollution, malnutrition, fire hazards)**

PO 1. Identify a problem

PO 2. Use scientific findings to develop solutions

PO 3. Evaluate proposed solutions to the problem

PO 4. Modify solutions to the problem, if necessary

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- **3SC-F3. Describe and explain the interrelationship of populations, resources and environments**

PO 1. Describe populations, resources and environments (e.g., habitat, ecosystem, food chain)

PO 2. Explain interactions and interdependence among specific populations, resources and environments

- **3SC-F4. Identify and describe how technology contributes to solving problems**

PO 1. Identify various technologies (e.g., zipper, paper clips, computers)

PO 2. Describe how various technologies contribute to solving problems

ESSENTIALS (Grades 4-8)

Students know and are able to do all of the above and the following:

- **3SC-E1. Recognize how scientific knowledge, thinking processes and skills are used in a great variety of careers**

(Grades 4-5)

PO 1. Explain how scientific knowledge and skills are integral to a variety of careers

(Grades 6-8)

PO 1. Explain how scientific knowledge, thinking processes and skills are used to solve problems in a variety of careers

- **3SC-E2. Develop and use a systematic approach to analyze the risks associated with natural and biological hazards**

(Grades 4-5)

PO 1. Describe risks associated with natural and biological hazards

PO 2. Compare risk factors of several natural and biological hazards

(Grades 6-8)

PO 1. Analyze the risk factors associated with natural and biological hazards

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- **3SC-E3. Identify a specific need and propose a solution or product that addresses this need, taking into consideration various factors**

(Grades 4-5)

- PO 1. Identify a human or environmental need
- PO 2. Describe the various factors affecting the need
- PO 3. Propose a solution or product that addresses the need

(Grades 6-8)

- PO 1. Design a solution or product that addresses a need and considers the factors of an environmental or human problem

- **3SC-E4. Implement a proposed solution or design and evaluate its merit**

(Grades 4-5)

- PO 1. Evaluate the possible strengths and weaknesses of a given solution to a problem

(Grades 6-8)

- PO 1. Apply a proposed solution to a problem
- PO 2. Evaluate the merit of a proposed solution

PROFICIENCY (Grades 9-12)

Students know and are able to do all of the above and the following:

- **3SC-P1. Apply scientific thought processes and procedures to personal and social issues**

- PO 1. Apply scientific thought processes of skepticism, empiricism, objectivity and logic to seek a solution to personal and social issues
- PO 2. Apply a scientific method to the solution of personal and social issues

- **3SC-P2. Propose and test, using computer software or common materials, a solution to an existing problem; or design a product to meet a need, using a model or simulation**

- PO 1. Describe a problem or need
- PO 2. Propose a solution to the problem or design a product to meet the need
- PO 3. Design a method of testing the solution or design a model or simulation to test the product
- PO 4. Carry out the test of the solution or product
- PO 5. Evaluate the test results

- **3SC-P3. Compare and contrast the goals of science and technology**

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- PO 1. Define the goals of science and the goals of technology
- PO 2. Compare the goals of science and the goals of technology
- PO 3. Describe the impact of technology on the life, physical, earth and space sciences

- **3SC-P4. Identify and describe the basic processes of the natural ecosystems and how these processes affect, and are affected by, humans**

- PO 1. Describe the basic processes of the natural ecosystems (e.g., water cycle, nutrient cycles)
- PO 2. Explain how these processes affect, and are affected by, humans

- **3SC-P5. Describe and explain factors that affect population size and growth (e.g., birth and death rates, quality of environment, disease, education)**

- PO 1. Describe biotic and abiotic factors that affect populations
- PO 2. Predict the effect of a change in a specific factor on a population

DISTINCTION (Honors)

Students know and able to do all of the above and the following:

- **3SC-D1. Explore the scientific and technological aspects of contemporary problems; analyze and evaluate proposed solutions**

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STANDARD 4: LIFE SCIENCE

Students understand the characteristics of living things, the diversity of life and how organisms change over time in terms of biological adaptation and genetics. Students understand the interrelationships of matter and energy in living organisms and the interactions of living organisms with their environment.

READINESS (Kindergarten)

Students know and are able to do the following:

- **4SC-R1. Distinguish living from non-living things**

PO 1. Identify living things

PO 2. Identify non-living things

PO 3. Describe differences between living and non-living things

- **4SC-R2. Describe the basic needs of living organisms**

PO 1. Describe the basic needs of living organisms for survival

- **4SC-R3. Recognize and distinguish similarities and differences in diverse species**

PO 1. Identify observable similarities among diverse species (e.g., number of legs, body coverings, size)

PO 2. Identify observable differences among diverse species

PO 3. Compare the observable similarities and differences among diverse species

FOUNDATIONS (Grades 1-3)

Students know and are able to do all of the above and the following:

- **4SC-F1. Describe and explain cause-and-effect relationships in living systems**

PO 1. Identify cause-and-effect relationships in living systems

PO 2. Explain cause-and-effect relationships in living systems

- **4SC-F2. Trace the life cycles of various organisms**

PO 1. Identify the stages in a life cycle

PO 2. Record life cycle stages in sequence

- **4SC-F3. Identify the basic structures and functions of plants and animals**

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- PO 1. Identify basic animal structures
- PO 2. Describe the functions of basic animal structures
- PO 3. Identify basic plant structures
- PO 4. Describe the functions of basic plant structures

- **4SC-F4. Identify characteristics of plants and animals (including extinct organisms) that allow them to live in specific environments**

- PO 1. Identify adaptations of plants that allow them to live in specific environments
- PO 2. Identify adaptations of animals that allow them to live in specific environments

- **4SC-F5. Recognize that component parts make up the human body systems (e.g., digestive, muscular, skeletal)**

- PO 1. Identify major organs (e.g., lungs, heart, skin) within systems

- **4SC-F6. Recognize that offspring within families have both similarities and differences**

- PO 1. Identify similarities that offspring can have within a family
- PO 2. Identify differences that offspring can have within a family

- **4SC-F7. Explain the interaction of living and non-living components within ecosystems**

- PO 1. Identify living components within ecosystems
- PO 2. Identify non-living components within ecosystems
- PO 3. Describe the interaction among living and non-living components in an ecosystem

ESSENTIALS (Grades 4-8)

Students know and are able to do all of the above and the following:

- **4SC-E1. Construct classification systems based on the structure of organisms**

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(Grades 4-5)

- PO 1. Construct a simple classification system based on physical characteristics
- PO 2. Arrange several organisms into a classification system

(Grades 6-8)

- PO 1. Describe how organisms are classified
- PO 2. Construct classification systems for grouping organisms
- PO 3. Identify organisms based on existing classification systems

- **4SC-E2. Compare and contrast the basic structures, components and functions of various cells**

(Grades 4-5)

- PO 1. Identify the basic structures of various cells
- PO 2. Identify the basic functions of various cells
- PO 3. Differentiate between the basic functions of various cells

(Grades 6-8)

- PO 1. Analyze the basic structures, components and functions of various cells
- PO 2. Differentiate among types of various cells

- **4SC-E3. Explain the various levels of organization in relationship to structure and function within an organism, including cells, tissues and organs**

(Grades 4-5)

- PO 1. Identify the main structures of cells within an organism
- PO 2. Identify the main structures of tissues within an organism
- PO 3. Identify the main structures of organs within an organism
- PO 4. Identify the interrelationships among cells, tissues and organs

(Grades 6-8)

- PO 1. Distinguish among cells, tissues and organs
- PO 2. Identify the main structures and functions of cells within an organism
- PO 3. Identify the main structures and functions of tissue within an organism
- PO 4. Identify the main structures and functions of organ systems within an organism

- **4SC-E4. Identify the systems involved in such vital functions as digestion, respiration, reproduction, circulation, excretion, movement, control and coordination**

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(Grades 4-5)

- PO 1. Identify the major components of vital body systems
- PO 2. Identify the functions of systems (e.g., digestion, respiration, reproduction, circulation, excretion, movement, control, coordination)

(Grades 6-8)

- PO 1. Describe how various systems work together to perform a vital function

- **4SC-E5. Describe changes or constancy in groups of organisms over geologic time**

(Grades 4-5)

- PO 1. Describe how organisms have changed over time
- PO 2. Cite examples of organisms which have remained relatively constant

(Grades 6-8)

- PO 1. Describe organism adaptations or constancy over geologic time
- PO 2. Identify environmental factors that may determine adaptations or constancy of an organism over geologic time

- **4SC-E6. Describe the role of genes in heredity**

(Grades 4-5)

- PO 1. Define the terms heredity and genes
- PO 2. Distinguish between physical characteristics which are, and are not, inherited

(Grades 6-8)

- PO 1. Explain the basic principles of heredity and genetics
- PO 2. Distinguish between dominant and recessive traits
- PO 3. Describe information that is carried in a gene

- **4SC-E7. Explain and model the interaction and interdependence of living and non-living components within ecosystems, including the adaptation of plants and animals to their environment**

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(Grades 4-5)

- PO 1. Describe the components of an ecosystem
- PO 2. Describe how living and non-living components interact within an ecosystem
- PO 3. Describe how living and non-living components are interdependent within an ecosystem
- PO 4. Explain how plant species adapt to their environment

(Grades 6-8)

- PO 1. Explain the role of living/non-living components in an ecosystem
- PO 2. Create a model of the interaction of living/non-living components within an ecosystem

PROFICIENCY (Grades 9-12)

Students know and are able to do all of the above and the following:

4SC-P1. Use and construct a variety of classification systems, including evolutionary relationships.

- PO 1. Employ classification systems to identify organisms
- PO 2. Create classification systems to identify organisms
- PO 3. Use a biological classification scheme to infer and discuss the degree of divergence of various species from prior organisms

• **4SC-P2. Describe the molecular basis of heredity (e.g., DNA, genes, chromosomes and mutations)**

- PO 1. Explain the relationships among DNA, genes and chromosomes
- PO 2. Describe the structure and function of DNA and its role in heredity
- PO 3. Describe how the various types of mutations may act as a source of genetic diversity
- PO 4. Describe how genetic information is transmitted from parents to offspring

• **4SC-P3. Describe the basic cellular processes of photosynthesis, respiration, protein synthesis and cell division**

- PO 1. Differentiate between the processes of photosynthesis and respiration in terms of energy flow, reactants and products
- PO 2. Describe the process of protein synthesis

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PO 3. Compare the purpose and process of mitosis with the purpose and process of meiosis

- **4SC-P4. Describe and explain the cycling of matter and the flow of energy through the ecosystem's living and non-living components**

PO 1. Explain the relationships among abiotic and biotic components of an ecosystem in terms of energy flow and the cycling of matter

- **4SC-P5. Describe and explain how energy is used in the maintenance, repair, growth and development of cells**

PO 1. Describe the energy demands required by physiological mechanisms needed to regulate homeostasis

PO 2. Describe the energy demands required by cells for growth, development and repair

- **4SC-P6. Describe and explain how the environment can affect the number of species and the diversity of species in an environment**

PO 1. Explain how the adaptations of various species are related to their success in an ecosystem

PO 2. Explain why genetic variation within a population can impact the success of a species subjected to new environmental conditions

PO 3. Predict how a change in an environmental factor can affect the number of organisms in a population

PO 4. Predict how a change in an environmental factor can affect the biodiversity in an ecosystem

- **4SC-P7. Describe the role of the systems (e.g., nervous, digestive, respiratory) that regulate the behaviors of multi-celled organisms**

PO 1. Describe the physiological relationship of the systems and their function in homeostasis

PO 2. Describe an organism's behavioral responses to internal and external stimuli

PO 3. Compare the selective advantage of several behavioral responses

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- **4SC-P8. Explain how evolution provides a scientific explanation for the fossil record of ancient life forms, as well as for the striking molecular similarities observed among the diverse species of living organisms.**

PO 1. Using fossil records, trace the changes in number and type of organisms over time

PO 2. Compare the fossil record of one ancient organism to the modern form of that organism (e.g. ammonite to nautilus, eohippus to horse) identifying molecular and/or structural similarities

- **4SC-P9. Use scientific evidence to demonstrate that descent from common ancestors produced today's diversity of organisms over more than 3.5 billion years of evolution.**

PO 1. Using scientific evidence, (e.g., the fossil record, homologous structures, embryological development or biochemical similarities) illustrate that descent from common ancestors produced today's diversity of organisms

- **4SC-P10. Demonstrate an understanding of the theory of evolution by natural selection as a consequence of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring**

PO 1. Identify the components of natural selection

PO 2. Predict the success or failure of a population of organisms over time when exposed to changing environmental factors

PO 3. Predict the success or failure of a population of organisms over time based on the genetic variability of offspring and ability to reproduce

DISTINCTION (Honors)

Students know and are able to do all of the above and the following:

- **4SC-D1. Analyze the general structure and function of DNA and its role in heredity, protein synthesis, and disease as a vehicle for genetic continuity and as a source of genetic diversity upon which natural selection can act**

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- **4SC-D2. Explain the role of exposure to certain factors (e.g., sunlight, ozone, nitrates) that may increase the rate of mutation, the incidence of cancer and other diseases, or the opportunities for other adaptations**

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STANDARD 5: PHYSICAL SCIENCE

Students understand the nature of matter and energy including their forms, the changes they undergo and their interactions.

READINESS (Kindergarten)

Students know and are able to do the following:

- **5SC-R1. Compare objects in terms of common physical properties**

PO 1. Identify physical properties of objects (e.g., shape, texture, size, color)

PO 2. Compare objects in terms of physical properties

FOUNDATIONS (Grades 1-3)

Students know and are able to do all of the above and the following:

- **5SC-F1. Create mixtures (e.g., salt and sand, iron filings and soil) and separate them based on differences in properties**

PO 1. Construct a mixture

PO 2. Separate the mixture into original substances

- **5SC-F2. Demonstrate that light, heat, motion, magnetism and sound can cause changes**

PO 1. Demonstrate that light can cause change

PO 2. Demonstrate that heat can cause change

PO 3. Demonstrate that motion can cause change

PO 4. Demonstrate that magnetism can cause change

PO 5. Demonstrate that sound can cause change

- **5SC-F3. Demonstrate and explain that materials exist in different states (solid, liquid and gas) and can change from one to another**

PO 1. Identify the different states of matter

PO 2. Demonstrate that matter can change and exist in one or more states

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- **5SC-F4. Recognize that light travels in a straight line and can be reflected, refracted or absorbed**

PO 1. Demonstrate that light travels in a straight line

PO 2. Demonstrate that light can be reflected

PO 3. Demonstrate that light can be refracted

PO 4. Demonstrate that light can be absorbed

ESSENTIALS (Grades 4-8)

Students know and are able to do all of the above and the following:

- **5SC-E1. Examine, describe, compare, measure, and classify objects and mixtures of substances based on common physical and chemical properties (e.g., states of matter, mass, volume, electrical charge, density, boiling points, pH, magnetism, solubility)**

(Grades 4-5)

PO 1. Identify common physical and chemical properties

PO 2. Compare physical and chemical properties of common objects

PO 3. Compare physical and chemical properties of common mixtures

(Grades 6-8)

PO 1. Classify objects and mixtures of substances based on physical and chemical properties

PO 2. Analyze physical and chemical properties of objects and mixtures

- **5SC-E2. Classify and describe matter in terms of elements, compounds, mixtures, atoms and molecules**

(Grades 4-5)

PO 1. Distinguish among matter, mixtures and compounds

(Grades 6-8)

PO 1. Classify matter in terms of elements, compounds, mixtures, atoms and molecules

PO 2. Describe elements, compounds, mixtures, atoms and molecules as they relate to matter

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- **5SC-E3. Show that energy exists in many forms and can be transferred in many ways**

(Grades 4-5)

PO 1. Identify various types of energy sources

PO 2. Describe how energy is transferred

(Grades 6-8)

PO 1. Define the law of conservation of energy

PO 2. Describe how energy is a property of a substance

PO 3. Explain ways in which energy is transferred

- **5SC-E4. Identify and predict what will change and what will remain unchanged when matter experiences an external force or energy change (e.g., boiling a liquid; comparing the force, distance and work involved in simple machines)**

(Grades 4-5)

PO 1. Define force

PO 2. Describe the effects of various forces on an object

PO 3. Describe how a change in energy will affect matter

(Grades 6-8)

PO 1. Identify properties of matter that will/will not change when matter experiences external force or energy change

PO 2. Predict the outcome when matter experiences an external force or energy change

- **5SC-E5. Describe, measure and calculate characteristics (e.g., speed, distance, mass, force, gravity) of moving objects and their interactions (e.g., force, velocity, acceleration, potential energy, and kinetic energy) within a system**

(Grades 4-5)

PO 1. Define terms associated with moving objects

PO 2. Describe interactions of moving objects

(Grades 6-8)

PO 1. Analyze moving objects within a system using Newton's laws of motion

PROFICIENCY (Grades 9-12)

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Students know and are able to do all of the above and the following:

- **5SC-P1. Predict chemical and physical properties of substances (e.g., color, solubility, chemical reactivity, melting point, boiling point)**

PO 1. Describe physical and chemical properties that are used to characterize substances

PO 2. Determine physical and chemical properties of a substance through observation, measurement and experimentation

PO 3. Separate mixtures of substances based on their physical and chemical properties

- **5SC-P2. Describe and explain properties and composition of samples of matter, using models (including atomic and molecular structure and the periodic table)**

PO 1. Use models of atomic and molecular structure to explain properties of matter

PO 2. Use the periodic table to predict properties of elements and compounds

PO 3. Predict the properties of substances based upon ionic, covalent, or hydrogen bonding

- **5SC-P3. Identify, measure, calculate, and analyze qualitative and quantitative relationships associated with energy forms and energy transfer or transformation (e.g., changes in temperature, velocity, potential energy, kinetic energy, conduction, convection, radiation)**

PO 1. Identify qualitative and quantitative relationships associated with energy (e.g., heat, mechanical, electrical)

PO 2. Measure quantitative (e.g., heat, mechanical, electrical) relationships associated with energy

PO 3. Calculate quantitative relationships associated with energy (e.g., heat, mechanical, electrical)

- **5SC-P4. Observe, measure and calculate quantities to demonstrate conservation of matter and energy in chemical changes (e.g., acid base, precipitation, heat)**

PO 1. Use the law of conservation of matter to explain the quantitative relationships between reactants and products in chemical reactions

PO 2. Quantify the mass relationships between reactants and products in chemical reactions

PO 3. Use the law of conservation of energy to explain the energy changes in chemical reactions

PO 4. Quantify the energy changes in chemical reactions

- **5SC-P5. Describe and predict chemical reactions (including combustion and simple chemical reactions) and physical interaction of matter (including velocity, force, work and power), using words or symbolic equations**

PO 1. Express a chemical reaction by using a balanced equation

PO 2. Predict the products of a chemical reaction using types of reactions (e.g., synthesis, decomposition, replacement, combustion)

PO 3. Describe physical interactions through use of word equations or formulae

PO 4. Predict the results of a physical interaction by using an algebraic formula

- **5SC-P6. Describe and explain physical interactions of matter and energy, using conceptual models (e.g., particle model for gaseous behavior)**

PO 1. Demonstrate the use of conceptual models in science (e.g., formulae, diagrams, graphs)

PO 2. Describe physical interactions of matter and energy (e.g., phase change, gas laws, momentum conservation)

- PO 3. Justify the validity of known conceptual models applied to physical phenomena

- **5SC-P7. Demonstrate the understanding of gravitation as a universal force that each mass exerts on any other mass**

PO 1. Use the universal law of gravitation to predict how the gravity force changes with a change of distance and/or mass

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- **5SC-P8. Demonstrate qualitative understanding of the 1st Law of Thermodynamics (conservation of matter and energy) and the 2nd Law of Thermodynamics (entropy)**

P O 1. Use the 1st Law of Thermodynamics to explain the energy changes in a physical system

PO 2. Describe a sequence of events that illustrates the 2nd Law of Thermodynamics

DISTINCTION (Honors)

Students know and are able to do all of the above and the following:

- **5SC-D1. Relate their prior knowledge and understanding of properties of matter to observable characteristics of materials and emerging technologies (e.g., semiconductors, superconductors, photovoltaics, ceramics)**
- **5SC-D2. Model quantitative aspects of chemical and physical interactions (e.g., rates of reactions, stoichiometry, electromagnetic phenomena, statics and dynamics, electrochemistry)**
- **5SC-D3. Apply knowledge and understanding of chemical and physical interactions (e.g., rates of reactions, stoichiometry, electromagnetic phenomena, statics and dynamics, electrochemistry)**
- **5SC-D4. Describe the changes (e.g., mass-energy conversions) and predict products (e.g., particles, new elements) in nuclear reactions**

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STANDARD 6: EARTH AND SPACE SCIENCE

Students understand the composition, formative processes, and history of the earth, the solar system and the universe.

READINESS (Kindergarten)

Students know and are able to do the following:

- **6SC-R1. Identify basic phenomena and changes in the sky (e.g., sunrise, moon, stars)**

PO 1. Identify basic phenomena in the sky

PO 2. Describe changes that occur in the sky

- **6SC-R2. Understand that the sun heats and lights the earth**

PO 1. Demonstrate that the sun heats and lights the earth

- **6SC-R3. Identify how the weather affects daily activities**

PO 1. Identify basic weather phenomena (e.g., temperature, wind, precipitation)

PO 2. Explain how weather affects daily activities

- **6SC-R4. Identify basic earth materials (rocks, soils, water and gases) and their common uses**

PO 1. Identify basic earth materials

PO 2. Identify common uses of basic earth materials

FOUNDATIONS (Grades 1-3)

Students know and are able to do all of the above and the following:

- **6SC-F1. Describe the basic earth materials (rocks, soils, water and gases) and their physical properties**

PO 1. Identify physical properties of earth materials

PO 2. Describe physical properties of earth materials

- **6SC-F2. Identify the planets and their relationship to the sun**

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- PO 1. Identify the planets of the solar system
- PO 2. Describe the relationship of the planets to the sun

- **6SC-F3. Identify the seasons and their characteristics**

- PO 1. Identify the seasons
- PO 2. Describe the characteristics of each season

- **6SC-F4. Identify and describe the patterns of movement of objects in the sky**

- PO 1. Identify objects that move in the sky
- PO 2. Describe patterns of change visible in the sky over time (e.g., seasonal position of the sun, constellations, the moon)
- PO 3. Describe the patterns of movement of objects in the sky

- **6SC-F5. Identify major features of natural processes and forces that shape the earth's surface, including weathering and volcanic activity**

- PO 1. Identify natural forces (e.g., water, ice, wind) that shape the earth's surface
- PO 2. Identify natural processes (e.g., weathering, erosion, global warming) that gradually shape the earth's surface
- PO 3. Identify natural processes (e.g., earthquake, floods, volcanic eruptions) that rapidly shape the earth's surface

- **6SC-F6. Describe natural events and how humans are affected by them**

- PO 1. Identify natural events that affect humans
- PO 2. Explain how natural events impact human life

- **6SC-F7. Measure and record changes in weather conditions**

- PO 1. Measure weather conditions (e.g., temperature, wind speed, rainfall)
- PO 2. Record weather conditions
- PO 3. Interpret changes in weather conditions

- **6SC-F8. Describe how fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at the time.**

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- PO 1. Identify how fossils provide evidence about plants that lived long ago
- PO 2. Identify how fossils provide evidence about animals that lived long ago
- PO 3. Explain how fossils of plants and animals provide evidence about the nature of the environment at the time

ESSENTIALS (Grades 4-8)

Students know and are able to do all of the above and the following:

- **6SC-E1. Describe and model the motion of earth in relation to the sun, including the concepts of day, night, season and year**

(Grades 4-5)

- PO 1. Distinguish between revolution and rotation
- PO 2. Describe how the earth's movement, in relation to the sun, creates day and night

(Grades 6-8)

- PO 1. Explain the motion of earth in relation to the sun, including the concepts of day, night, season and year

- **6SC-E2. Describe common objects in the solar system and explain their relationships**

(Grades 4-5)

- PO 1. Describe common objects in the solar system
- PO 2. Explain how objects in the solar system are related

(Grades 6-8)

- PO 1. Describe common objects in the solar system galaxy and the universe
- PO 2. Explain the relationship between common objects in the solar system galaxy and the universe

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- **6SC-E3. Describe the composition (including the formation of minerals, rocks and soil) and the structure of the earth**

(Grades 4-5)

PO 1. Describe the layers of the earth and their compositions

PO 2. Explain how rocks, minerals and soil are formed

(Grades 6-8)

PO 1. Explain the processes involved in the formation of the earth's structure

- **6SC-E4. Provide evidence of how life and environmental conditions have changed**

(Grades 4-5)

PO 1. Describe how life has changed over time (geologic and recent)

PO 2. Describe how environmental conditions have changed over time (geologic and recent)

(Grades 6-8)

PO 1. Compare and contrast the life and environmental conditions within geological time periods

- **6SC-E5. Explain how earth processes seen today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past**

(Grades 4-5)

PO 1. Identify earth processes

PO 2. Compare the processes which affect the earth today with those that occurred in the past

(Grades 6-8)

PO 1. Interpret evidence that erosion, plate movement and changes in atmospheric composition as seen today also occurred in the past

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- **6SC-E6. Describe the distribution and circulation of the world's water through ocean currents, glaciers, rivers, ground water and atmosphere**

(Grades 4-5)

PO 1. Explain how water is cycled in nature

PO 2. Identify the distribution of water on earth, underground and in the atmosphere

(Grades 6-8)

PO 1. Describe the role water plays within the operation of the earth

PO 2. Describe the movement of water on the earth

- **6SC-E7. Describe the composition and physical characteristics (including currents, waves, tides and features of the ocean floor) of the earth's bodies of water**

(Grades 4-5)

PO 1. Describe currents, waves, tides and ocean floor features

PO 2. Describe the basic characteristics of the earth's bodies of fresh water and salt water

(Grades 6-8)

PO 1. Describe the types of bodies of water and their physical characteristics

PO 2. Describe the chemical characteristics of salt water and fresh water

PO 3. Describe the physical characteristics of salt water and fresh water

- **6SC-E8. Describe and model large-scale and local weather systems**

(Grades 4-5)

PO 1. Describe the differences between weather and climate

PO 2. Define basic terms associated with weather systems including fronts, pressure systems and types of clouds

(Grades 6-8)

PO 1. Create a weather system model

PO 2. Describe large-scale and local weather systems

- **6SC-E9. Describe the composition, properties and structure of the atmosphere**

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(Grades 4-5)

PO 1. Describe the properties and the composition of the layers of the atmosphere

(Grades 6-8).

PO 1. Create a model of the structure of the atmosphere

- **6SC-E10. Explain how technology has impacted both earth and space science**

(Grades 4-5)

PO 1. Explain the impact of technology on earth science

PO 2. Explain the impact of technology on space science

(Grades 6-8)

PO 1. Describe some technological advances that have impacted both earth and space science

PROFICIENCY (Grades 9-12)

Students know and are able to do all of the above and the following:

- **6SC-P1. Explain prominent scientific theories of the origin of: the universe (Big Bang Theory), the solar system (formation from a nebular cloud of dust and gas), and life forms (evolution)**

PO 1. Describe the processes explained by prominent scientific theories of the origin of the universe

PO 2. Describe the processes explained by prominent scientific theories of the origin of the solar system

PO 3. Describe the processes explained by prominent scientific theories of the origin of life forms

PO 4. Relate physical laws to processes explained by prominent scientific theories of the origin of the universe, solar system, and life forms

- **6SC-P2. Demonstrate an understanding of the earth's tilt, rotation and revolution and their effects on the seasons and the length of days**

PO 1. Describe how the earth's rotation causes day and night

PO 2. Describe how the earth's tilt on its axis and revolution around the sun cause changes in relative length of days and nights

PO 3. Describe how the earth's tilt on its axis and revolution around the sun cause changes in seasons

PO 4. Describe the flow of energy to and from the earth based on its shape, tilt, rotation and revolution

- **6SC-P3. Use the theory of plate tectonics to explain relationships among earthquakes, volcanoes, mid-oceanic ridges and deep sea trenches**

PO 1. Describe the relationship between the earth's internal heat and plate tectonics

PO 2. Describe the relationships among earthquakes, volcanoes, mid-oceanic ridges, deep sea trenches and tectonic plates

- **6SC-P4. Use evidence (e.g., fossils, rock layers, ice cores, radiometric dating) to investigate how earth has changed or remained constant over short and long periods of time**

PO 1. Provide evidence for changes in earth's geologic history, using data from relative age-dating techniques

PO 2. Provide evidence for changes in earth's geologic history, using data from absolute age-dating techniques

PO 3. Describe changes or relative constancy in earth's geologic history, using evidence gained through geologic dating techniques

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- **6SC-P5. Identify, investigate and predict the factors that influence the quality of water and how it can be reused, recycled and conserved**

PO 1. Describe the properties of water that make water a unique and essential substance

PO 2. Describe factors that impact water quality

PO 3. Describe factors that influence the reuse, recycling and conservation of water

PO 4. Predict future trends in water quality control and conservation, based on factors that influence water quality and usage

- **6SC-P6. Identify and compare the interactions between water and other earth systems including the biosphere, lithosphere and atmosphere**

PO 1. Describe the processes involved in the water cycle

PO 2. Describe the interactions between water and the biosphere

PO 3. Describe the interactions between water and the lithosphere

PO 4. Describe the interactions between water and the atmosphere

PO 5. Compare the interactions between water and earth systems

- **6SC-P7. Investigate, analyze and evaluate the factors that may influence weather; describe their effects on the environment and daily activities on earth**

PO 1. Analyze how weather and climate are influenced by heat transferred from the sun to the earth

PO 2. Analyze how weather is influenced by both natural and artificial earth features (e.g., mountain ranges, cities, bodies of water)

PO 3. Analyze how weather is influenced by both natural and artificial dynamic processes (e.g., sunspots, volcanoes, pollution, air and ocean currents)

PO 4. Evaluate the effects of various weather factors on the environment and daily activities on earth

DISTINCTION (Honors)

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Students know and are able to do all of the above and the following:

- **6SC-D1. Identify and predict natural hazards, using historical data**
- **6SC-D2. Analyze and evaluate prominent scientific theories of the origin of the universe**
- **6SC-D3. Explain the geochemical cycle through the movement of matter as it exists in different chemical reservoirs**

SCIENCE GLOSSARY

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Classify	To relate objects and events according to their properties or attributes based on their similarities
Equilibrium	The physical state in which forces and changes occur in opposite and offsetting directions. Steady state, balance, and homeostasis also describe equilibrium states
Evolution	Evolution is a series of changes, some gradual and some sporadic, that accounts for the present form and function of objects, organisms, and natural and designed systems. The general idea of evolution is that the present arises from materials and forms of the past.
Experiment	To test a hypothesis through the manipulation and control of independent variables and noting the effects on a dependent variable. Interpreting and presenting results in the form of a report that others can follow to replicate the experiment
Fact	A confirmed, or at least agreed-upon, empirical observation or conclusion
Homeostasis	A relatively stable state of equilibrium or a tendency toward such a state between the different, but interdependent, elements or groups of elements of an organism or group
Homologous	To have the same relative position, value or structure
Hypothesize	To state a tentative generalization of observations or inferences that may be used to explain a relatively large number of events that is subject to immediate or eventual testing by one or more experiments
Infer	To derive a conclusion from facts or premises
Justify	To show or prove that something is right or reasonable
Measure	To express the amount of an object or substance in quantitative terms, such as meters, liters, grams
Models	Tentative schemes or structures that correspond to real objects, events, or classes of events
Observe	To note the properties of objects and situations using the five senses

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Phenomenon	An observable fact or event; a fact or event of scientific interest susceptible of scientific description and explanation
Predict	To forecast a future occurrence based on past observation or the extension of an idea
Protocol	The plan of a scientific experiment; a written plan of action
Scatter plot	A graph of the points representing a collection of data
Science	A set of cognitive and methodological techniques designed to describe and interpret observed or inferred phenomena, past or present, aimed at building a testable body of knowledge which is open to rejection or confirmation
Scientific method	The use of hypothesis, experiment, inference to derive and improve models
Science as inquiry	Inquiry is a multifaceted activity which includes asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments
System	An organized group of related objects or components that form a whole. For example, systems can consist of organisms, machines, fundamental particles, galaxies, ideas, numbers, transportation, and education. Systems have boundaries, components, resources flow (input and output), and feedback
Technology	The application of science to solve practical problems, doing something more efficiently, or improving the quality of life
Theory	An integrated, comprehensive explanation of a lot of facts and capable of generating hypotheses and testable predictions about the natural world
Venn diagram	An arrangement of circles to represent logical relationships demonstrated by the inclusion, exclusion or the intersection of circles

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