

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Kindergarten

Instruction for students identified as having a significant cognitive disability should be developed from Arizona's Alternate Academic Standards. Only those performance objectives that have an identified alternate are required. When developing lessons or activities aligned to the grade level alternate standards, teachers should consider individual student abilities and their need for accommodations, cues, manipulatives/objects, augmentative devices, and communication systems. In addition, the depth and breadth of the alternate academic standard can be simplified based on the student's current cognitive abilities. Teachers can also develop lessons using performance objectives without alternates for those students who have developed those specific skills.

The goal in the development of the standard was to assure that the six strands and five unifying concepts are interwoven into a fabric of science that represents the true nature of science. Students have the opportunity to develop both the skills and content knowledge necessary to be scientifically literate members of the community.

Strands 1, 2, and 3 are designed to be explicitly taught *and* embedded *within* each of the content Strands 4, 5, and 6, and are not intended to be taught in isolation. The processes, skills, and content of the first three strands are designed to "umbrella" and complement the content of Life Science, Physical Science, and Earth and Space Science.

Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Observe, ask questions, and make predictions.

PO 1. Observe common objects using multiple senses.

PO 2. Ask questions based on experiences with objects, organisms, and events in the environment.

PO 3. Predict results of an investigation based on life, physical, and Earth and space sciences (e.g., the five senses, changes in weather).

Concept 2: Scientific Testing (Investigating and Modeling)

Participate in planning and conducting investigations, and recording data.

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

Alternate: Demonstrate safe behavior.

PO 2. Participate in guided investigations in life, physical, and Earth and space sciences.

Alternate: Participate in investigations in life, physical, and Earth and space sciences.

PO 3. Perform simple measurements using non-standard units of measure to collect data.

Concept 3: Analysis and Conclusions

Organize and analyze data; compare to predictions.

PO 1. Organize (e.g., compare, classify, and sequence) objects, organisms, and events according to various characteristics. (See M00-S4C4-01 and M00-S4C4-03)

Alternate: Organize objects according to various characteristics. (e.g. living/non living; water animals/land animals, hard/soft, etc.)

PO 2. Compare objects according to their measurable characteristics (e.g., longer/shorter, lighter/heavier). (See M00-S4C4-01)

Alternate: Compare objects according to their measurable characteristics (e.g., longer/shorter, lighter/heavier).

Concept 4: Communication

Communicate results of investigations.

PO 1. Communicate observations with pictographs, pictures, models, and/or words. (See M00-S2C1-02)

Alternate: Communicate observations with pictographs, pictures, models, and/or words.

PO 2. Communicate with other groups to describe the results of an investigation. (See LS-R3 and LS-R5)

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual and cultural contributions to scientific knowledge.

PO 1. Give examples of how diverse people (e.g., children, parents, weather reporters, cooks, healthcare workers, gardeners) use science in daily life.

PO 2. Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., Jane Goodall [scientist], supports Strand 4; Louis Braille [inventor], supports Strand 4.

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

No performance objectives at this grade level

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

No performance objectives at this grade level

Concept 2: Science and Technology in Society

Understand the impact of technology.

PO 1. Describe how simple tools (e.g., scissors, pencils, paper clips, hammers) can make tasks easier.

Alternate: Use simple classroom tools.

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: Characteristics of Organisms

Understand that basic structures in plants and animals serve a function.

PO 1. Distinguish between living things and nonliving things.

Alternate: Identify living and nonliving things.

PO 2. Name the following human body parts:

- head
- shoulders
- arms
- elbows
- wrists
- hands
- fingers
- legs
- hips
- knees
- ankles
- feet
- heels
- toes

Alternate: Identify human body parts.

PO 3. Identify the five senses and their related body parts:

- sight – eyes
- hearing – ears
- smell – nose
- taste – tongue
- touch – skin

Alternate: Identify any of the five senses and their related body parts.

Concept 2: Life Cycles

Understand the life cycles of plants and animals.

PO 1. Describe that most plants and animals will grow to physically resemble their parents.

Concept 3: Organisms and Environments

Understand the relationships among various organisms and their environment.

PO 1. Identify some plants and animals that exist in the local environment.

Alternate: Identify an animal that exists in the local environment.

PO 2. Identify that plants and animals need the following to grow and survive:

- food
- water
- air
- space

Alternate: Identify that animals need food and water to grow and survive.

PO 3. Describe changes observed in a small system (e.g., ant farm, plant terrarium, aquarium).

Concept 4: Diversity, Adaptation, and Behavior

Identify plant and animal adaptations.

No performance objectives at this grade level

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties of Objects and Materials

Classify objects and materials by their observable properties.

PO 1. Identify the following observable properties of objects using the senses:

- shape
- texture
- size
- color (See M00-S4C1-02 and M00-S4C1-03)

Alternate: Identify observable properties of objects using one of the 5 senses.

PO 2. Compare objects by the following observable properties:

- size
- color
- type of material (See M00-S4C1-02)

Concept 2: Position and Motion of Objects

Understand spatial relationships and the way objects move.

PO 1. Describe spatial relationships (i.e., above, below, next to, left, right, middle, center) of objects. (See M00-S4C1-02 and 3SS-R1-01)

Concept 3: Energy and Magnetism

Investigate different forms of energy.

PO 1. Investigate how applied forces (push and pull) can make things move.

PO 2. Investigate how forces can make things move without another thing touching them (e.g., magnets, static electricity).

PO 3. Sort materials according to whether they are or are not attracted by a magnet.

Alternate: Use a magnet.

PO 4. Identify familiar everyday uses of magnets (e.g., in toys, cabinet locks, decoration).

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Properties of Earth Materials

Identify the basic properties of Earth materials.

PO 1. Identify rocks, soil, and water as basic Earth materials.

Alternate: Identify rocks, soil, and water.

PO 2. Compare physical properties (e.g., color, texture, capacity to retain water) of basic Earth materials.

PO 3. Classify a variety of objects as being natural or man-made.

PO 4. Identify ways some natural or man-made materials can be reused or recycled (e.g., efficient use of paper, recycle aluminum cans).

Concept 2: Objects in the Sky

Identify objects in the sky.

No performance objectives at this grade level

Concept 3: Changes in the Earth and Sky

Understand characteristics of weather conditions and climate.

PO 1. Identify the following aspects of weather:

- temperature
- wind
- precipitation
- storms

PO 2. Describe observable changes in weather.

Alternate: Describe weather.

PO 3. Give examples of how the weather affects people's daily activities.

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Grade 1

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Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses
Observe, ask questions, and make predictions.
PO 1. Compare common objects using multiple senses. Alternate: Identify common objects using any of the five senses.
PO 2. <i>Ask questions based on experiences with objects, organisms, and events in the environment. (See M01-S2C1-01)</i>
PO 3. <i>Predict results of an investigation based on life, physical, and Earth and space sciences (e.g., animal life cycles, physical properties, Earth materials).</i>

Concept 2: Scientific Testing (Investigating and Modeling)

Participate in planning and conducting investigations, and recording data.

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

Alternate: Demonstrate safe behavior and appropriate procedures.

PO 2. Participate in guided investigations in life, physical, and Earth and space sciences.

Alternate: Participate in investigations in life, physical, and Earth and space sciences.

PO 3. Use simple tools such as rulers, thermometers, magnifiers, and balances to collect data (U.S. customary units). (See M01-S4C4-07)

Alternate: Use simple tools.

PO 4. Record data from guided investigations in an organized and appropriate format (e.g., lab book, log, notebook, chart paper). (See W01-S3C2-01 and W01-S3C3-01)

Concept 3: Analysis and Conclusions

Organize and analyze data; compare to predictions.

PO 1. Organize (e.g., compare, classify, and sequence) objects, organisms, and events according to various characteristics. (See M01-S4C4-01)

Alternate: Organize objects and organisms according to various characteristics (e.g. living/non living; water animals/land animals, hard/soft, color).

PO 2. Compare the results of the investigation to predictions made prior to the investigation.

Concept 4: Communication

Communicate results of investigations.

PO 1. Communicate the results of an investigation using pictures, graphs, models, and/or words. (See M01-S2C1-02 and W01-S3C3-02)

Alternate: Communicate observations with pictographs, pictures, models, and/or words.

PO 2. Communicate with other groups to describe the results of an investigation. (See LS-F1)

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual and cultural contributions to scientific knowledge.

PO 1. Give examples of how diverse people (e.g., children, parents, weather reporters, cooks, healthcare workers, gardeners) use science in daily life.

Alternate: Identify how people use science in daily life.

PO 2. Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., Sally Ride [scientist], supports Strand 6; Neil Armstrong [astronaut, engineer], supports Strand 6).

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

No performance objectives at this grade level

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments
Describe the interactions between human populations, natural hazards, and the environment.
No performance objectives at this grade level

Concept 2: Science and Technology in Society
Understand the impact of technology.
PO 1. Identify various technologies (e.g., automobiles, radios, refrigerators) that people use. Alternate: Identify common technology in the classroom (radio, computer, television, refrigerators).
PO 2. Describe how suitable tools (e.g., magnifiers, thermometers) help make better observations and measurements.

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: Characteristics of Organisms

Understand that basic structures in plants and animals serve a function.

PO 1. Identify the following as characteristics of living things:

- growth and development
- reproduction
- response to stimulus

Alternate: Identify living and nonliving things.

PO 2. Compare the following observable features of living things:

- movement – legs, wings
- protection – skin, feathers, tree bark
- respiration – lungs, gills
- support – plant stems, tree trunks

Alternate: Identify features of living things.

PO 3. Identify observable similarities and differences (e.g., number of legs, body coverings, size) between/among different groups of animals.

Alternate: Identify similarities or differences between/among different animals.

Concept 2: Life Cycles

Understand the life cycles of plants and animals.

PO 1. Identify stages of human life (e.g., infancy, adolescence, adulthood).

PO 2. Identify similarities and differences between animals and their parents.

Concept 3: Organisms and Environments

Understand the relationships among various organisms and their environment.

PO 1. Identify some plants and animals that exist in the local environment.

Alternate: Identify an animal that exists in the local environment.

PO 2. Compare the habitats (e.g., desert, forest, prairie, water, underground) in which plants and animals live.

PO 3. Describe how plants and animals within a habitat are dependent on each other.

Concept 4: Diversity, Adaptation, and Behavior

Identify plant and animal adaptations.

No performance objectives at this grade level

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties of Objects and Materials

Classify objects and materials by their observable properties.

PO 1. Classify objects by the following observable properties:

- shape
- texture
- size
- color
- weight

Alternate: *Identify observable properties of objects using one of the 5 senses.*

PO 2. Classify materials as solids or liquids.

Alternate: **Identify solids and liquids.**

Concept 2: Position and Motion of Objects

Understand spatial relationships and the way objects move.

PO 1. Demonstrate the various ways that objects can move (e.g., straight line, zigzag, back-and-forth, round-and-round, fast, slow).

Concept 3: Energy and Magnetism

Investigate different forms of energy.

No performance objectives at this grade level

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Properties of Earth Materials

Identify the basic properties of Earth materials.

PO 1. Describe the following basic Earth materials:

- rocks
- soil
- water

Alternate: Identify rocks, soil, and water.

PO 2. Compare the following physical properties of basic Earth materials:

- color
- texture
- capacity to retain water

Alternate: Sort basic materials by physical properties (color, texture).

PO 3. Identify common uses (e.g., construction, decoration) of basic Earth materials (i.e., rocks, water, soil).

PO 4. Identify the following as being natural resources:

- air
- water
- soil
- trees
- wildlife

PO 5. Identify ways to conserve natural resources (e.g., reduce, reuse, recycle, find alternatives).

Concept 2: Objects in the Sky

Identify objects in the sky.

PO 1. Identify evidence that the Sun is the natural source of heat and light on the Earth (e.g., warm surfaces, shadows, shade).

Alternate: Identify the sun.

PO 2. Compare celestial objects (e.g., Sun, Moon, stars) and transient objects in the sky (e.g., clouds, birds, airplanes, contrails).

Alternate: Identify the moon.

PO 3. Describe observable changes that occur in the sky, (e.g., clouds forming and moving, the position of the Moon).

Concept 3: Changes in the Earth and Sky

Understand characteristics of weather conditions and climate.

PO 1. Identify the following characteristics of seasonal weather patterns:

- temperature
- type of precipitation
- wind

Alternate: Describe weather.

PO 2. Analyze how the weather affects daily activities.

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Grade 2

Instruction for students identified as having a significant cognitive disability should be developed from Arizona's Alternate Academic Standards. Only those performance objectives that have an identified alternate are required. When developing lessons or activities aligned to the grade level alternate standards, teachers should consider individual student abilities and their need for accommodations, cues, manipulatives/objects, augmentative devices, and communication systems. In addition, the depth and breadth of the alternate academic standard can be simplified based on the student's current cognitive abilities. Teachers can also develop lessons using performance objectives without alternates for those students who have developed those specific skills.

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Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Observe, ask questions, and make predictions.

PO 1. Formulate relevant questions about the properties of objects, organisms, and events in the environment. (See M02-S2C1-01)

Alternate: Ask questions about objects or organisms in the environment.

PO 2. Predict the results of an investigation (e.g., in animal life cycles, phases of matter, the water cycle).

Concept 2: Scientific Testing (Investigating and Modeling)

Participate in planning and conducting investigations, and recording data.

PO 1. *Demonstrate safe behavior and appropriate procedures (e.g., use of instruments, materials, organisms) in all science inquiry.*

Alternate: Demonstrate safe behavior and appropriate procedures.

PO 2. *Participate in guided investigations in life, physical, and Earth and space sciences.*

Alternate: Participate in investigations in life, physical, and Earth and space sciences.

PO 3. Use simple tools such as rulers, thermometers, magnifiers, and balances to collect data (U.S. customary units). (See M02-S4C4-05 and M02-S4C4-06)

Alternate: Use simple tools.

PO 4. Record data from guided investigations in an organized and appropriate format (e.g., lab book, log, notebook, chart paper). (See W02-S3C2-01 and W02-S3C3-01)

Concept 3: Analysis and Conclusions

Organize and analyze data; compare to predictions.

PO 1. Organize data using graphs (i.e., pictograph, tally chart), tables, and journals.

Alternate: Place given data on graphs, tables, and journals (pictograph, tally chart, tables).

PO 2. Construct reasonable explanations of observations on the basis of data obtained (e.g., Based

PO 3. Compare the results of the investigation to predictions made prior to the investigation.

Alternate: Discuss the results of an investigation.

PO 4. Generate questions for possible future investigations based on the conclusions of the investigation.

Concept 4: Communication

Communicate results of investigations.

PO 1. Communicate the results and conclusions of an investigation (e.g., verbal, drawn, or written). (See M02-S2C1-02 and W02-S3C2-01)

Alternate: Communicate observations with pictographs, pictures, models, and/or words.

PO 2. Communicate with other groups to describe the results of an investigation. (See LS-F1)

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual and cultural contributions to scientific knowledge.

PO 1. *Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., Daniel Hale Williams [physician], supports Strand 4; Charles Drew [physician], supports Strand 4; Elizabeth Blackwell [physician])*

PO 2. Identify science-related career opportunities.
Alternate: Identify how people use science in daily life.

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

PO 1. Identify components of familiar systems (e.g., organs of the digestive system, bicycle).

PO 2. Identify the following characteristics of a system:

- consists of multiple parts or subsystems
- parts work interdependently

PO 3. Identify parts of a system too small to be seen (e.g., plant and animal cells).

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

No performance objectives at this grade level

Concept 2: Science and Technology in Society

Understand the impact of technology.

PO 1. Analyze how various technologies impact aspects of people's lives (e.g., entertainment, medicine, transportation, communication).

Alternate: Identify technology in people's lives.

PO 2. Describe important technological contributions made by people, past and present:

- automobile – Henry Ford
- airplane – Wilbur and Orville Wright
- telephone – Alexander G. Bell

PO 3. Identify a simple problem that could be solved by using a suitable tool.

Alternate: Identify a tool to solve a simple problem.

Strand 4: Life Science

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Concept 1: Characteristics of Organisms

Understand that basic structures in plants and animals serve a function.

PO 1. Identify animal structures that serve different functions (e.g., sensory, defense, locomotion).

Alternate: Identify animal body parts.

PO 2. Identify the following major parts of:

- the digestive system – mouth, esophagus, stomach, small and large intestines
- respiratory system – nose, trachea, lungs, diaphragm
- circulatory system – heart, arteries, veins, blood (See 1CH-F3-01)

PO 3. Describe the basic functions of the following systems:

- digestive – breakdown and absorption of food, disposal of waste
- respiratory – exchange of oxygen and carbon dioxide
- circulatory – transportation of nutrients and oxygen throughout the body (See 1CH-F3-02)

Concept 2: Life Cycles

Understand the life cycles of plants and animals.

PO 1. Describe the life cycles of various insects.

PO 2. Describe the life cycles of various mammals.

PO 3. Compare the life cycles of various organisms.

Concept 3: Organisms and Environments

Understand the relationships among various organisms and their environment.

No performance objectives at this grade level

Concept 4: Diversity, Adaptation, and Behavior

Identify plant and animal adaptations.

No performance objectives at this grade level

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties of Objects and Materials

Classify objects and materials by their observable properties.

PO 1. Describe objects in terms of measurable properties (e.g., length, volume, weight, temperature) using scientific tools. (See M02-S4C4-01 and M02-S4C4-02)

Alternate: Measure objects.

PO 2. Classify materials as solids, liquids, or gases.

Alternate: Identify solids, liquids, and gases.

PO 3. Demonstrate that water can exist as a:

- gas – vapor
- liquid – water
- solid – ice

PO 4. Demonstrate that solids have a definite shape and that liquids and gases take the shape of their containers.

Concept 2: Position and Motion of Objects

Understand spatial relationships and the way objects move.

No performance objectives at this grade level

Concept 3: Energy and Magnetism

Investigate different forms of energy.

No performance objectives at this grade level

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Properties of Earth Materials

Identify the basic properties of Earth materials.

No performance objectives at this grade level

Concept 2: Objects in the Sky

Identify objects in the sky.

No performance objectives at this grade level

Concept 3: Changes in the Earth and Sky

Understand characteristics of weather conditions and climate.

PO 1. Measure weather conditions (e.g., temperature, precipitation). (See M02-S4C4-04 and M02-S4C4-05)

Alternate: Describe weather.

PO 2. Record weather conditions (e.g., temperature, precipitation).

PO 3. Identify the following types of clouds:

- cumulus
- stratus
- cirrus

Alternate: Identify clouds.

PO 4. Analyze the relationship between clouds, temperature, and weather patterns.

Alternate: Discuss weather changes.

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Grade 3

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Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Observe, ask questions, and make predictions.

PO 1. Formulate relevant questions about the properties of objects, organisms, and events of the environment using observations and prior knowledge. (See M03-S2C1-01)

Alternate: Ask questions related to the environment.

PO 2. Predict the results of an investigation based on observed patterns, not random guessing.

Concept 2: Scientific Testing (Investigating and Modeling)

Participate in planning and conducting investigations, and recording data.

PO 1. *Demonstrate safe behavior and appropriate procedures (e.g., use of instruments, materials, organisms) in all science inquiry.*

Alternate: Demonstrate safe behavior and appropriate procedures.

PO 2. Plan a simple investigation (e.g., one plant receives adequate water, one receives too much water, and one receives too little water) based on the formulated questions.

PO 3. Conduct simple investigations (e.g., related to plant life cycles, changing the pitch of a sound, properties of rocks) in life, physical, and Earth and space sciences.

Alternate: Participate in simple investigations

PO 4. Use metric and U.S. customary units to measure objects. (See M03-S4C4-04)

Alternate: Use simple measurement tools.

PO 5. Record data in an organized and appropriate format (e.g., t-chart, table, list, written log).
(See W03-S3C2-01 and W03-S3C3-01)

Alternate: Record data.

Concept 3: Analysis and Conclusions

Organize and analyze data; compare to predictions.

PO 1. Organize data using the following methods with appropriate labels:

- bar graphs
- pictographs
- tally charts (See M03-S2C1-02)

Alternate: Place given data on graphs, tables, and journals (pictograph, tally chart, tables).

PO 2. Construct reasonable interpretations of the collected data based on formulated questions.
(See M03-S2C1-03)

PO 3. Compare the results of the investigation to predictions made prior to the investigation.

PO 4. Generate questions for possible future investigations based on the conclusions of the investigation.

PO 5. Record questions for further inquiry based on the conclusions of the investigation.

Concept 4: Communication

Communicate results of investigations.

PO 1. Communicate investigations and explanations using evidence and appropriate terminology.
(See W03-S3C2-01)

Alternate: Communicate observations with pictographs, pictures, models, and/or words.

PO 2. Describe an investigation in ways that enable others to repeat it.

PO 3. Communicate with other groups to describe the results of an investigation. (See LS-E1)

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual and cultural contributions to scientific knowledge.

PO 1. *Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., John Muir [naturalist], supports Strand 4; Thomas Edison [inventor], supports Strand 5; Mae Jemison [engineer, physician, astronaut], supports Strand 6.; Edmund Halley [scientist], supports Strand 6).*

PO 2. Describe science-related career opportunities.

Alternate: Identify how people use science in daily life.

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

PO 1. Describe how, in a system (e.g., terrarium, house) with many components, the components usually influence one another.

PO 2. Explain why a system may not work if a component is defective or missing.

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

PO 1. Describe the major factors that could impact a human population (e.g., famine, drought, disease, improved transportation, medical breakthroughs).

PO 2. Describe the beneficial and harmful impacts of natural events and human activities on the environment (e.g., forest fires, flooding, pesticides).

Concept 2: Science and Technology in Society

Understand the impact of technology.

PO 1. Identify ways that people use tools and techniques to solve problems.

Alternate: Identify tools and technology.

PO 2. Describe the development of different technologies (e.g., communication, entertainment, transportation, medicine) in response to resources, needs, and values.

Alternate: Identify technology in people's lives.

PO 3. Design and construct a technological solution to a common problem or need using common materials.

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: Characteristics of Organisms

Understand that basic structures in plants and animals serve a function.

PO 1. Describe the function of the following plant structures:

- roots – absorb nutrients
- stems – provide support
- leaves – synthesize food
- flowers – attract pollinators and produce seeds for reproduction

Alternate: Identify parts of plants.

Concept 2: Life Cycles

Understand the life cycles of plants and animals.

PO 1. Compare life cycles of various plants (e.g., conifers, flowering plants, ferns).

PO 2. Explain how growth, death, and decay are part of the plant life cycle.

Concept 3: Organisms and Environments

Understand the relationships among various organisms and their environment.

PO 1. Identify the living and nonliving components of an ecosystem.

Alternate: Identify living and nonliving things in an ecosystem.

PO 2. Examine an ecosystem to identify microscopic and macroscopic organisms.

PO 3. Explain the interrelationships among plants and animals in different environments:

- producers – plants
- consumers – animals
- decomposers – fungi, insects, bacteria

PO 4. Describe how plants and animals cause change in their environment.

PO 5. Describe how environmental factors (e.g., soil composition, range of temperature, quantity and quality of light or water) in the ecosystem may affect a member organism's ability to grow, reproduce, and thrive.

Concept 4: Diversity, Adaptation, and Behavior

Identify plant and animal adaptations.

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

PO 2. Describe ways that species adapt when introduced into new environments.

PO 3. Cite examples of how a species' inability to adapt to changing conditions in the ecosystem led to the extinction of that species.

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties of Objects and Materials

Classify objects and materials by their observable properties.

No performance objectives at this grade level

Concept 2: Position and Motion of Objects

Understand spatial relationships and the way objects move.

No performance objectives at this grade level

Concept 3: Energy and Magnetism

Investigate different forms of energy.

PO 1. Demonstrate that light can be:

- reflected (with mirrors)
- refracted (with prisms)
- absorbed (by dark surfaces)

Alternate: Demonstrate that light can be reflected.

PO 2. Describe how light behaves on striking objects that are:

- transparent (clear plastic)
- translucent (waxed paper)
- opaque (cardboard)

PO 3. Demonstrate that vibrating objects produce sound.

Alternate: Demonstrate that vibrating objects produce sound.

PO 4. Demonstrate that the pitch of a sound depends on the rate of the vibration (e.g., a long rubber band has a lower pitch than a short rubber band).

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Properties of Earth Materials

Identify the basic properties of Earth materials.

PO 1. Identify the layers of the Earth:

- crust
- mantle
- core (inner and outer)

Alternate: Identify Earth.

PO 2. Describe the different types of rocks and how they are formed:

- metamorphic
- igneous
- sedimentary

PO 3. Classify rocks based on the following physical properties:

- color
- texture

Alternate: Sort rocks based on color and size.

PO 4. Describe fossils as a record of past life forms.

PO 5. Describe how fossils are formed.

PO 6. Describe ways humans use Earth materials (e.g., fuel, building materials, growing food).

Concept 2: Objects in the Sky

Identify objects in the sky.

No performance objectives at this grade level

Concept 3: Changes in the Earth and Sky

Understand characteristics of weather conditions and climate.

No performance objectives at this grade level.

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Grade 4

Instruction for students identified as having a significant cognitive disability should be developed from Arizona's Alternate Academic Standards. Only those performance objectives that have an identified alternate are required. When developing lessons or activities aligned to the grade level alternate standards, teachers should consider individual student abilities and their need for accommodations, cues, manipulatives/objects, augmentative devices, and communication systems. In addition, the depth and breadth of the alternate academic standard can be simplified based on the student's current cognitive abilities. Teachers can also develop lessons using performance objectives without alternates for those students who have developed those specific skills.

The goal in the development of the standard was to assure that the six strands and five unifying concepts are interwoven into a fabric of science that represents the true nature of science. Students have the opportunity to develop both the skills and content knowledge necessary to be scientifically literate members of the community.

Strands 1, 2, and 3 are designed to be explicitly taught *and* embedded *within* each of the content Strands 4, 5, and 6, and are not intended to be taught in isolation. The processes, skills, and content of the first three strands are designed to "umbrella" and complement the content of Life Science, Physical Science, and Earth and Space Science.

Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Observe, ask questions, and make predictions.

PO 1. Differentiate inferences from observations.

PO 2. Formulate a relevant question through observations that can be tested by an investigation.

(See M04-S2C1-01)

Alternate: Develop questions about investigations.

PO 3. Formulate predictions in the realm of science based on observed cause and effect relationships.

Alternate: Develop predictions about investigations.

PO 4. Locate information (e.g., book, article, website) related to an investigation. (See W04-S3C6-01 and R04-S3C1-05)

Alternate: Identify a resource that could be used in an investigation.

Concept 2: Scientific Testing (Investigating and Modeling)

Participate in planning and conducting investigations, and recording data.

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

Alternate: Demonstrate safe behavior and appropriate procedures.

- PO 2. Plan a simple investigation that identifies the variables to be controlled.
- PO 3. Conduct controlled investigations (e.g., related to erosion, plant life cycles, weather, magnetism) in life, physical, and Earth and space sciences.
Alternate: Participate in an investigation.
- PO 4. Measure using appropriate tools (e.g., ruler, scale, balance) and units of measure (i.e., metric, U.S. customary). (See M04-S4C4-03 and M04-S4C4-07)
Alternate: Identify measurement tools needed.
- PO 5. Record data in an organized and appropriate format (e.g., t-chart, table, list, written log). (See W04-S3C2-01 and W04-S3C3-01)
Alternate: Record data in charts or logs.

Concept 3: Analysis and Conclusions

Organize and analyze data; compare to predictions.

- PO 1. Analyze data obtained in a scientific investigation to identify trends. (See M04-S2C1-03)
Alternate: Place given data on graphs, tables, and journals (pictograph, tally chart, tables).
- PO 2. Formulate conclusions based upon identified trends in data. (See M04-S2C1-03)
Alternate: Discuss conclusions based on data.
- PO 3. Determine that data collected is consistent with the formulated question.
- PO 4. Determine whether the data supports the prediction for an investigation.
- PO 5. Develop new questions and predictions based upon the data collected in the investigation.

Concept 4: Communication

Communicate results of investigations.

- PO 1. Communicate verbally or in writing the results of an inquiry. (See W04-S3C3-01)
Alternate: Communicate results of an investigation.
- PO 2. Choose an appropriate graphic representation for collected data:
 - bar graph
 - line graph
 - Venn diagram
 - Model (See M04-S2C1-02)
- PO 3. Communicate with other groups or individuals to compare the results of a common investigation.

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual and cultural contributions to scientific knowledge.

PO 1. Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., Margaret Mead [anthropologist], supports Strand 4; Nikola Tesla [engineer, inventor] supports Strand 5; Michael Faraday [scientist], supports Strand 5; Benjamin Franklin [scientist], supports Strand 5).

PO 2. Describe science-related career opportunities.
Alternate: Identify science-related careers.

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

PO 1. Explain the role of experimentation in scientific inquiry.

PO 2. Describe the interaction of components in a system (e.g., flashlight, radio).

PO 3. Explain various ways scientists generate ideas (e.g., observation, experiment, collaboration, theoretical and mathematical models).

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

PO 1. Describe how natural events and human activities have positive and negative impacts on environments (e.g., fire, floods, pollution, dams).

Alternate: Identify different natural events.

PO 2. Evaluate the consequences of environmental occurrences that happen either rapidly (e.g., fire, flood, tornado) or over a long period of time (e.g., drought, melting ice caps, the greenhouse effect, erosion).

Alternate: Identify the harmful impact of natural events.

Concept 2: Science and Technology in Society

Understand the impact of technology.

PO 1. Describe how science and technology (e.g., computers, air conditioning, medicine) have improved the lives of many people.

Alternate: Identify how technology improves lives.

PO 2. Describe benefits (e.g., easy communications, rapid transportation) and risks (e.g., pollution, destruction of natural resources) related to the use of technology.

PO 3. Design and construct a technological solution to a common problem or need using common materials.

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: Characteristics of Organisms

Understand that basic structures in plants and animals serve a function.

PO 1. Compare structures in plants (e.g., roots, stems, leaves, flowers) and animals (e.g., muscles, bones, nerves) that serve different functions in growth and survival.

Alternate: Identify parts of plants and animals.

PO 2. Classify animals by identifiable group characteristics:

- vertebrates – mammals, birds, fish, reptiles, amphibians
- invertebrates – insects, arachnids

Concept 2: Life Cycles

Understand the life cycles of plants and animals.

No performance objectives at this grade level

Concept 3: Organisms and Environments

Understand the relationships among various organisms and their environment.

PO 1. Describe ways various resources (e.g., air, water, plants, animals, soil) are utilized to meet the needs of a population.

Alternate: Identify what plants and animals need to survive.

PO 2. Differentiate renewable resources from nonrenewable resources.

PO 3. Analyze the effect that limited resources (e.g., natural gas, minerals) may have on an environment.

PO 4. Describe ways in which resources can be conserved (e.g., by reducing, reusing, recycling, finding substitutes).

Alternate: Demonstrate how to recycle or reuse.

Concept 4: Diversity, Adaptation, and Behavior

Identify plant and animal adaptations.

PO 1. Recognize that successful characteristics of populations are inherited traits that are favorable in a particular environment.

Alternate: Identify characteristics of animals or plants that help them to survive.

PO 2. Give examples of adaptations that allow plants and animals to survive.

- camouflage – horned lizards, coyotes
- mimicry – Monarch and Viceroy butterflies
- physical – cactus spines
- mutualism – species of acacia that harbor ants, which repel other harmful insects

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties of Objects and Materials

Classify objects and materials by their observable properties.

No performance objectives at this grade level

Concept 2: Position and Motion of Objects

Understand spatial relationships and the way objects move.

No performance objectives at this grade level

Concept 3: Energy and Magnetism

Investigate different forms of energy.

- PO 1. Demonstrate that electricity flowing in circuits can produce light, heat, sound, and magnetic effects.
- PO 2. Construct series and parallel electric circuits.
- PO 3. Explain the purpose of conductors and insulators in various practical applications.
- PO 4. Investigate the characteristics of magnets (e.g., opposite poles attract, like poles repel, the force between two magnet poles depends on the distance between them).
Alternate: Use magnets with a variety of objects.
- PO 5. State cause and effect relationships between magnets and circuitry.

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Properties of Earth Materials

Identify the basic properties of Earth materials.

No performance objectives at this grade level

Concept 2: Earth's Processes and Systems

Understand the processes acting on the Earth and their interaction with the Earth systems.

PO 1. Identify the Earth processes that cause erosion.

PO 2. Describe how currents and wind cause erosion and land changes.

Alternate: Describe the effect of wind on land.

PO 3. Describe the role that water plays in the following processes that alter the Earth's surface features:

- erosion
- deposition
- weathering

Alternate: Describe the effect of water on land.

PO 4. Compare rapid and slow processes that change the Earth's surface, including:

- rapid – earthquakes, volcanoes, floods
- slow – wind, weathering

PO 5. Identify the Earth events that cause changes in atmospheric conditions (e.g., volcanic eruptions, forest fires).

PO 6. Analyze evidence that indicates life and environmental conditions have changed (e.g., tree rings, fish fossils in desert regions, ice cores).

Concept 3: Changes in the Earth and Sky

Understand characteristics of weather conditions and climate.

PO 1. Identify the sources of water within an environment (e.g., ground water, surface water, atmospheric water, glaciers).

Alternate: Identify sources of water.

PO 2. Describe the distribution of water on the Earth's surface.

PO 3. Differentiate between weather and climate as they relate to the southwestern United States.

Alternate: Discuss local weather.

PO 4. Measure changes in weather (e.g., precipitation, wind speed, barometric pressure).

Alternate: Chart daily weather.

PO 5. Interpret the symbols on a weather map or chart to identify the following:

- temperatures
- fronts
- precipitation

Alternate: Identify symbols related to weather.

PO 6. Compare weather conditions in various locations (e.g., regions of Arizona, various U.S. cities, coastal vs. interior geographical regions).

Alternate: Discuss weather conditions in different seasons.

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Grade 5

Instruction for students identified as having a significant cognitive disability should be developed from Arizona's Alternate Academic Standards. Only those performance objectives that have an identified alternate are required. When developing lessons or activities aligned to the grade level alternate standards, teachers should consider individual student abilities and their need for accommodations, cues, manipulatives/objects, augmentative devices, and communication systems. In addition, the depth and breadth of the alternate academic standard can be simplified based on the student's current cognitive abilities. Teachers can also develop lessons using performance objectives without alternates for those students who have developed those specific skills.

The goal in the development of the standard was to assure that the six strands and five unifying concepts are interwoven into a fabric of science that represents the true nature of science. Students have the opportunity to develop both the skills and content knowledge necessary to be scientifically literate members of the community.

Strands 1, 2, and 3 are designed to be explicitly taught *and* embedded *within* each of the content Strands 4, 5, and 6, and are not intended to be taught in isolation. The processes, skills, and content of the first three strands are designed to "umbrella" and complement the content of Life Science, Physical Science, and Earth and Space Science.

Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Formulate predictions, questions, or hypotheses based on observations. Locate appropriate resources.

PO 1. Formulate a relevant question through observations that can be tested by an investigation. (See M05-S2C1-01)

Alternate: Develop questions about investigations.

PO 2. Formulate predictions in the realm of science based on observed cause and effect relationships.

Alternate: Develop predictions about investigations.

PO 3. Locate information (e.g., book, article, website) related to an investigation. (See W05-S3C6-01 and R05-S3C1-05)

Alternate: Identify a resource that could be used in an investigation.

Concept 2: Scientific Testing (Investigating and Modeling)

Design and conduct controlled investigations.

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

Alternate: Demonstrate safe behavior and appropriate procedures.

PO 2. Plan a simple investigation that identifies the variables to be controlled.

PO 3. Conduct simple investigations (e.g., related to forces and motion, Earth processes) based on student-developed questions in life, physical, and Earth and space sciences.

Alternate: Participate in an investigation.

PO 4. Measure using appropriate tools (e.g., ruler, scale, balance) and units of measure (i.e., metric, U.S. customary). (See M05-S4C4-01)

Alternate: Measure using appropriate tools.

PO 5. Record data in an organized and appropriate format (e.g., t-chart, table, list, written log). (See W05-S3C2-01 and W05-S3C3-01)

Alternate: Record data in charts or logs.

Concept 3: Analysis and Conclusions

Analyze and interpret data to explain correlations and results; formulate new questions.

PO 1. Analyze data obtained in a scientific investigation to identify trends and form conclusions. (See M05-S2C1-03)

Alternate: Place given data on graphs, tables, and journals (pictograph, tally chart, tables).

PO 2. Analyze whether the data is consistent with the proposed explanation that motivated the investigation.

PO 3. Evaluate the reasonableness of the outcome of an investigation.

PO 4. Develop new investigations and predictions based on questions that arise from the findings of

Alternate: Ask questions based on data.

PO 5. Identify possible relationships between variables in simple investigations (e.g., time and distance; incline and mass of object).

Concept 4: Communication

Communicate results of investigations.

PO 1. Communicate verbally or in writing the results of an inquiry. (See W05-S3C3-01)

Alternate: Communicate results of an investigation.

PO 2. Choose an appropriate graphic representation for collected data:

- bar graph
- line graph
- Venn diagram
- model (See M05-S2C1-02)

Alternate: Display data on a graph.

PO 3. Communicate with other groups or individuals to compare the results of a common investigation.

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual, cultural, and technological contributions to scientific knowledge.

PO 1. Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., Percy Lavon Julian [scientist], supports Strand 4; Niels Bohr [scientist], supports Strand 5; Edwin Hubble [scientist], supports Strand 6).

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

PO 1. Provide examples that support the premise that science is an ongoing process that changes in response to new information and discoveries (e.g., space exploration, medical advances).

PO 2. Explain the cycle by which new scientific knowledge generates new scientific inquiry.

PO 3. Describe how scientific knowledge is subject to modification and/or change as new information/technology challenges prevailing theories.

PO 4. Compare collaborative approaches that scientists use for investigations (e.g., teams, individual with peer review).

Alternate: Participate in different approaches of learning.

PO 5. Describe qualities of the scientists' habits of mind (e.g., openness, skepticism, integrity, tolerance).

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

- PO 1. Explain the impacts of natural hazards on habitats (e.g., global warming, floods, asteroid or large meteor impacts).
Alternate: Identify different natural events.
- PO 2. Propose a solution, resource, or product that addresses a specific human, animal, or habitat need.
- PO 3. Evaluate the possible strengths and weaknesses of a proposed solution to a specific problem relevant to human, animal, or habitat needs.

Concept 2: Science and Technology in Society

Develop viable solutions to a need or problem.

- PO 1. Describe the relationship between science and technology.
Alternate: Identify how technology has changed your life.
- PO 2. Explain how scientific knowledge, skills, and technological capabilities are integral to a variety of careers.
Alternate: Identify how technology is used in careers.
- PO 3. *Design and construct a technological solution to a common problem or need using common materials.*

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: Structure and Function in Living Systems

Understand the relationships between structures and functions of organisms.

PO 1. Identify the functions and parts of the skeletal system:

- protection – rib cage, cranium
- support – vertebrae
- movement – pelvis, femur, hip

Alternate: Identify that animals and humans have skeletons.

PO 2. Identify the following types of muscles:

- cardiac – heart
- smooth – stomach
- skeletal – biceps

Alternate: Identify that animals and humans have muscles.

PO 3. Identify the functions and parts of the nervous system:

- control center – brain
- relay mechanism – spinal cord
- transport messages – nerves

PO 4. Distinguish between voluntary and involuntary responses.

Concept 2: Reproduction and Heredity

Understand the basic principles of heredity.

No performance objectives at this grade level

Concept 3: Populations of Organisms in an Ecosystem

Analyze the relationships among various organisms and their environment.

No performance objectives at this grade level

Concept 4: Diversity, Adaptation, and Behavior

Identify structural and behavioral adaptations.

No performance objectives at this grade level

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties and Changes of Properties in Matter

Understand physical and chemical properties of matter.

PO 1. Identify that matter is made of smaller units called:

- molecules (e.g., H₂O, CO₂)
- atoms (e.g., H, N, Na)

PO 2. Distinguish between mixtures and compounds.

PO 3. Describe changes of matter:

- physical – cutting wood, ripping paper, freezing water
- chemical – burning of wood, rusting of iron, milk turning sour

Alternate: Demonstrate a physical change in matter.

Concept 2: Motion and Forces

Understand the relationship between force and motion.

PO 1. Describe the following forces:

- gravity
- friction

PO 2. Describe the various effects forces can have on an object (e.g., cause motion, halt motion, change direction of motion, cause deformation).

Alternate: Identify the effect of force on a person or object.

PO 3. Examine forces and motion through investigations using simple machines (e.g., wedge, plane, wheel and axle, pulley, lever).

PO 4. Demonstrate effects of variables on an object's motion (e.g., incline angle, friction, applied forces).

Concept 3: Transfer of Energy

Understand that energy can be stored and transferred.

No performance objectives at this grade level

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Structure of the Earth

Describe the composition and interactions between the structure of the Earth and its atmosphere.

No performance objectives at this grade level

Concept 2: Earth's Processes and Systems

Understand the processes acting on the Earth and their interaction with the Earth systems.

PO 1. Describe how the Moon's appearance changes during a four-week lunar cycle.

Alternate: Identify phases of the moon.

PO 2. Describe how Earth's rotation results in day and night at any particular location.

Alternate: Identify that Earth rotates and revolves around the sun.

PO 3. Distinguish between revolution and rotation.

PO 4. Describe the role of gravity as an attractive force between celestial objects.

Concept 3: Earth in the Solar System

Understand the relationships of the Earth and other objects in the solar system.

PO 1. Identify the known planets of the solar system.

Alternate: Identify any of the planets in the solar system.

PO 2. Describe the distinguishing characteristics of the known planets in the solar system.

PO 3. Describe various objects in the sky (e.g., asteroids, comets, stars, meteors/shooting stars).

PO 4. Describe the change in position and motion of the following objects in the sky over time:

- real motion – Moon, planets
- apparent motion (due to the motion of the Earth) – Sun, Moon, stars

PO 5. Explain the apparent motion of the Sun and stars.

PO 6. Describe efforts to explore space (e.g., Apollo missions, space shuttles, Hubble space telescope, space probes). (See Strand 2)

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Grade 6

Instruction for students identified as having a significant cognitive disability should be developed from Arizona's Alternate Academic Standards. Only those performance objectives that have an identified alternate are required. When developing lessons or activities aligned to the grade level alternate standards, teachers should consider individual student abilities and their need for accommodations, cues, manipulatives/objects, augmentative devices, and communication systems. In addition, the depth and breadth of the alternate academic standard can be simplified based on the student's current cognitive abilities. Teachers can also develop lessons using performance objectives without alternates for those students who have developed those specific skills.

The goal in the development of the standard was to assure that the six strands and five unifying concepts are interwoven into a fabric of science that represents the true nature of science. Students have the opportunity to develop both the skills and content knowledge necessary to be scientifically literate members of the community.

Strands 1, 2, and 3 are designed to be explicitly taught *and* embedded *within* each of the content Strands 4, 5, and 6, and are not intended to be taught in isolation. The processes, skills, and content of the first three strands are designed to "umbrella" and complement the content of Life Science, Physical Science, and Earth and Space Science.

Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Formulate predictions, questions, or hypotheses based on observations. Locate appropriate resources.

PO 1. Differentiate among a question, hypothesis, and prediction.

PO 2. Formulate questions based on observations that lead to the development of a hypothesis.
(See M06-S2C1-01)

Alternate: Formulate questions from observations.

PO 3. Locate research information, not limited to a single source, for use in the design of a controlled investigation.

(See W06-S3C6-01, R06-S3C1-06, and R06-S3C2-03)

Alternate: Identify a resource that could be used in an investigation.

Concept 2: Scientific Testing (Investigating and Modeling)

Design and conduct controlled investigations.

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

Alternate: Demonstrate safe behavior and appropriate procedures.

PO 2. Design an investigation to test individual variables using scientific processes.

Alternate: Participate in an investigation.

PO 3. Conduct a controlled investigation using scientific processes.

PO 4. Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers). (See M06-S4C4-02)

Alternate: Measure using appropriate tools.

PO 5. Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs. (See W06-S3C2-01 and W06-S3C3-01)

Alternate: Record data in charts or logs.

Concept 3: Analysis and Conclusions

Analyze and interpret data to explain correlations and results; formulate new questions.

PO 1. Analyze data obtained in a scientific investigation to identify trends. (See M06-S2C1-03)

Alternate: Place given data on graphs, tables, and journals (pictograph, tally charts, tables).

PO 2. Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events).

Alternate: Identify a cause and effect relationship in an investigation.

PO 3. Evaluate the observations and data reported by others.

Alternate: Ask questions based on data.

PO 4. Interpret simple tables and graphs produced by others.

PO 5. Analyze the results from previous and/or similar investigations to verify the results of the current investigation.

PO 6. Formulate new questions based on the results of a completed investigation.

Concept 4: Communication

Communicate results of investigations.

PO 1. Choose an appropriate graphic representation for collected data:

- line graph
- double bar graph
- stem and leaf plot
- histogram (See M06-S2C1-02)

PO 2. Display data collected from a controlled investigation. (See M06-S2C1-02)

Alternate: Display data from an investigation.

PO 3. Communicate the results of an investigation with appropriate use of qualitative and quantitative information. (See W06-S3C2-01)

PO 4. Create a list of instructions that others can follow in carrying out a procedure (without the use of personal pronouns). (See W06-S3C3-01)

PO 5. Communicate the results and conclusion of the investigation. (See W06-S3C6-02).

Alternate: Communicate the results of an investigation.

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual, cultural, and technological contributions to scientific knowledge.

- PO 1. Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., Jacques Cousteau [inventor, marine explorer], supports Strand 4; William Beebe [scientist], supports Strand 4; Thor Heyerdahl [anthropologist], supports Strand 6).*
- PO 2. Describe how a major milestone in science or technology has revolutionized the thinking of the time (e.g., Cell Theory, sonar, SCUBA, underwater robotics).
- PO 3. Analyze the impact of a major scientific development occurring within the past decade.
- PO 4. Describe the use of technology in science-related careers.
Alternate: Identify the use of technology in science-related careers.

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

- PO 1. Describe how science is an ongoing process that changes in response to new information and discoveries.
- PO 2. Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories.
- PO 3. Apply the following scientific processes to other problem solving or decision making situations:
- observing
 - questioning
 - communicating
 - comparing
 - measuring
 - classifying
 - predicting
 - organizing data
 - inferring
 - generating hypotheses
 - identifying variables

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

PO 1. Evaluate the effects of the following natural hazards:

- sandstorm
- hurricane
- tornado
- ultraviolet light
- lightning-caused fire

Alternate: Identify the effects of natural hazards.

PO 2. Describe how people plan for, and respond to, the following natural disasters:

- drought
- flooding
- tornadoes

Concept 2: Science and Technology in Society

Develop viable solutions to a need or problem.

PO 1. Propose viable methods of responding to an identified need or problem.

PO 2. Compare possible solutions to best address an identified need or problem.

Alternate: Identify a solution to a scientific problem.

PO 3. Design and construct a solution to an identified need or problem using simple classroom materials.

PO 4. Describe a technological discovery that influences science.

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: Structure and Function in Living Systems

Understand the relationships between structures and functions of organisms.

PO 1. Explain the importance of water to organisms.

Alternate: Identify the importance of water.

PO 2. Describe the basic structure of a cell, including:

- cell wall
- cell membrane
- nucleus

PO 3. Describe the function of each of the following cell parts:

- cell wall
- cell membrane
- nucleus

PO 4. Differentiate between plant and animal cells.

PO 5. Explain the hierarchy of cells, tissues, organs, and systems.

PO 6. Relate the following structures of living organisms to their functions:

Animals

- respiration – gills, lungs
- digestion – stomach, intestines
- circulation – heart, veins, arteries, capillaries
- locomotion – muscles, skeleton

Plants

- transpiration – stomata, roots, xylem, phloem
- absorption – roots, xylem, phloem
- response to stimulus (phototropism, hydrotropism, geotropism) – roots, xylem, phloem

Alternate: Identify the main parts of plants and animals and their functions.

PO 7. Describe how the various systems of living organisms work together to perform a vital function:

- respiratory and circulatory
- muscular and skeletal
- digestive and excretory

Concept 2: Reproduction and Heredity

Understand the basic principles of heredity.

No performance objectives at this grade level

Concept 3: Populations of Organisms in an Ecosystem

Analyze the relationships among various organisms and their environment.

PO 1. Explain that sunlight is the major source of energy for most ecosystems.

(See Strand 5 Concept 3 and Strand 6 Concept 2)

Alternate: Identify the importance of sunlight.

PO 2. Describe how the following environmental conditions affect the quality of life:

- water quality
- climate
- population density
- smog

Concept 4: Diversity, Adaptation, and Behavior

Identify structural and behavioral adaptations.

No performance objectives at this grade level

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties and Changes of Properties in Matter

Understand physical and chemical properties of matter.

No performance objectives at this grade level

Concept 2: Motion and Forces

Understand the relationship between force and motion.

No performance objectives at this grade level

Concept 3: Transfer of Energy

Understand that energy can be stored and transferred.

PO 1. Identify various ways in which electrical energy is generated using renewable and nonrenewable resources (e.g., wind, dams, fossil fuels, nuclear reactions).

Alternate: Identify energy.

PO 2. Identify several ways in which energy may be stored.

PO 3. Compare the following ways in which energy may be transformed:

- mechanical to electrical
- electrical to thermal

PO 4. Explain how thermal energy (heat energy) can be transferred by:

- conduction
- convection
- radiation

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Structure of the Earth

Describe the composition and interactions between the structure of the Earth and its atmosphere.

- PO 1. Describe the properties and the composition of the layers of the atmosphere.
- PO 2. Explain the composition, properties, and structure of the Earth's lakes and rivers.
Alternate: Identify Earth's different bodies of water.
- PO 3. Explain the composition, properties, and structures of the oceans' zones and layers.
- PO 4. Analyze the interactions between the Earth's atmosphere and the Earth's bodies of water.
- PO 5. Describe ways scientists explore the Earth's atmosphere and bodies of water.

Concept 2: Earth's Processes and Systems

Understand the processes acting on the Earth and their interaction with the Earth systems.

- PO 1. Explain how water is cycled in nature
- PO 2. Identify the distribution of water within or among the following:
- atmosphere
 - lithosphere
 - hydrosphere
- PO 3. Analyze the effects that bodies of water have on the climate of a region.
- PO 4. Analyze the following factors that affect climate:
- ocean currents
 - elevation
 - location
- Alternate: Identify that different locations on Earth have different climates.**
- PO 5. Analyze the impact of large-scale weather systems on the local weather.
- PO 6. Create a weather system model that includes:
- the Sun
 - the atmosphere
 - bodies of water

Concept 3: Earth in the Solar System

Understand the relationships of the Earth and other objects in the solar system.

No performance objectives at this grade level.

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Grade 7

Instruction for students identified as having a significant cognitive disability should be developed from Arizona's Alternate Academic Standards. Only those performance objectives that have an identified alternate are required. When developing lessons or activities aligned to the grade level alternate standards, teachers should consider individual student abilities and their need for accommodations, cues, manipulatives/objects, augmentative devices, and communication systems. In addition, the depth and breadth of the alternate academic standard can be simplified based on the student's current cognitive abilities. Teachers can also develop lessons using performance objectives without alternates for those students who have developed those specific skills.

The goal in the development of the standard was to assure that the six strands and five unifying concepts are interwoven into a fabric of science that represents the true nature of science. Students have the opportunity to develop both the skills and content knowledge necessary to be scientifically literate members of the community.

Strands 1, 2, and 3 are designed to be explicitly taught *and* embedded *within* each of the content Strands 4, 5, and 6, and are not intended to be taught in isolation. The processes, skills, and content of the first three strands are designed to "umbrella" and complement the content of Life Science, Physical Science, and Earth and Space Science.

Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Formulate predictions, questions, or hypotheses based on observations. Locate appropriate resources.

PO 1. *Formulate questions based on observations that lead to the development of a hypothesis. (See M07-S2C1-01)*

Alternate: Formulate questions from observations.

PO 2. Select appropriate resources for background information related to a question, for use in the design of a controlled investigation. (See W07-S3C6-01, R07-S3C1-06, and R07-S3C2-03)

Alternate: Identify a resource that could be used in an investigation.

PO 3. Explain the role of a hypothesis in a scientific inquiry.

Alternate: Predict an outcome of an experiment.

Concept 2: Scientific Testing (Investigating and Modeling)

Design and conduct controlled investigations.

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

Alternate: Demonstrate safe behavior and appropriate procedures.

PO 2. *Design an investigation to test individual variables using scientific processes.*

Alternate: Participate in an investigation.

PO 3. Conduct a controlled investigation, utilizing multiple trials, to test a hypothesis using scientific processes.

PO 4. Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers).

Alternate: Measure using appropriate tools.

PO 5. Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs. (See W07-S3C2-01 and W07-S3C3-01)

Alternate: Record data in charts or logs.

Concept 3: Analysis and Conclusions

Analyze and interpret data to explain correlations and results; formulate new questions.

PO 1. Analyze data obtained in a scientific investigation to identify trends.

Alternate: Place given data on graphs, tables, and journals (pictograph, tally charts, tables).

PO 2. Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events).

Alternate: Identify a cause and effect relationship in an investigation.

PO 3. Analyze results of data collection in order to accept or reject the hypothesis.

PO 4. Determine validity and reliability of results of an investigation.

PO 5. Formulate a conclusion based on data analysis.

PO 6. Refine hypotheses based on results from investigations.

PO 7. Formulate new questions based on the results of a previous investigation.

Alternate: Formulate questions that could be answered from an investigation.

Concept 4: Communication

Communicate results of investigations.

PO 1. Choose an appropriate graphic representation for collected data:

- line graph
- double bar graph
- stem and leaf plot
- histogram (See M07-S2C1-03)

Alternate: Select graphic representation for collected data.

PO 2. Display data collected from a controlled investigation. (See M07-S2C1-03)

Alternate: Display data from an investigation.

PO 3. Communicate the results of an investigation with appropriate use of qualitative and quantitative information. (See W07-S3C2-01)

Alternate: Communicate the results of an investigation.

PO 4. Write clear, step-by-step instructions for following procedures.

Alternate: Follow a list of instructions.

PO 5. Communicate the results and conclusion of the investigation. (See W07-S3C6-02)

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual, cultural, and technological contributions to scientific knowledge.

PO 1. Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., Rachel Carson [scientist], supports Strand 4; Luis Alvarez [scientist] and Walter Alvarez [scientist], support Strand 6; Percival Lowell [scientist], supports Strand 6; Copernicus [scientist], supports Strand 6).

Alternate: Identify important science-related people, past and present.

PO 2. Describe how a major milestone in science or technology has revolutionized the thinking of the time (e.g., global positioning system, telescopes, seismographs, photography).

PO 3. Analyze the impact of a major scientific development occurring within the past decade.

PO 4. Analyze the use of technology in science-related careers.

Alternate: Identify the use of technology in science-related careers.

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

PO 1. Describe how science is an ongoing process that changes in response to new information and discoveries.

PO 2. Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories.

PO 3. Apply the following scientific processes to other problem solving or decision making situations:

- *observing*
- *questioning*
- *communicating*
- *comparing*
- *measuring*
- *classifying*
- *predicting*
- *organizing data*
- *inferring*
- *generating hypotheses*
- *identifying variables*

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

PO 1. Analyze environmental risks (e.g., pollution, destruction of habitat) caused by human interaction with biological or geological systems.

Alternate: Identify environmental risks caused by humans.

PO 2. Analyze environmental benefits of the following human interactions with biological or geological systems:

- reforestation
- habitat restoration
- construction of dams

PO 3. Propose possible solutions to address the environmental risks in biological or geological systems.

Concept 2: Science and Technology in Society

Develop viable solutions to a need or problem.

PO 1. Propose viable methods of responding to an identified need or problem.

PO 2. Compare solutions to best address an identified need or problem.

PO 3. Design and construct a solution to an identified need or problem using simple classroom materials.

Alternate: Identify a solution to a problem in the classroom.

PO 4. Describe a scientific discovery that influences technology.

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: Structure and Function in Living Systems

Understand the relationships between structures and functions of organisms.

No performance objectives at this grade level

Concept 2: Reproduction and Heredity

Understand the basic principles of heredity.

No performance objectives at this grade level

Concept 3: Populations of Organisms in an Ecosystem

Analyze the relationships among various organisms and their environment.

PO 1. Compare food chains in a specified ecosystem and their corresponding food web.

Alternate: Identify food chains.

PO 2. Explain how organisms obtain and use resources to develop and thrive in:

- niches
- predator/prey relationships

PO 3. Analyze the interactions of living organisms with their ecosystems:

- limiting factors
- carrying capacity

PO 4. Evaluate data related to problems associated with population growth (e.g., overgrazing, forest management, invasion of non-native species) and the possible solutions.

PO 5. Predict how environmental factors (e.g., floods, droughts, temperature changes) affect survival rates in living organisms.

PO 6. Create a model of the interactions of living organisms within an ecosystem.

Concept 4: Diversity, Adaptation, and Behavior

Identify structural and behavioral adaptations.

No performance objectives at this grade level

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties and Changes of Properties in Matter
--

Understand physical and chemical properties of matter.
--

No performance objectives at this grade level

Concept 2: Motion and Forces

Understand the relationship between force and motion.

No performance objectives at this grade level

Concept 3: Transfer of Energy

Understand that energy can be stored and transferred.

No performance objectives at this grade level

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Structure of the Earth

Describe the composition and interactions between the structure of the Earth and its atmosphere.

PO 1. Classify rocks and minerals by the following observable properties:

- grain
- color
- texture
- hardness

Alternate: Sort rocks and minerals by observable properties.

PO 2. Describe the properties and the composition of the following major layers of the Earth:

- crust
- mantle
- core

Alternate: Identify the major parts of Earth (land, water, mountains, etc.).

PO 3. Explain the following processes involved in the formation of the Earth's structure:

- erosion
- deposition
- plate tectonics
- volcanism

PO 4. Describe how the rock and fossil record show that environmental conditions have changed over geologic and recent time.

Concept 2: Earth's Processes and Systems

Understand the processes acting on the Earth and their interaction with the Earth systems.

PO 1. Explain the rock cycle.

PO 2. Distinguish the components and characteristics of the rock cycle for the following types of rocks:

- igneous
- metamorphic
- sedimentary

PO 3. Analyze the evidence that lithospheric plate movements occur.

PO 4. Explain lithospheric plate movement as a result of convection.

PO 5. Relate plate boundary movements to their resulting landforms, including:

- mountains
- faults
- rift valleys
- trenches
- volcanoes

PO 6. Describe how earthquakes are measured.

Alternate: Identify earthquakes.

Concept 3: Earth in the Solar System

Understand the relationships of the Earth and other objects in the solar system.

PO 1. Explain the phases of the Moon in terms of the relative positions of the Earth, Sun, and Moon.

PO 2. Construct a model for the relative positions of the Earth, Sun, and Moon as they relate to corresponding eclipses.

Alternate: Identify the places of the sun, moon, and Earth.

PO 3. Explain the interrelationship between the Earth's tides and the Moon.

PO 4. Explain the seasons in the Northern and Southern Hemispheres in terms of the tilt of the Earth's axis relative to the Earth's revolution around the Sun.

Alternate: Identify seasons in North America.

PO 5. Identify the following major constellations visible (seasonally) from the Northern Hemisphere:

- Orion
- Ursa Major (Great Bear)
- Cygnus
- Scorpius
- Cassiopeia

PO 6. Explain the relationship among common objects in the solar system, galaxy, and the universe.

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

Grade 8

Instruction for students identified as having a significant cognitive disability should be developed from Arizona's Alternate Academic Standards. Only those performance objectives that have an identified alternate are required. When developing lessons or activities aligned to the grade level alternate standards, teachers should consider individual student abilities and their need for accommodations, cues, manipulatives/objects, augmentative devices, and communication systems. In addition, the depth and breadth of the alternate academic standard can be simplified based on the student's current cognitive abilities. Teachers can also develop lessons using performance objectives without alternates for those students who have developed those specific skills.

The goal in the development of the standard was to assure that the six strands and five unifying concepts are interwoven into a fabric of science that represents the true nature of science. Students have the opportunity to develop both the skills and content knowledge necessary to be scientifically literate members of the community.

Strands 1, 2, and 3 are designed to be explicitly taught *and* embedded *within* each of the content Strands 4, 5, and 6, and are not intended to be taught in isolation. The processes, skills, and content of the first three strands are designed to "umbrella" and complement the content of Life Science, Physical Science, and Earth and Space Science.

Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Formulate predictions, questions, or hypotheses based on observations. Locate appropriate resources.

PO 1. *Formulate questions based on observations that lead to the development of a hypothesis.*
(See M08-S2C1-01)

Alternate: *Formulate questions from observations.*

PO 2. Use appropriate research information, not limited to a single source, to use in the development of a testable hypothesis.

(See W08-S3C6-01, R08-S3C1-06, and R08-S3C2-03)

Alternate: *Identify a resource that could be used in an investigation.*

PO 3. Generate a hypothesis that can be tested.

Alternate: *Predict an outcome of an experiment.*

Concept 2: Scientific Testing (Investigating and Modeling)

Design and conduct controlled investigations.

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

Alternate: *Demonstrate safe behavior and appropriate procedures.*

PO 2. Design a controlled investigation to support or reject a hypothesis.

Alternate: Participate in the design of an investigation.

PO 3. Conduct a controlled investigation to support or reject a hypothesis.

Alternate: Participate in an experiment.

PO 4. *Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers).*

Alternate: Measure using appropriate tools.

PO 5. *Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs. (See W08-S3C2-01 and W08-S3C3-01)*

Alternate: Record data in charts or logs.

Concept 3: Analysis and Conclusions

Analyze and interpret data to explain correlations and results; formulate new questions.

PO 1. *Analyze data obtained in a scientific investigation to identify trends. (See M08-S2C1-08)*

Alternate: Analyze data obtained in a scientific investigation.

PO 2. *Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events).*

Alternate: Demonstrate a cause and effect relationship.

PO 3. Interpret data that show a variety of possible relationships between two variables, including:

- positive relationship
- negative relationship
- no relationship

PO 4. Formulate a future investigation based on the data collected.

PO 5. Explain how evidence supports the validity and reliability of a conclusion.

PO 6. Identify the potential investigational error that may occur (e.g., flawed investigational design, inaccurate measurement, computational errors, unethical reporting).

Alternate: Explain the outcome of an experiment.

PO 7. Critique scientific reports from periodicals, television, or other media.

Alternate: Locate scientific reports from television or internet.

PO 8. *Formulate new questions based on the results of a previous investigation.*

Alternate: Formulate questions that could be answered from an investigation.

Concept 4: Communication

Communicate results of investigations.

PO 1. Communicate the results of an investigation.

Alternate: Communicate the results of an investigation.

PO 2. Choose an appropriate graphic representation for collected data:

- line graph
- double bar graph
- stem and leaf plot
- histogram (See M08-S2C1-03)

Alternate: Select graphic representation for collected data.

PO 3. Present analyses and conclusions in clear, concise formats. (See W08-S3C6-02)

PO 4. Write clear, step-by-step instructions for conducting investigations or operating equipment (without the use of personal pronouns). (See W08-S3C3-01)

Alternate: Communicate step-by-step instructions for an investigation.

PO 5. Communicate the results and conclusion of the investigation. See W08-S3C6-02)

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual, cultural, and technological contributions to scientific knowledge.

PO 1. *Identify how diverse people and/or cultures, past and present, have made important contributions to scientific innovations (e.g., Watson and Crick [scientists], support Strand 4; Rosalind Franklin [scientist], supports Strand 4; Charles Darwin [scientist], supports Strand 4; George Washington Carver [scientist, inventor], supports Strand 4; Joseph Priestley [scientist], supports Strand 5; Sir Frances Bacon [philosopher], supports Strand 5; Isaac Newton [scientist], supports Strand 5).*

PO 2. Evaluate the effects of the following major scientific milestones on society:

- Mendelian Genetics
- Newton's Law

PO 3. Evaluate the impact of a major scientific development occurring within the past decade.

PO 4. Evaluate career opportunities related to life and physical sciences.

Alternate: Identify careers related to science.

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

PO 1. *Apply the following scientific processes to other problem solving or decision making situations:*

- *observing*
- *questioning*
- *communicating*
- *comparing*
- *measuring*
- *classifying*
- *predicting*
- *organizing data*
- *inferring*
- *generating hypotheses*
- *identifying variables*

PO 2. *Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories.*

PO 3. Defend the principle that accurate record keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society.

PO 4. Explain why scientific claims may be questionable if based on very small samples of data, biased samples, or samples for which there was no control.

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

PO 1. Analyze the risk factors associated with natural, human induced, and/or biological hazards, including:

- waste disposal of industrial chemicals
- greenhouse gases

Alternate: Identify environmental risks caused by humans.

PO 2. Analyze possible solutions to address the environmental risks associated with chemicals and biological systems.

Alternate: Identify possible solutions to address environmental risks.

Concept 2: Science and Technology in Society

Develop viable solutions to a need or problem.

PO 1. Propose viable methods of responding to an identified need or problem.

PO 2. Compare solutions to best address an identified need or problem.

PO 3. Design and construct a solution to an identified need or problem using simple classroom materials.

Alternate: Identify a solution to a problem in the classroom.

PO 4. Compare risks and benefits of the following technological advances:

- radiation treatments
- genetic engineering (See Strand 4 Concept 2)
- airbags (See Strand 5 Concept 2)

Alternate: Identify benefits of technological advances.

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: Structure and Function in Living Systems

Understand the relationships between structures and functions of organisms.

No performance objectives at this grade level

Concept 2: Reproduction and Heredity

Understand the basic principles of heredity.

PO 1. Explain the purposes of cell division:

- growth and repair
- reproduction

PO 2. Explain the basic principles of heredity using the human examples of:

- eye color
- widow's peak
- blood type

Alternate: Identify the basic principles of heredity.

PO 3. Distinguish between the nature of dominant and recessive traits in humans.

Concept 3: Populations of Organisms in an Ecosystem

Analyze the relationships among various organisms and their environment.

No performance objectives at this grade level

Concept 4: Diversity, Adaptation, and Behavior

Identify structural and behavioral adaptations.

PO 1. Explain how an organism's behavior allows it to survive in an environment.

PO 2. Describe how an organism can maintain a stable internal environment while living in a constantly changing external environment.

PO 3. Determine characteristics of organisms that could change over several generations.

PO 4. Compare the symbiotic and competitive relationships in organisms within an ecosystem (e.g., lichen, mistletoe/tree, clownfish/sea anemone, native/non-native species).

PO 5. Analyze the following behavioral cycles of organisms:

- hibernation
- migration
- dormancy (plants)

Alternate: Identify organisms that hibernate, migrate, and that are dormant.

PO 6. Describe the following factors that allow for the survival of living organisms:

- protective coloration
- beak design
- seed dispersal
- pollination

Alternate: Identify characteristics that help animals in survival.

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Properties and Changes of Properties in Matter

Understand physical and chemical properties of matter.

PO 1. Identify different kinds of matter based on the following physical properties:

- states
- density
- boiling point
- melting point
- solubility

Alternate: Identify states of matter.

PO 2. Identify different kinds of matter based on the following chemical properties:

- reactivity
- pH
- oxidation (corrosion)

PO 3. Identify the following types of evidence that a chemical reaction has occurred:

- formation of a precipitate
- generation of gas
- color change
- absorption or release of heat

PO 4. Classify matter in terms of elements, compounds, or mixtures.

PO 5. Classify mixtures as being homogeneous or heterogeneous.

PO 6. Explain the systematic organization of the periodic table.

PO 7. Investigate how the transfer of energy can affect the physical and chemical properties of matter.

Alternate: Identify the transfer of energy and its effects on matter.

Concept 2: Motion and Forces

Understand the relationship between force and motion.

PO 1. Demonstrate velocity as the rate of change of position over time.

PO 2. Identify the conditions under which an object will continue in its state of motion (Newton's 1st Law of Motion).

PO 3. Describe how the acceleration of a body is dependent on its mass and the net applied force (Newton's 2nd Law of Motion).

PO 4. Describe forces as interactions between bodies (Newton's 3rd Law of Motion).

Alternate: Identify forces as interactions between bodies (Newton's 3rd Law of Motion).

PO 5. Create a graph devised from measurements of moving objects and their interactions, including:

- position-time graphs
- velocity-time graphs

Concept 3: Transfer of Energy

Understand that energy can be stored and transferred.

No performance objectives at this grade level

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Structure of the Earth

Describe the composition and interactions between the structure of the Earth and its atmosphere.

No performance objectives at this grade level

Concept 2: Earth's Processes and Systems

Understand the processes acting on the Earth and their interaction with the Earth systems.

No performance objectives at this grade level

Concept 3: Earth in the Solar System

Understand the relationships of the Earth and other objects in the solar system.

No performance objectives at this grade level

SCIENCE STANDARD ARTICULATED BY GRADE LEVEL

High School

Instruction for students identified as having a significant cognitive disability should be developed from Arizona's Alternate Academic Standards. Only those performance objectives that have an identified alternate are required. When developing lessons or activities aligned to the grade level alternate standards, teachers should consider individual student abilities and their need for accommodations, cues, manipulatives/objects, augmentative devices, and communication systems. In addition, the depth and breadth of the alternate academic standard can be simplified based on the student's current cognitive abilities. Teachers can also develop lessons using performance objectives without alternates for those students who have developed those specific skills.

The Arizona high school science standard was designed to support the instruction and assessment of students. Science instruction should involve students actively using scientific processes to understand course content and make connections to real life and related areas of study. The goal in the development of the standard was to assure that the six strands and five unifying concepts are interwoven into a fabric of science that represents the true nature of science. Students have the opportunity to develop both the skills and content knowledge necessary to be scientifically literate members of the community.

Strands 1, 2, and 3 (Inquiry Process, History and Nature of Science, and Science in Personal and Social Perspective) contain the processes and connections desired of Arizona students and must, therefore, be reflected in all science courses. These strands are designed to be explicitly taught *and* embedded *within* each of the content Strands 4, 5, and 6, and are not intended to be taught in isolation. The processes, skills, and content of the first three strands are designed to "umbrella" and complement the content of Life Science, Physical Science, and Earth and Space Science.

At the high school level, Strands 4, 5, and 6 (Life Science, Physical Science, and Earth and Space Science) contain content area knowledge and skills that are, by nature, course specific. These strands were written to provide frameworks for complete courses in Life, Physics, Chemistry, and Earth and Space sciences.

The high school science Arizona Instrument to Measure Standards (AIMS) will be administered as an end of course test. For each course tested, all performance objectives in Strands 1, 2 and 3 may be included on the assessment. Depending on the course tested, performance objectives from Strand 4, 5, or 6, will be measured. For example, an end of course AIMS for high school biology could include performance objectives from Strands 1, 2, 3, and 4. A blueprint of the Science AIMS will be available following test development.

Strand 1: Inquiry Process

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concept 1: Observations, Questions, and Hypotheses

Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.

PO 1. Evaluate scientific information for relevance to a given problem. (See R09-S3C1, R10-S3C1, R11-S3C1, and R12-S3C1)

Alternate: Identify scientific information.

PO 2. Develop questions from observations that transition into testable hypotheses.

Alternate: Formulate questions from observations.

PO 3. Formulate a testable hypothesis.

PO 4. Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).

Alternate: Predict an outcome of an investigation.

Concept 2: Scientific Testing (Investigating and Modeling)

Design and conduct controlled investigations.

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

Alternate: Demonstrate safe behavior and appropriate procedures.

PO 2. Identify the resources needed to conduct an investigation.

Alternate: Identify materials or resources needed to conduct an investigation.

PO 3. Design an appropriate protocol (written plan of action) for testing a hypothesis:

- Identify dependent and independent variables in a controlled investigation.
- Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes).
- Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators).

Alternate: Participate in the design of an investigation.

PO 4. Conduct a scientific investigation that is based on a research design.

Alternate: Conduct an investigation.

PO 5. Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.

Alternate: Record data in charts or logs.

Concept 3: Analysis, Conclusions, and Refinements

Evaluate experimental design, analyze data to explain results and propose further investigations.

Design models.

PO 1. Interpret data that show a variety of possible relationships between variables, including:

- positive relationship
- negative relationship
- no relationship

Alternate: Answer questions about data from an investigation.

PO 2. Evaluate whether investigational data support or do not support the proposed hypothesis.

Alternate: Draw conclusions based on data from an investigation.

PO 3. Critique reports of scientific studies (e.g., published papers, student reports).

- PO 4. Evaluate the design of an investigation to identify possible sources of procedural error, including:
- sample size
 - trials
 - controls
 - analyses
- PO 5. Design models (conceptual or physical) of the following to represent "real world" scenarios:
- carbon cycle
 - water cycle
 - phase change
 - collisions
- PO 6. Use descriptive statistics to analyze data, including:
- mean
 - frequency
 - range (See MHS-S2C1-10)
- PO 7. Propose further investigations based on the findings of a conducted investigation.

Concept 4: Communication

Communicate results of investigations.

- PO 1. For a specific investigation, choose an appropriate method for communicating the results.
(See W09-S3C2-01 and W10-S3C3-01)
Alternate: *Communicate the results of an investigation.*
- PO 2. Produce graphs that communicate data. (See MHS-S2C1-02)
Alternate: **Create graphs that communicate data.**
- PO 3. Communicate results clearly and logically.
- PO 4. Support conclusions with logical scientific arguments.

Strand 2: History and Nature of Science

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concept 1: History of Science as a Human Endeavor

Identify individual, cultural, and technological contributions to scientific knowledge.

PO 1. Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.

PO 2. Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.

PO 3. Analyze how specific changes in science have affected society.

PO 4. Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.

Alternate: Identify how science has impacted society.

Concept 2: Nature of Scientific Knowledge

Understand how science is a process for generating knowledge.

PO 1. Specify the requirements of a valid, scientific explanation (theory), including that it be:

- logical
- subject to peer review
- public
- respectful of rules of evidence

PO 2. Explain the process by which accepted ideas are challenged or extended by scientific innovation.

PO 3. Distinguish between pure and applied science.

PO 4. Describe how scientists continue to investigate and critically analyze aspects of theories.

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

PO 1. Evaluate how the processes of natural ecosystems affect, and are affected by, humans.

Alternate: Identify how humans effect the environment.

PO 2. Describe the environmental effects of the following natural and/or human-caused hazards:

- flooding
- drought
- earthquakes
- fires
- pollution
- extreme weather

Alternate: Identify natural and human-caused hazards.

PO 3. Assess how human activities (e.g., clear cutting, water management, tree thinning) can affect the potential for hazards.

PO 4. Evaluate the following factors that affect the quality of the environment:

- urban development
- smoke
- volcanic dust

PO 5. Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity.

Concept 2: Science and Technology in Society

Develop viable solutions to a need or problem.

PO 1. Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems:

- various forms of alternative energy
- storage of nuclear waste
- abandoned mines
- greenhouse gases
- hazardous wastes

PO 2. Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.

PO 3. Support a position on a science or technology issue.

PO 4. Analyze the use of renewable and nonrenewable resources in Arizona:

- water
- land
- soil
- minerals
- air

Alternate: Identify ways to conserve resources in the environment.

PO 5. Evaluate methods used to manage natural resources (e.g., reintroduction of wildlife, fire ecology).

Concept 3: Human Population Characteristics

Analyze factors that affect human populations.

PO 1. Analyze social factors that limit the growth of a human population, including:

- affluence
- education
- access to health care
- cultural influences

Alternate: Identify factors that can affect health.

PO 2. Describe biotic (living) and abiotic (nonliving) factors that affect human populations.

PO 3. Predict the effect of a change in a specific factor on a human population.

Strand 4: Life Science

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 1: The Cell

Understand the role of the cell and cellular processes.

- PO 1. Describe the role of energy in cellular growth, development, and repair.
Alternate: Identify how energy plays a role in growth and development.
- PO 2. Compare the form and function of prokaryotic and eukaryotic cells and their cellular components.
- PO 3. Explain the importance of water to cells.
- PO 4. Analyze mechanisms of transport of materials (e.g., water, ions, macromolecules) into and out of cells:
- passive transport
 - active transport
- PO 5. Describe the purposes and processes of cellular reproduction.

Concept 2: Molecular Basis of Heredity

Understand the molecular basis of heredity and resulting genetic diversity.

- PO 1. Analyze the relationships among nucleic acids (DNA, RNA), genes, and chromosomes.
- PO 2. Describe the molecular basis of heredity, in viruses and living things, including DNA replication and protein synthesis.
- PO 3. Explain how genotypic variation occurs and results in phenotypic diversity.
Alternate: Compare personal traits to family traits.
- PO 4. Describe how meiosis and fertilization maintain genetic variation.

Concept 3: Interdependence of Organisms

Analyze the relationships among various organisms and their environment.

- PO 1. Identify the relationships among organisms within populations, communities, ecosystems, and biomes.
Alternate: Identify the relationship between organisms living in the same environment.
- PO 2. Describe how organisms are influenced by a particular combination of biotic (living) and abiotic (nonliving) factors in an environment.
Alternate: Identify how organisms are influenced by factors in the environment.
- PO 3. Assess how the size and the rate of growth of a population are determined by birth rate, death rate, immigration, emigration, and carrying capacity of the environment.

Concept 4: Biological Evolution

Understand the scientific principles and processes involved in biological evolution.

- PO 1. Identify the following components of natural selection, which can lead to speciation:
- potential for a species to increase its numbers
 - genetic variability and inheritance of offspring due to mutation and recombination of genes
 - finite supply of resources required for life
 - selection by the environment of those offspring better able to survive and produce offspring
- Alternate: Identify characteristics of animals that help them to exist in their environments.**
- PO 2. Explain how genotypic and phenotypic variation can result in adaptations that influence an organism's success in an environment.
- PO 3. Describe how the continuing operation of natural selection underlies a population's ability to adapt to changes in the environment and leads to biodiversity and the origin of new species.
- PO 4. Predict how a change in an environmental factor (e.g., rainfall, habitat loss, non-native species) can affect the number and diversity of species in an ecosystem.
- PO 5. Analyze how patterns in the fossil record, nuclear chemistry, geology, molecular biology, and geographical distribution give support to the theory of organic evolution through natural selection over billions of years and the resulting present day biodiversity.
- PO 6. Analyze, using a biological classification system (i.e., cladistics, phylogeny, morphology, DNA analysis), the degree of relatedness among various species.
- Alternate: Classify the characteristics of organisms.**

Concept 5: Matter, Energy, and Organization in Living Systems (Including Human Systems)

Understand the organization of living systems, and the role of energy within those systems.

- PO 1. Compare the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products.
- Alternate: Identify photosynthesis.**
- PO 2. Describe the role of organic and inorganic chemicals (e.g., carbohydrates, proteins, lipids, nucleic acids, water, ATP) important to living things.
- PO 3. Diagram the following biogeochemical cycles in an ecosystem:
- water
 - carbon
 - nitrogen
- Alternate: Identify the water cycle.**
- PO 4. Diagram the energy flow in an ecosystem through a food chain.
- Alternate: Identify the energy flow of a food chain.**
- PO 5. Describe the levels of organization of living things from cells, through tissues, organs, organ systems, organisms, populations, and communities to ecosystems.

Strand 5: Physical Science

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concept 1: Structure and Properties of Matter

Understand physical, chemical, and atomic properties of matter.

- PO 1. Describe substances based on their physical properties.
Alternate: Identify substances based on their physical properties.
- PO 2. Describe substances based on their chemical properties.
- PO 3. Predict properties of elements and compounds using trends of the periodic table (e.g., metals, non-metals, bonding – ionic/covalent).
- PO 4. Separate mixtures of substances based on their physical properties.
- PO 5. Describe the properties of electric charge and the conservation of electric charge.
Alternate: Identify an electric charge.
- PO 6. Describe the following features and components of the atom:
- protons
 - neutrons
 - electrons
 - mass
 - number and type of particles
 - structure
 - organization
- PO 7. Describe the historical development of models of the atom.
- PO 8. Explain the details of atomic structure (e.g., electron configuration, energy levels, isotopes).

Concept 2: Motions and Forces

Analyze relationships between forces and motion.

- PO 1. Determine the rate of change of a quantity (e.g., rate of erosion, rate of reaction, rate of growth, velocity).
- PO 2. Analyze the relationships among position, velocity, acceleration, and time:
- graphically
 - mathematically

- PO 3. Explain how Newton's 1st Law applies to objects at rest or moving at constant velocity.
Alternate: Demonstrate an example of Newton's 1st Law of Motion applied to different objects.
- PO 4. Using Newton's 2nd Law of Motion, analyze the relationships among the net force acting on a body, the mass of the body, and the resulting acceleration:
- graphically
 - mathematically
- PO 5. Use Newton's 3rd Law to explain forces as interactions between bodies (e.g., a table pushing up on a vase that is pushing down on it; an athlete pushing on a basketball as the ball pushes back on her).
- PO 6. Analyze the two-dimensional motion of objects by using vectors and their components.
- PO 7. Give an example that shows the independence of the horizontal and vertical components of projectile motion.
- PO 8. Analyze the general relationships among force, acceleration, and motion for an object undergoing uniform circular motion.
- PO 9. Represent the force conditions required to maintain static equilibrium.
- PO 10. Describe the nature and magnitude of frictional forces.
Alternate: Identify different frictional forces.
- PO 11. Using the Law of Universal Gravitation, predict how the gravitational force will change when the distance between two masses changes or the mass of one of them changes.
- PO 12. Using Coulomb's Law, predict how the electrical force will change when the distance between two point charges changes or the charge of one of them changes.
- PO 13. Analyze the impulse required to produce a change in momentum.
- PO 14. Quantify interactions between objects to show that the total momentum is conserved in both collision and recoil situations.

Concept 3: Conservation of Energy and Increase in Disorder

Understand ways that energy is conserved, stored, and transferred.

- PO 1. Describe the following ways in which energy is stored in a system:
- mechanical
 - electrical
 - chemical
 - nuclear
- PO 2. Describe various ways in which energy is transferred from one system to another (e.g., mechanical contact, thermal conduction, electromagnetic radiation.)
- PO 3. Recognize that energy is conserved in a closed system.
- PO 4. Calculate quantitative relationships associated with the conservation of energy.
- PO 5. Analyze the relationship between energy transfer and disorder in the universe (2nd Law of Thermodynamics).

PO 6. Distinguish between heat and temperature.
Alternate: Identify heat and temperature.

PO 7. Explain how molecular motion is related to temperature and phase changes.

Concept 4: Chemical Reactions

Investigate relationships between reactants and products in chemical reactions.

PO 1. Apply the law of conservation of matter to changes in a system.

PO 2. Identify the indicators of chemical change, including formation of a precipitate, evolution of a gas, color change, absorption or release of heat energy.

PO 3. Represent a chemical reaction by using a balanced equation.

PO 4. Distinguish among the types of bonds (i.e., ionic, covalent, metallic, hydrogen bonding).

PO 5. Describe the mole concept and its relationship to Avogadro's number.

PO 6. Solve problems involving such quantities as moles, mass, molecules, volume of a gas, and molarity using the mole concept and Avogadro's number.

PO 7. Predict the properties (e.g., melting point, boiling point, conductivity) of substances based upon bond type.

Alternate: Identify boiling and freezing different liquids and solids.

PO 8. Quantify the relationships between reactants and products in chemical reactions (e.g., stoichiometry, equilibrium, energy transfers).

PO 9. Predict the products of a chemical reaction using types of reactions (e.g., synthesis, decomposition, replacement, combustion).

PO 10. Explain the energy transfers within chemical reactions using the law of conservation of energy.

PO 11. Predict the effect of various factors (e.g., temperature, concentration, pressure, catalyst) on the equilibrium state and on the rates of chemical reaction.

PO 12. Compare the nature, behavior, concentration, and strengths of acids and bases.

PO 13. Determine the transfer of electrons in oxidation/reduction reactions.

Concept 5: Interactions of Energy and Matter

Understand the interactions of energy and matter.

PO 1. Describe various ways in which matter and energy interact (e.g., photosynthesis, phase change).

PO 2. Describe the following characteristics of waves:

- wavelength
- frequency
- period
- amplitude

PO 3. Quantify the relationships among the frequency, wavelength, and the speed of light.

- PO 4. Describe the basic assumptions of kinetic molecular theory.
- PO 5. Apply kinetic molecular theory to the behavior of matter (e.g., gas laws).
- PO 6. Analyze calorimetric measurements in simple systems and the energy involved in changes of state.
Alternate: Identify measurement of calories.
- PO 7. Explain the relationship between the wavelength of light absorbed or released by an atom or molecule and the transfer of a discrete amount of energy.
- PO 8. Describe the relationship among electric potential, current, and resistance in an ohmic system.
- PO 9. Quantify the relationships among electric potential, current, and resistance in an ohmic system.

Strand 6: Earth and Space Science

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concept 1: Geochemical Cycles

Analyze the interactions between the Earth's structures, atmosphere, and geochemical cycles.

- PO 1. Identify ways materials are cycled within the Earth system (i.e., carbon cycle, water cycle, rock cycle).
- PO 2. Demonstrate how dynamic processes such as weathering, erosion, sedimentation, metamorphism, and orogenesis relate to redistribution of materials within the Earth system.
- PO 3. Explain how the rock cycle is related to plate tectonics.
- PO 4. Demonstrate how the hydrosphere links the biosphere, lithosphere, cryosphere, and atmosphere.
- PO 5. Describe factors that impact current and future water quantity and quality including surface, ground, and local water issues.
- PO 6. Analyze methods of reclamation and conservation of water.
Alternate: Identify ways to save water.
- PO 7. Explain how the geochemical processes are responsible for the concentration of economically valuable minerals and ores in Arizona and worldwide.

Concept 2: Energy in the Earth System (Both Internal and External)

Understand the relationships between the Earth's land masses, oceans, and atmosphere.

- PO 1. Describe the flow of energy to and from the Earth.
 - PO 2. Explain the mechanisms of heat transfer (convection, conduction, radiation) among the atmosphere, land masses, and oceans.
 - PO 3. Distinguish between weather and climate.
Alternate: Identify weather and climate.
- Internal Energy:**
- PO 4. Demonstrate the relationship between the Earth's internal convective heat flow and plate tectonics.
 - PO 5. Demonstrate the relationships among earthquakes, volcanoes, mountain ranges, mid-oceanic ridges, deep sea trenches, and tectonic plates.
 - PO 6. Distinguish among seismic S, P, and surface waves.

PO 7. Analyze the seismic evidence (S and P waves) used to determine the structure of the Earth.

PO 8. Describe how radioactive decay maintains the Earth's internal temperature.

External Energy:

PO 9. Explain the effect of heat transfer on climate and weather.

PO 10. Demonstrate the effect of the Earth's rotation (i.e., Coriolis effect) on the movement of water and air.

PO 11. Describe the origin, life cycle, and behavior of weather systems (i.e., air mass, front, high and low systems, pressure gradients).

PO 12. Describe the conditions that cause severe weather (e.g., hurricanes, tornadoes, thunderstorms).

Alternate: Identify conditions that cause severe weather.

PO 13. Propose appropriate safety measures that can be taken in preparation for severe weather.

Alternate: Identify safety measures that can be taken in preparation for severe weather.

PO 14. Analyze how weather is influenced by both natural and artificial Earth features (e.g., mountain ranges, bodies of water, cities, air pollution).

PO 15. List the factors that determine climate (e.g., altitude, latitude, water bodies, precipitation, prevailing winds, topography).

PO 16. Explain the causes and/or effects of climate changes over long periods of time (e.g., glaciation, desertification, solar activity, greenhouse effect).

PO 17. Investigate the effects of acid rain, smoke, volcanic dust, urban development, and greenhouse gases, on climate change over various periods of time.

Concept 3: Origin and Evolution of the Earth System

Analyze the factors used to explain the history and evolution of the Earth.

Earth Origin/System:

PO 1. Describe the scientific theory of the origin of the solar system (solar nebular hypothesis).

PO 2. Describe the characteristics, location, and motions of the various kinds of objects in our solar system, including the Sun, planets, satellites, comets, meteors, and asteroids.

PO 3. Explain the phases of the Moon, eclipses (lunar and solar), and the interaction of the Sun, Moon, and Earth (tidal effect).

Earth History/Evolution:

PO 4. Interpret a geologic time scale.

PO 5. Distinguish between relative and absolute geologic dating techniques.

PO 6. Investigate scientific theories of how life originated on Earth (high temperature, low oxygen, clay catalyst model).

- PO 7. Describe how life on Earth has influenced the evolution of the Earth's systems.
- PO 8. Sequence major events in the Earth's evolution (e.g., mass extinctions, glacial episodes) using relative and absolute dating data.
- PO 9. Analyze patterns in the fossil record related to the theory of organic evolution.

Concept 4: Origin and Evolution of the Universe

Analyze the factors used to explain the origin and evolution of the universe.

- PO 1. Describe the Big Bang Theory as an explanation for the origin of the universe.
- PO 2. Describe the fusion process that takes place in stars.
- PO 3. Analyze the evolution of various types of stars using the Hertzsprung-Russell (HR) diagram.
- PO 4. Compare the evolution (life cycles) of stars of different masses (low and high mass).
- PO 5. Explain the formation of the light elements in stars and the heavier elements (what astronomers call "metals") in supernova explosions.
- PO 6. Explain the evolution and life cycles of galaxies.