SCIENCE

ARIZONA ACADEMIC CONTENT STANDARDS

SCIENCE

Articulated by Grade Level

Approved by Arizona State Board of Education
May 24, 2004
(Updated March 10, 2005)

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EXTERNAL REVIEWERS/CONSULTANTS

Reynaldo Gomez, Ph.D., (Arizona State University) is an Associate Professor of Early Childhood Education. He teaches undergraduate and graduate courses in early childhood education curriculum and play, and classroom organization and management. His research focus is on children's play as it relates to their growth and development, parental involvement in early childhood programs, and the development of appropriate playgrounds for children.

Thomas M. Haladyna, Ph.D., (Arizona State University West) is a Professor of Educational Psychology and a nationally known expert on testing. He has received a yearlong appointment as a visiting scholar at the Educational Testing Service (ETS) in Princeton, N.J., and participated in the National Assessment of Educational Progress Testing Program. He has written several books and journal articles about achievement testing and has served as a consultant on testing issues for many clients, including state departments of education, school districts, and national certification and licensing boards. Dr. Haladyna's research focuses on test score validity. He is a member of the National Assessment and Accountability Advisory Committee for the Arizona Department of Education.

Lawrence S. Lerner, Ph.D. (California State University, Long Beach) is Professor Emeritus of Physics and Astronomy and the recipient of several university-wide Teaching Excellence awards. Dr. Lerner is the author of two university-level physics textbooks and numerous other publications in condensed-matter physics, the history of science, and science education. Dr. Lerner was a major author and editor of the content sections of the 1990
Science Framework for California Public Schools, and has been involved in state standards evaluations through the Thomas B. Fordham Foundation, authoring several publications including *Good Science, Bad Science: Teaching Evolution in the States* and *State Science Standards*. He has also consulted with numerous state departments of education and foundations on matters concerning K-12 science standards. He has been a contributing editor to The Textbook Letter, which evaluates middle- and secondary-school texts in science and other subjects, and a member of the National Faculty for the Humanities, Arts, and Sciences.

Jane Maienschein, Ph.D., (Arizona State University) is a Regents' Professor and Director for the Center for Biology and Society. She specializes in the history and philosophy of biology and the way that biology, bioethics, and biopolicy play out in society. Focusing on research in embryology, genetics, and cytology, Dr. Maienschein combines detailed analysis of the epistemological standards, theories, laboratory practices and experimental approaches with study of the people, institutions, and changing social, political, and legal context in which science thrives. She loves teaching and is committed to public education about biology and its human dimensions. She contributed to the development of the Arizona Science Standards, adopted in 1998 and has received numerous faculty and teaching awards, including the 2000 Parents Association Professor of the Year Chair. She is a co-editor of the *Journal of the History of Biology*, and has published books, including *Whose View of Life? Embryos, Cloning, and Stem Cells* and *Transforming Traditions in American Biology*.

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Peter Rillero, Ph.D., (Arizona State University West) is an Associate Professor in Science Education. He conducts academic and service activities in science education, teaches site-based courses in elementary science and social studies methods for junior and senior students, an elementary science methods course for post-degree students, and a secondary biology methods course for the Department of Life Sciences. In addition to the numerous journal articles, books, and publications he has authored and co-authored, he is a consulting editor and book reviewer for *Science Activities* journal; a member of the Board of Directors of the Arizona Alliance for Science, Mathematics, and Technology; and a reviewer for the *Electronic Journal of Science Education*.

Dennis Sunal, Ph.D. (University of Alabama) is a Professor of Science Education and the Project Director of NASA's Project NOVA. His research interests include the impact of innovative course design and pedagogy on undergraduate student learning; the nature of science; research, design, and best practice in online learning; scientific reasoning: exploring characteristics of student's argumentation of science concepts; learning and teaching energy concepts, K-12: misconceptions and conceptual reconstruction strategies; and alternative conceptions of aerospace concepts by college students.

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INTRODUCTION

Students are naturally curious about the world and their place in it. Sustaining this curiosity and giving it a scientific foundation must be a high priority in Arizona schools. Application of scientific thinking enables Arizona students to strengthen skills that people use every day: solving problems creatively, thinking critically, working cooperatively in teams, using technology effectively, and valuing lifelong learning.

Science education is much more than merely learning content. It is the active process of investigation and the critical review of evidence related to the world around us, both visible and invisible. Science is a dynamic process of gathering and evaluating information, looking for patterns, and then devising and testing possible explanations. Active engagement in scientific investigation leads students to think critically and to develop reasoning skills that allow them to become independent, lifelong learners. Science methods and thought processes have application well beyond the bounds of science and support learning goals in all subject areas.

The Arizona Science Standard Articulated by Grade Level has been written for ALL students. The science standard is set with the expectation that science instruction occurs at all grade levels – beginning in early grades with simple exploration, progressing to increasingly organized and sophisticated science investigations in higher grades.

Underlying all of the science standard strands are the five unifying concepts as identified in the National Science Education Standards (1995):

- Systems, Order, and Organization
- Evidence, Models, and Explanation
- Constancy, Change, and Measurement
- Evolution and Equilibrium
- Form and Function

This conceptual framework provides students with productive and insightful ways of considering and integrating a range of basic ideas that explain the natural world. Because the understanding and abilities associated with major conceptual and procedural schemes need to be developed over an entire education, the unifying concepts and processes transcend disciplinary boundaries.

These unifying concepts can be introduced in early grades and developed appropriately through the elementary grades and high school. Students should be explicitly shown how each of these unifying concepts apply to and connect life, physical, and Earth and space sciences. These science content areas can be taught in conjunction with each other, as well as with other subject areas in an interdisciplinary approach. The unifying concepts in science education help focus instruction and provide a link to other disciplines.

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BACKGROUND

The state Board of Education adopted the Arizona Academic Standards in 1998 to define what Arizona's students need to know and be able to do by the end of twelfth grade. Developed by committees comprised of educators, parents, students, and business and community leaders, these standards were written in grade-level clusters with benchmarks at 3, 5, 8, and high school.

RATIONALE

Requirements in the *No Child Left Behind Act of 2001* (NCLB) and the need for periodic review of the state academic standards prompted the decision by the Arizona Department of Education (ADE) to refine and articulate the academic standard for science by grade level. This refinement and articulation project was started in April 2003, and was completed in May 2004.

METHODOLOGY

The Science Standard Revision Committee was composed of a statewide representation of scientists and science educators to reflect school districts large and small, rural and urban, as well as the ethnic diversity of Arizona. National science consultants, university professors, and community members advised the committee and provided valuable reviews of the work in progress. The goal was to articulate, or align, the current academic standards by grade level (K-8) and in high school with the state requirement of two years of high school science.

The committee utilized several nationally recognized publications to establish content guidelines during the development of the draft:

- National Research Council (NRC)
  - *National Science Education Standards*
  - *Inquiry and the National Science Education Standards*
  - *Designing Mathematics or Science Curriculum Programs*

- The American Association for the Advancement of Science
  - *Atlas of Science Literacy*
  - *Benchmarks for Science Literacy*
  - *Design for Science Literacy*
  - *Science for All Americans*
- *Science Framework for the 1996 and 2000 National Assessment of Educational Progress (NAEP)*

The committee created draft documents by first reviewing the existing standards. The performance objectives were articulated, or aligned, to the appropriate grade levels. Over a period of months, subcommittees, composed of representatives of the full committee, met to refine the documents. A guiding principle in the articulation process was whether a performance objective was reasonable, useful, and appropriate. The measurability of each performance objective was also considered.

External reviews by nationally recognized consultants and reviews by university and local experts provided additional guidance and perspective to the committees.

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Public review of the Science Standard Articulated by Grade Level occurred during the month of February 2004. A draft of the standard was placed on the ADE website with the option for individuals to make comments online. Six public hearings occurred throughout the state to collect additional comments. After all public comments were collected and organized, the committee met to review them and to recommend appropriate modifications to the standard. This final draft was presented to the state Board of Education in May 2004 for adoption as the Arizona Science Standard Articulated by Grade Level.

ORGANIZATION OF THE SCIENCE STANDARD

The Science Standard Articulated by Grade Level is divided into the following six strands:

1. Inquiry Process
2. History and Nature of Science
3. Science in Personal and Social Perspectives
4. Life Science
5. Physical Science
6. Earth and Space Science

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.

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.

The itemized portions of the performance objectives, shown with bullets, provide the specific content that is to be learned by students as part of the outcome of the performance objective. The format of this itemized list does not imply that all components must be taught in one lesson or in any particular order. Teachers should decide how best to organize the content to meet the needs of their students.

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Strand One: Inquiry Process

"Science as inquiry is basic to science education and a controlling principle in the continuing organization and selection of students' activities. Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry…" (NSES 1995). 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.

Strand Two: History and Nature of Science

"*Knowledge of the nature of science is central to the understanding of the scientific enterprise.*" (NAEP 2000) 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.

Strand Three: 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.

Strand Four: Life Science

"The fundamental goal of life sciences is to attempt to understand and explain the nature of life." (NAEP 2000) 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.

Strand Five: Physical Science

"*The physical science component … should probe the following major topics: matter and its transformations, energy and its transformations, and the motion of things*." (NAEP 2000) 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.

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Strand Six: Earth and Space Science

"*Earth science is the study of the planets, Earth's composition, processes, environments and history, focusing on the solid Earth, and its interaction with air and water*." (NAEP 2000) 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.

Glossary – Words and terms defined in the glossary are found throughout the document. The committee provided definitions for teachers to ensure that the meaning of each term was consistent in grades K – high school. These definitions are not vocabulary words to be taught to students in isolation; they represent the terminology students will learn through the lessons prepared by the classroom teacher. If a word or term encompasses more in-depth meaning at subsequent levels, or different meanings within different disciplines of science, the definition notes this.

Cross-references – Select performance objectives within the Science Standard contain cross-references to other subject areas or other areas of science. These cross-references were inserted to assist the classroom teacher with identifying connections between the Science Standard and other subject areas to promote the teaching of a comprehensive curriculum at each grade level. These cross-references provide a starting point for integration and are not intended to be inclusive of all opportunities for integrating content. For example, Strand 3 of the Reading Standard (Informational Text) can be taught or reinforced with all areas of the Science Standard. Teachers are encouraged to explore the extensive opportunities to integrate writing, math, social studies, technology and the other academic standards with the Science Standard.

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Strand 1: Inquiry Process

"Science as inquiry is basic to science education and a controlling principle in the continuing organization and selection of students' activities. Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry…" (National Science Education Standards, 1995).

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:	**K-4**	**Observations, Questions, and Hypotheses**	Observe, ask questions, and make predictions.
	5-8	**Observations, Questions, and Hypotheses**	Formulate predictions, questions, or hypotheses based on observations. Locate appropriate resources.
	HS	**Observations, Questions, and Hypotheses**	Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.
Concept 2:	**K-4**	**Scientific Testing (Investigating and Modeling)**	Participate in planning and conducting investigations, and recording data.
	5-8	**Scientific Testing (Investigating and Modeling)**	Design and conduct controlled investigations.
	HS	**Scientific Testing (Investigating and Modeling)**	Design and conduct controlled investigations.
Concept 3:	**K-4**	**Analysis and Conclusions**	Organize and analyze data; compare to predictions.
	5-8	**Analysis and Conclusions**	Analyze and interpret data to explain correlations and results; formulate new questions.
	HS	**Analysis, Conclusions, and Refinements**	Evaluate experimental design, analyze data to explain results and to propose further investigations. Design models.

Concept 4:	**K-4**	**Communication**	Communicate results of investigations.
	5-8	**Communication**	Communicate results of investigations.
	HS	**Communication**	Communicate results of investigations.

Strand 2: History and Nature of Science

"*Knowledge of the nature of science is central to the understanding of the scientific enterprise.*" (National Assessment of Educational Progress, 2000)

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:	**K-4**	**History of Science as a Human Endeavor**	Identify individual and cultural contributions to scientific knowledge.
	5-8	**History of Science as a Human Endeavor**	Identify individual, cultural, and technological contributions to scientific knowledge.
	HS	**History of Science as a Human Endeavor**	Identify individual, cultural, and technological contributions to scientific knowledge.
Concept 2:	**K-4**	**Nature of Scientific Knowledge**	Understand how science is a process for generating knowledge.
	5-8	**Nature of Scientific Knowledge**	Understand how science is a process for generating knowledge.
	HS	**Nature of Scientific Knowledge**	Understand how scientists evaluate and extend scientific knowledge.

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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:	**K-4**	**Changes in Environments**	Describe the interactions between human populations, natural hazards, and the environment.
	5-8	**Changes in Environments**	Describe the interactions between human populations, natural hazards, and the environment.
	HS	**Changes in Environments**	Describe the interactions between human populations, natural hazards, and the environment.
Concept 2:	**K-4**	**Science and Technology in Society**	Understand the impact of technology.
	5-8	**Science and Technology in Society**	Develop viable solutions to a need or problem.
	HS	**Science and Technology in Society**	Develop viable solutions to a need or problem.
Concept 3:	**HS**	**Human Population Characteristics**	Analyze factors that affect human populations.

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Strand 4: Life Science

"The fundamental goal of life sciences is to attempt to understand and explain the nature of life." (NAEP 2000)

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:	**K-4**	**Characteristics of Organisms**	Understand that basic structures in plants and animals serve a function.
	5-8	**Structure and Function in Living Systems**	Understand the relationships between structures and functions of organisms.
	HS	**The Cell**	Understand the role of the cell and cellular processes.
Concept 2:	**K-4**	**Life Cycles**	Understand the life cycles of plants and animals.
	5-8	**Reproduction and Heredity**	Understand the basic principles of heredity.
	HS	**Molecular Basis of Heredity**	Understand the molecular basis of heredity and resulting genetic diversity.
Concept 3:	**K-4**	**Organisms and Environments**	Understand the relationships among various organisms and their environment.
	5-8	**Populations of Organisms in an Ecosystem**	Analyze the relationships among various organisms and their environment.
	HS	**Interdependence of Organisms**	Analyze the relationships among various organisms and their environment.
Concept 4:	**K-4**	**Diversity, Adaptation, and Behavior**	Identify plant and animal adaptations.
	5-8	**Diversity, Adaptation, and Behavior**	Identify structural and behavioral adaptations.
	HS	**Biological Evolution**	Understand the scientific principles and processes involved in biological evolution.
Concept 5:	**HS**	**Matter, Energy, and Organization in Living Systems (Including Human Systems)**	Understand the organization of living systems, and the role of energy within those systems.

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Strand 5: Physical Science

"The physical science component … should probe the following major topics: matter and its transformations, energy and its transformations, and the motion of things." (NAEP 2000)

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:	**K-4**	**Properties of Objects and Materials**	Classify objects and materials by their observable properties.
	5-8	**Properties and Changes of Properties in Matter**	Understand physical and chemical properties of matter.
	HS	**Structure and Properties of Matter**	Understand physical, chemical, and atomic properties of matter.
Concept 2:	**K-4**	**Position and Motion of Objects**	Understand spatial relationships and the way objects move.
	5-8	**Motion and Forces**	Understand the relationship between force and motion.
	HS	**Motions and Forces**	Analyze relationships between forces and motion.
Concept 3:	**K-4**	**Energy and Magnetism**	Investigate different forms of energy.
	5-8	**Transfer of Energy**	Understand that energy can be stored and transferred.
	HS	**Conservation of Energy and Increase in Disorder**	Understand ways that energy is conserved, stored, and transferred.
Concept 4:	**HS**	**Chemical Reactions**	Investigate relationships between reactants and products in chemical reactions.
Concept 5:	**HS**	**Interactions of Energy and Matter**	Understand the interactions of energy and matter.

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Strand 6: Earth and Space Science

"*Earth science is the study of the planets, Earth's composition, processes, environments and history, focusing on the solid Earth, and its interaction with air and water.*" (NAEP 2000)

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:	**K-4**	**Properties of Earth Materials**	Identify the basic properties of Earth materials.
	5-8	**Structure of the Earth**	Describe the composition and interactions between the structure of the Earth and its atmosphere.
	HS	**Geochemical Cycles**	Analyze the interactions between the Earth's structures, atmosphere, and geochemical cycles.
Concept 2:	**K-3**	**Objects in the Sky**	Identify objects in the sky.
	4-8	**Earth's Processes and Systems**	Understand the processes acting on the Earth and their interaction with the Earth systems.
	HS	**Energy in the Earth System (Both Internal and External)**	Understand the relationships between the Earth's land masses, oceans, and atmosphere.
Concept 3:	**K-4**	**Changes in the Earth and Sky**	Understand characteristics of weather conditions and climate.
	5-8	**Earth in the Solar System**	Understand the relationships of the Earth and other objects in the solar system.
	HS	**Origin and Evolution of the Earth System**	Analyze the factors used to explain the history and evolution of the Earth.
Concept 4:	**HS**	**Origin and Evolution of the Universe**	Analyze the factors used to explain the origin and evolution of the universe.

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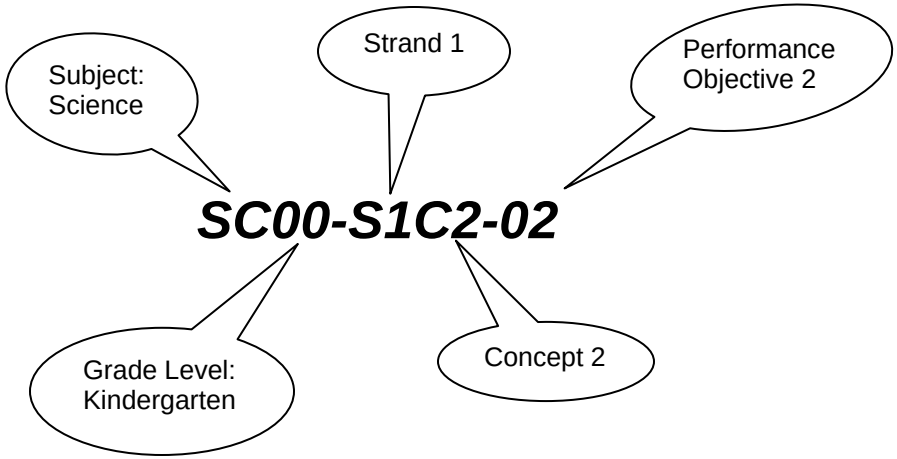
Coding for Articulated Standards



Examples of Science items:

SC04-S3C1-03 (Grade 4, Strand 3, Concept 1, PO 3)
SCHS-S2C2-01 (High School, Strand 2, Concept 2, PO 1)

Cross-curricular references are provided in the Science Standard where appropriate. Examples of coding for other subjects are shown below:

Examples of Mathematics items:

M01-S1C2-02 (Grade 1, Strand 1, Concept 2, PO 2)
MHS-S5C1-01 (High School, Strand 5, Concept 1, PO 1)

Examples of Reading items:

R04-S3C2-02 (Grade 4, Strand 2, Concept 2, PO 2)
R09-S1C4-01 (Grade 9, Strand 1, Concept 4, PO 1)

Example of Health item:

1CH-F3 (Strand 1, Foundations, Concept 3)

Example of Writing item:

W07-S3C6-01 (Grade 7, Strand 3, Concept 6, PO 1)

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Distribution of Concepts Across Grade Levels

Strand	Concept	Concept Name	K	1	2	3	4	5	6	7	8	HS
1 Inquiry Process	1	Observations, Questions, and Hypotheses										
	2	Scientific Testing (Investigating and Modeling)										
	3	Analysis and Conclusions										
	4	Communication										
2 History and Nature of Science	1	History of Science as a Human Endeavor										
	2	Nature of Scientific Knowledge										
3 Science in Personal and Social Perspectives	1	Changes in Environment										
	2	Science and Technology in Society										
	3	Human Population Characteristics (HS)										
4 Life Science	1	Characteristics Of Organisms (K-4); Structure and Function in Living Systems (5-8); The Cell (HS)										
	2	Life Cycles (K-4); Reproduction and Heredity (5-8); Molecular Basis of Heredity (HS)										
	3	Organisms and Environments (K-4); Populations of Organisms in an Ecosystem (5-8); Interdependence of Organisms (HS)										
	4	Diversity, Adaptation, and Behavior (K-8); Biological Evolution (HS)										
	5	Matter, Energy, and Organization in Living Systems (Including Human Systems) (HS)										

Science Standard
Articulated by Grade Level

Strand	Concept	Concept Name	K	1	2	3	4	5	6	7	8	HS
5 Physical Science	1	Properties of Objects and Materials (K-4); Properties and Changes of Properties in Matter (5-8); Structure and Properties of Matter (HS)										
	2	Position and Motion of Objects (K-4); Motion and Forces (5-8) Motions and Forces (HS)										
	3	Energy and Magnetism (K-4); Transfer of Energy (5-8); Conservation of Energy and Increase in Disorder (HS)										
	4	Chemical Reactions (HS)										
	5	Interactions of Energy and Matter (HS)										
6 Earth and Space Science	1	Properties of Earth Materials (K-4); Structure of the Earth (5-8); Geochemical Cycles (HS)										
	2	Objects in the Sky (K-3); Earth's Processes and Systems (4-8); Energy in the Earth System (Internal & External) (HS)										
	3	Changes in the Earth and Sky (K-4); Earth in the Solar System (5-8); Origin and Evolution of the Earth System (HS)										
	4	Origin and Evolution of the Universe (HS)										

Shaded areas in the grid indicate concepts that have performance objectives designated for specific grade levels. Each shaded area on the grid does not necessarily represent an entire unit of classroom instruction. The number of performance objectives within a concept varies by grade level.

Science Standard Articulated by Grade Level
Strand 1: Inquiry Process

Concept 1: Observations, Questions, and Hypotheses Observe, ask questions, and make predictions.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Observe common objects using multiple senses.	PO 1. Compare common objects using multiple senses.	PO 1. Formulate relevant questions about the properties of objects, organisms, and events in the environment. (See M02-S2C1-01)	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)	PO 1. Differentiate inferences from observations.
PO 2. Ask questions based on experiences with objects, organisms, and events in the environment. (See M00-S2C1-01*)*	*PO 2. Ask questions based on experiences with objects, organisms, and events in the environment. (See M01-S2C1-01)*	PO 2. Predict the results of an investigation (e.g., in animal life cycles, phases of matter, the water cycle).	PO 2. Predict the results of an investigation based on observed patterns, not random guessing.	PO 2. Formulate a relevant question through observations that can be tested by an investigation. (See M04-S2C1-01)
PO 3. Predict results of an investigation based on life, physical, and Earth and space sciences (e.g., the five senses, changes in weather).	*PO 3. Predict results of an investigation based on life, physical, and Earth and space sciences (e.g., animal life cycles, physical properties, Earth materials).*			PO 3. Formulate predictions in the realm of science based on observed cause and effect relationships.
				PO 4. Locate information (e.g., book, article, website) related to an investigation. (See W04-S3C6-01 and R04-S3C1-05)

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Concept 1: Observations, Questions, and Hypotheses Formulate predictions, questions, or hypotheses based on observations. Locate appropriate resources.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Formulate a relevant question through observations that can be tested by an investigation. *(See M05-S2C1-01)*	PO 1. Differentiate among a question, hypothesis, and prediction.	*PO 1. Formulate questions based on observations that lead to the development of a hypothesis.* *(See M07-S2C1-01)*	*PO 1. Formulate questions based on observations that lead to the development of a hypothesis.* *(See M08-S2C1-01)*
PO 2. Formulate predictions in the realm of science based on observed cause and effect relationships.	PO 2. Formulate questions based on observations that lead to the development of a hypothesis. (See M06-S2C1-01)	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 and R07-S3C1-06)	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 and R08-S3C2-03)
PO 3. Locate information (e.g., book, article, website) related to an investigation. *(See W05-S3C6-01 and R05-S3C1-05)*	PO 3. Locate research information, not limited to a single source, for use in the design of a controlled investigation. (See W06-S3C6-01 and R06-S3C1-06)	PO 3. Explain the role of a hypothesis in a scientific inquiry.	PO 3. Generate a hypothesis that can be tested.

Concept 1: Observations, Questions, and Hypotheses Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.
High School
PO 1. Evaluate scientific information for relevance to a given problem. (See R09-S3C1, R10-S3C1, R11-S3C1, R12-S3C1) PO 2. Develop questions from observations that transition into testable hypotheses. 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).

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Concept 2: Scientific Testing (Investigating and Modeling)
Participate in planning and conducting investigations, and recording data.

Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4
PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use of instruments, materials, organisms) in all science inquiry.	*PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use of instruments, materials, organisms) in all science inquiry.*	*PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use of instruments, materials, organisms) in all science inquiry.*	*PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use of instruments, materials, organisms) in all science inquiry.*	*PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.*
PO 2. Participate in guided investigations in life, physical, and Earth and space sciences.	*PO 2. Participate in guided investigations in life, physical, and Earth and space sciences.*	*PO 2. Participate in guided investigations in life, physical, and Earth and space sciences.*	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 2. Plan a simple investigation that identifies the variables to be controlled.
PO 3. Perform simple measurements using non-standard units of measure to collect data.	PO 3. Use simple tools such as rulers, thermometers, magnifiers, and balances to collect data (U.S. customary units). (See M01-S4C4-07)	*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)*	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.	PO 3. Conduct controlled investigations (e.g., related to erosion, plant life cycles, weather, magnetism) in life, physical, and Earth and space sciences.
	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)	*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)*	PO 4. Use metric and U.S. customary units to measure objects. (See M03-S4C4-04)	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)

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Concept 2: Scientific Testing (Investigating and Modeling) Participate in planning and conducting investigations, and recording data.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
			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)	*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)*

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Concept 2: Scientific Testing (Investigating and Modeling)
Design and conduct controlled investigations.

Grade 5	Grade 6	Grade 7	Grade 8
PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.	*PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.*	*PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.*	*PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.*
PO 2. Plan a simple investigation that identifies the variables to be controlled.	PO 2. Design an investigation to test individual variables using scientific processes.	*PO 2. Design an investigation to test individual variables using scientific processes.*	PO 2. Design a controlled investigation to support or reject a hypothesis.
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.	PO 3. Conduct a controlled investigation using scientific processes.	PO 3. Conduct a controlled investigation, utilizing multiple trials, to test a hypothesis using scientific processes.	PO 3. Conduct a controlled investigation to support or reject a hypothesis.
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)*	PO 4. Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers). (See M06-S4C4-02)	*PO 4. Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers).*	*PO 4. Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers).*
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)*	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)	*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)*	*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)*

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Concept 2: Scientific Testing (Investigating and Modeling)

Design and conduct controlled investigations.

High School

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

PO 2. Identify the 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).

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

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

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Concept 3: Analysis and Conclusions Organize and analyze data; compare to predictions.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
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)	*PO 1. Organize (e.g., compare, classify, and sequence) objects, organisms, and events according to various characteristics.* *(See M01-S4C4-01)*	PO 1. Organize data using graphs (i.e., pictograph, tally chart), tables, and journals. (See M02-S2C1-02)	PO 1. Organize data using the following methods with appropriate labels: • bar graphs • pictographs • tally charts (See M03-S2C1-02)	PO 1. Analyze data obtained in a scientific investigation to identify trends. (See M04-S2C1-03)
PO 2. Compare objects according to their measurable characteristics (e.g., longer/shorter, lighter/heavier). (See M00-S4C4-01)	PO 2. Compare the results of the investigation to predictions made prior to the investigation.	PO 2. Construct reasonable explanations of observations on the basis of data obtained (e.g., Based on the data, does this make sense? Could this really happen?). (See M02-S2C1-04)	PO 2. Construct reasonable interpretations of the collected data based on formulated questions. (See M03-S2C1-03)	PO 2. Formulate conclusions based upon identified trends in data. (See M04-S2C1-03)
		PO 3. Compare the results of the investigation to predictions made prior to the investigation.	*PO 3. Compare the results of the investigation to predictions made prior to the investigation.*	PO 3. Determine that data collected is consistent with the formulated question.
		PO 4. Generate questions for possible future investigations based on the conclusions of the investigation.	*PO 4. Generate questions for possible future investigations based on the conclusions of the investigation.*	PO 4. Determine whether the data supports the prediction for an investigation.

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Concept 3: Analysis and Conclusions Organize and analyze data; compare to predictions.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
			PO 5. Record questions for further inquiry based on the conclusions of the investigation.	PO 5. Develop new questions and predictions based upon the data collected in the investigation.

Concept 3: Analysis and Conclusions Analyze and interpret data to explain correlations and results; formulate new questions.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Analyze data obtained in a scientific investigation to identify trends and form conclusions. (See M05-S2C1-03)	PO 1. Analyze data obtained in a scientific investigation to identify trends. (See M06-S2C1-03)	*PO 1. Analyze data obtained in a scientific investigation to identify trends.* *(See M07-S2C1-07 and M07-S2C1-08)*	*PO 1. Analyze data obtained in a scientific investigation to identify trends.* *(See M08-S2C1-08)*
PO 2. Analyze whether the data is consistent with the proposed explanation that motivated the 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).	*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).*	*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).*
PO 3. Evaluate the reasonableness of the outcome of an investigation.	PO 3. Evaluate the observations and data reported by others.	PO 3. Analyze results of data collection in order to accept or reject the hypothesis.	PO 3. Interpret data that show a variety of possible relationships between two variables, including: • positive relationship • negative relationship • no relationship
PO 4. Develop new investigations and predictions based on questions that arise from the findings of an investigation.	PO 4. Interpret simple tables and graphs produced by others.	PO 4. Determine validity and reliability of results of an investigation.	PO 4. Formulate a future investigation based on the data collected.

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Concept 3: Analysis and Conclusions

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

Grade 5	Grade 6	Grade 7	Grade 8
PO 5. Identify possible relationships between variables in simple investigations (e.g., time and distance; incline and mass of object).	PO 5. Analyze the results from previous and/or similar investigations to verify the results of the current investigation.	PO 5. Formulate a conclusion based on data analysis.	PO 5. Explain how evidence supports the validity and reliability of a conclusion.
	PO 6. Formulate new questions based on the results of a completed investigation.	PO 6. Refine hypotheses based on results from investigations.	PO 6. Identify the potential investigational error that may occur (e.g., flawed investigational design, inaccurate measurement, computational errors, unethical reporting).
		PO 7. Formulate new questions based on the results of a previous investigation.	PO 7. Critique scientific reports from periodicals, television, or other media.
			PO 8. Formulate new questions based on the results of a previous investigation.

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Concept 3: Analysis, Conclusions, and Refinements

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

High School

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

- *positive relationship*
- *negative relationship*
- *no relationship*

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

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.

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Concept 4: Communication Communicate results of investigations.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Communicate observations with pictographs, pictures, models, and/or words. (See M00-S2C1-02)	PO 1. Communicate the results of an investigation using pictures, graphs, models, and/or words. (See M01-S2C1-02 and W01-S3C2-02)	PO 1. Communicate the results and conclusions of an investigation (e.g., verbal, drawn, or written). (See M02-S2C1-02 and W02-S3C2-02)	PO 1. Communicate investigations and explanations using evidence and appropriate terminology. (See W03-S3C2-01)	PO 1. Communicate verbally or in writing the results of an inquiry. (See W04-S3C3-01)
PO 2. Communicate with other groups to describe the results of an investigation. (See LS-R3 and LS-R5)	*PO 2. Communicate with other groups to describe the results of an investigation.* *(See LS-F1)*	*PO 2. Communicate with other groups to describe the results of an investigation.* *(See LS-F1)*	PO 2. Describe an investigation in ways that enable others to repeat it. (See W03-S3C3-01 and LS-F1)	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 to describe the results of an investigation. *(See LS-E1)*	PO 3. Communicate with other groups or individuals to compare the results of a common investigation.

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Concept 4: Communication Communicate results of investigations.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Communicate verbally or in writing the results of an inquiry. *(See W05-S3C3-01)*	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 1. *Choose an appropriate graphic representation for collected data:* • *line graph* • *double bar graph* • *stem and leaf plot* • *histogram* *(See M07-S2C1-03)*	PO 1. Communicate the 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)*	PO 2. Display data collected from a controlled investigation. (See M06-S2C1-02)	*PO 2. Display data collected from a controlled investigation.* *(See M07-S2C1-03)*	*PO 2. Choose an appropriate graphic representation for collected data:* • *line graph* • *double bar graph* • *stem and leaf plot* • *histogram* *(See M08-S2C1-03)*
PO 3. Communicate with other groups or individuals to compare the results of a common investigation.	PO 3. Communicate the results of an investigation with appropriate use of qualitative and quantitative information. (See W06-S3C2-01)	*PO 3. Communicate the results of an investigation with appropriate use of qualitative and quantitative information.* *(See W07-S3C2-01)*	PO 3. Present analyses and conclusions in clear, concise formats. (See W08-S3C6-02)
	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 4. Write clear, step-by-step instructions for following procedures (without the use of personal pronouns). (See W07-S3C3-01)	PO 4. Write clear, step-by-step instructions for conducting investigations or operating equipment (without the use of personal pronouns). (See W08-S3C3-01)
	PO 5. Communicate the results and conclusion of the investigation. (See W06-S3C6-02)	*PO 5. Communicate the results and conclusion of the investigation.* *(See W07-S3C6-02)*	*PO 5. Communicate the results and conclusion of the investigation.* *(See W08-S3C6-02)*

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

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Concept 1: History of Science as a Human Endeavor Identify individual and cultural contributions to scientific knowledge.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Give examples of how diverse people (e.g., children, parents, weather reporters, cooks, healthcare workers, gardeners) use science in daily life.	*PO 1. Give examples of how diverse people (e.g., children, parents, weather reporters, cooks, healthcare workers, gardeners) use science in daily life.*	*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], supports Strand 4).*	*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 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. 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).	*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).*	PO 2. Identify science-related career opportunities.	PO 2. Describe science-related career opportunities.	*PO 2. Describe science-related career opportunities.*

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Concept 1: History of Science as a Human Endeavor Identify individual, cultural, and technological contributions to scientific knowledge.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
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).	*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 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).*	*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. 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 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 2. Evaluate the effects of the following major scientific milestones on society: • Mendelian Genetics • Newton's Laws
	PO 3. Analyze the impact of a major scientific development occurring within the past decade.	*PO 3. Analyze the impact of a major scientific development occurring within the past decade.*	PO 3. Evaluate the impact of a major scientific development occurring within the past decade.
	PO 4. Describe the use of technology in science-related careers.	PO 4. Analyze the use of technology in science-related careers.	PO 4. Evaluate career opportunities related to life and physical sciences.

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Concept 1: History of Science as a Human Endeavor Identify individual, cultural, and technological contributions to scientific knowledge.
High School
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.

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Concept 2: Nature of Scientific Knowledge Understand how science is a process for generating knowledge.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
		PO 1. Identify components of familiar systems (e.g., organs of the digestive system, bicycle).	PO 1. Describe how, in a system (e.g., terrarium, house) with many components, the components usually influence one another.	PO 1. Explain the role of experimentation in scientific inquiry.
		PO 2. Identify the following characteristics of a system: • consists of multiple parts or subsystems • parts work interdependently	PO 2. Explain why a system may not work if a component is defective or missing.	PO 2. Describe the interaction of components in a system (e.g., flashlight, radio).
		PO 3. Identify parts of a system too small to be seen (e.g., plant and animal cells).		PO 3. Explain various ways scientists generate ideas (e.g., observation, experiment, collaboration, theoretical and mathematical models).

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Concept 2: Nature of Scientific Knowledge Understand how science is a process for generating knowledge.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
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 1. Describe how science is an ongoing process that changes in response to new information and discoveries.	*PO 1. Describe how science is an ongoing process that changes in response to new information and discoveries.*	*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. Explain the cycle by which new scientific knowledge generates new scientific inquiry.	PO 2. Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories.	*PO 2. Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories.*	*PO 2. Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories.*
PO 3. Describe how scientific knowledge is subject to modification and/or change as new information/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	*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*	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.

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Concept 2: Nature of Scientific Knowledge Understand how science is a process for generating knowledge.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 4. Compare collaborative approaches that scientists use for investigations (e.g., teams, individual with peer review).			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.
PO 5. Describe qualities of the scientists' habits of mind (e.g., openness, skepticism, integrity, tolerance).			

Concept 2: Nature of Scientific Knowledge Understand how scientists evaluate and extend scientific knowledge.
High School
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.

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Concept 1: Changes in Environments Describe the interactions between human populations, natural hazards, and the environment.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
			PO 1. Describe the major factors that could impact a human population (e.g., famine, drought, disease, improved transportation, medical breakthroughs).	PO 1. Describe how natural events and human activities have positive and negative impacts on environments (e.g., fire, floods, pollution, dams).
			PO 2. Describe the beneficial and harmful impacts of natural events and human activities on the environment (e.g., forest fires, flooding, pesticides).	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).

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Concept 1: Changes in Environments Describe the interactions between human populations, natural hazards, and the environment.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Explain the impacts of natural hazards on habitats (e.g., global warming, floods, asteroid or large meteor impacts).	PO 1. Evaluate the effects of the following natural hazards: • sandstorm • hurricane • tornado • ultraviolet light • lightning-caused fire	PO 1. Analyze environmental risks (e.g., pollution, destruction of habitat) caused by human interaction with biological or geological systems.	PO 1. Analyze the risk factors associated with natural, human induced, and/or biological hazards, including: • waste disposal of industrial chemicals • greenhouse gases
PO 2. Propose a solution, resource, or product that addresses a specific human, animal, or habitat need.	PO 2. Describe how people plan for, and respond to, the following natural disasters: • drought • flooding • tornadoes	PO 2. Analyze environmental benefits of the following human interactions with biological or geological systems: • reforestation • habitat restoration • construction of dams	PO 2. Analyze possible solutions to address the environmental risks associated with chemicals and biological systems.
PO 3. Evaluate the possible strengths and weaknesses of a proposed solution to a specific problem relevant to human, animal, or habitat needs.		PO 3. Propose possible solutions to address the environmental risks in biological or geological systems.	

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Concept 1: Changes in Environments

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

High School

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

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

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

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.

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Concept 2: Science and Technology in Society Understand the impact of technology.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Describe how simple tools (e.g., scissors, pencils, paper clips, hammers) can make tasks easier.	PO 1. Identify various technologies (e.g., automobiles, radios, refrigerators) that people use.	PO 1. Analyze how various technologies impact aspects of people's lives (e.g., entertainment, medicine, transportation, communication).	PO 1. Identify ways that people use tools and techniques to solve problems.	PO 1. Describe how science and technology (e.g., computers, air conditioning, medicine) have improved the lives of many people.
	PO 2. Describe how suitable tools (e.g., magnifiers, thermometers) help make better observations and measurements.	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 2. Describe the development of different technologies (e.g., communication, entertainment, transportation, medicine) in response to resources, needs, and values.	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. Identify a simple problem that could be solved by using a suitable tool.	PO 3. Design and construct a technological solution to a common problem or need using common materials.	*PO 3. Design and construct a technological solution to a common problem or need using common materials.*

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Concept 2: Science and Technology in Society Develop viable solutions to a need or problem.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Describe the relationship between science and technology.	PO 1. Propose viable methods of responding to an identified need or problem.	*PO 1. Propose viable methods of responding to an identified need or problem.*	*PO 1. Propose viable methods of responding to an identified need or problem.*
PO 2. Explain how scientific knowledge, skills, and technological capabilities are integral to a variety of careers.	PO 2. Compare possible solutions to best address an identified need or problem.	*PO 2. Compare solutions to best address an identified need or problem.*	*PO 2. Compare solutions to best address an identified need or problem.*
PO 3. *Design and construct a technological solution to a common problem or need using common materials.*	PO 3. Design and construct a solution to an identified need or problem using simple classroom materials.	*PO 3. Design and construct a solution to an identified need or problem using simple classroom materials.*	*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.	PO 4. Describe a scientific discovery that influences technology.	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)

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Concept 2: Science and Technology in Society

Develop viable solutions to a need or problem.

High School

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

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

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Concept 3: Human Population Characteristics Analyze factors that affect human populations.
High School
PO 1. Analyze social factors that limit the growth of a human population, including: • affluence • education • access to health care • cultural influences 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.

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Concept 1: Characteristics of Organisms Understand that basic structures in plants and animals serve a function.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Distinguish between living things and nonliving things.	PO 1. Identify the following as characteristics of living things: • growth and development • reproduction • response to stimulus	PO 1. Identify animal structures that serve different functions (e.g., sensory, defense, locomotion).	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	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.
PO 2. Name the following human body parts: • head • legs • shoulders • hips • arms • knees • elbows • ankles • wrists • feet • hands • heels • fingers • toes (See 1CH-R3-01)	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	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 2. Classify animals by identifiable group characteristics: • vertebrates – mammals, birds, fish, reptiles, amphibians • invertebrates – insects, arachnids

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Concept 1: Characteristics of Organisms Understand that basic structures in plants and animals serve a function.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 3. Identify the five senses and their related body parts: • sight – eyes • hearing – ears • smell – nose • taste – tongue • touch – skin	PO 3. Identify observable similarities and differences (e.g., number of legs, body coverings, size) between/among different groups of animals.	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)		

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Concept 1: Structure and Function in Living Systems Understand the relationships between structures and functions of organisms.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Identify the functions and parts of the skeletal system: • protection – rib cage, cranium • support – vertebrae • movement – pelvis, femur, hip	PO 1. Explain the importance of water to organisms.		
PO 2. Identify the following types of muscles: • cardiac – heart • smooth – stomach • skeletal – biceps	PO 2. Describe the basic structure of a cell, including: • cell wall • cell membrane • nucleus		
PO 3. Identify the functions and parts of the nervous system: • control center – brain • relay mechanism – spinal cord • transport messages – nerves	PO 3. Describe the function of each of the following cell parts: • cell wall • cell membrane • nucleus		
PO 4. Distinguish between voluntary and involuntary responses.	PO 4. Differentiate between plant and animal cells.		
	PO 5. Explain the hierarchy of cells, tissues, organs, and systems.		

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Concept 1: Structure and Function in Living Systems Understand the relationships between structures and functions of organisms.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
	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		
	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		

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Concept 1: The Cell Understand the role of the cell and cellular processes.
High School
PO 1. Describe the role of energy in cellular growth, development, and repair. 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.

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Concept 2: Life Cycles Understand the life cycles of plants and animals.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Describe that most plants and animals will grow to physically resemble their parents.	PO 1. Identify stages of human life (e.g., infancy, adolescence, adulthood).	PO 1. Describe the life cycles of various insects.	PO 1. Compare life cycles of various plants (e.g., conifers, flowering plants, ferns).	
	PO 2. Identify similarities and differences between animals and their parents. (See 1CH-F4)	PO 2. Describe the life cycles of various mammals.	PO 2. Explain how growth, death, and decay are part of the plant life cycle.	
		PO 3. Compare the life cycles of various organisms.		

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Concept 2: Reproduction and Heredity Understand the basic principles of heredity.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
			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
			PO 3. Distinguish between the nature of dominant and recessive traits in humans.

Concept 2: Molecular Basis of Heredity Understand the molecular basis of heredity and resulting genetic diversity.
High School
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. PO 4. Describe how meiosis and fertilization maintain genetic variation.

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Concept 3: Organisms and Environments Understand the relationships among various organisms and their environment.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Identify some plants and animals that exist in the local environment.	*PO 1. Identify some plants and animals that exist in the local environment.*		PO 1. Identify the living and nonliving components of an ecosystem.	PO 1. Describe ways various resources (e.g., air, water, plants, animals, soil) are utilized to meet the needs of a population.
PO 2. Identify that plants and animals need the following to grow and survive: • food • water • air • space	PO 2. Compare the habitats (e.g., desert, forest, prairie, water, underground) in which plants and animals live.		PO 2. Examine an ecosystem to identify microscopic and macroscopic organisms.	PO 2. Differentiate renewable resources from nonrenewable resources.
PO 3. Describe changes observed in a small system (e.g., ant farm, plant terrarium, aquarium).	PO 3. Describe how plants and animals within a habitat are dependent on each other.		PO 3. Explain the interrelationships among plants and animals in different environments: • producers – plants • consumers – animals • decomposers – fungi, insects, bacteria	PO 3. Analyze the effect that limited resources (e.g., natural gas, minerals) may have on an environment.
			PO 4. Describe how plants and animals cause change in their environment.	PO 4. Describe ways in which resources can be conserved (e.g., by reducing, reusing, recycling, finding substitutes).

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Concept 3: Organisms and Environments Understand the relationships among various organisms and their environment.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
			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.	

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Concept 3: Populations of Organisms in an Ecosystem Analyze the relationships among various organisms and their environment.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
	PO 1. Explain that sunlight is the major source of energy for most ecosystems. (See Strand 5 Concept 3 and Strand 6 Concept 2)	PO 1. Compare food chains in a specified ecosystem and their corresponding food web.	
	PO 2. Describe how the following environmental conditions affect the quality of life: • water quality • climate • population density • smog	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.	

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Concept 3: Populations of Organisms in an Ecosystem Analyze the relationships among various organisms and their environment.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
		PO 6. Create a model of the interactions of living organisms within an ecosystem.	

Concept 3: Interdependence of Organisms Analyze the relationships among various organisms and their environment.
High School
PO 1. Identify the relationships among organisms within populations, communities, ecosystems, and biomes. PO 2. Describe how organisms are influenced by a particular combination of biotic (living) and abiotic (nonliving) factors in an 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.

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Concept 4: Diversity, Adaptation and Behavior Identify plant and animal adaptations.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
			PO 1. Identify adaptations of plants and animals that allow them to live in specific environments.	PO 1. Recognize that successful characteristics of populations are inherited traits that are favorable in a particular environment.
			PO 2. Describe ways that species adapt when introduced into new environments.	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
			PO 3. Cite examples of how a species' inability to adapt to changing conditions in the ecosystem led to the extinction of that species.	

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Concept 4: Diversity, Adaptation and Behavior Identify structural and behavioral adaptations.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
			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)
			PO 6. Describe the following factors that allow for the survival of living organisms: • protective coloration • beak design • seed dispersal • pollination

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Concept 4: Biological Evolution

Understand the scientific principles and processes involved in biological evolution.

High School

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

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.

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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.
High School
PO 1. Compare the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products. 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 PO 4. Diagram the energy flow in an ecosystem through 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.

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Concept 1: Properties of Objects and Materials Classify objects and materials by their observable properties.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Identify the following observable properties of objects using the senses: • shape • texture • size • color (See M00-S4C1-02 and M00-S4C1-03)	PO 1. Classify objects by the following observable properties: • shape • texture • size • color • weight	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)		
PO 2. Compare objects by the following observable properties: • size • color • type of material (See M00-S4C1-02)	PO 2. Classify materials as solids or liquids.	PO 2. Classify materials as solids, liquids, or 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.		

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Concept 1: Properties and Changes of Properties in Matter Understand physical and chemical properties of matter.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Identify that matter is made of smaller units called: • molecules (e.g., H_2O, CO_2) • atoms (e.g., H, N, Na)			PO 1. Identify different kinds of matter based on the following physical properties: • states • density • boiling point • melting point • solubility
PO 2. Distinguish between mixtures and compounds.			PO 2. Identify different kinds of matter based on the following chemical properties: • reactivity • pH • oxidation (corrosion)
PO 3. Describe changes of matter: • physical – cutting wood, ripping paper, freezing water • chemical – burning of wood, rusting of iron, milk turning sour			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.

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Concept 1: Properties and Changes of Properties in Matter Understand physical and chemical properties of matter.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
			PO 7. Investigate how the transfer of energy can affect the physical and chemical properties of matter.

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Concept 1: Structure and Properties of Matter

Understand physical, chemical, and atomic properties of matter.

High School

PO 1. Describe 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.

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).

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Concept 2: Position and Motion of Objects Understand spatial relationships and the way objects move.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
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)	PO 1. Demonstrate the various ways that objects can move (e.g., straight line, zigzag, back-and-forth, round-and-round, fast, slow).			

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Concept 2: Motion and Forces Understand the relationship between force and motion.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Describe the following forces: • gravity • friction			PO 1. Demonstrate velocity as the rate of change of position over time.
PO 2. Describe the various effects forces can have on an object (e.g., cause motion, halt motion, change direction of motion, cause deformation).			PO 2. Identify the conditions under which an object will continue in its state of motion (Newton's 1st Law of Motion).
PO 3. Examine forces and motion through investigations using simple machines (e.g., wedge, plane, wheel and axle, pulley, lever).			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. Demonstrate effects of variables on an object's motion (e.g., incline angle, friction, applied forces).			PO 4. Describe 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

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Concept 2: Motions and Forces

Analyze relationships between forces and motion.

High School

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.

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.

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.

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Concept 2: Motions and Forces Analyze relationships between forces and motion.
High School
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.

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Concept 3: Energy and Magnetism Investigate different forms of energy.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Investigate how applied forces (push and pull) can make things move.			PO 1. Demonstrate that light can be: • reflected (with mirrors) • refracted (with prisms) • absorbed (by dark surfaces)	PO 1. Demonstrate that electricity flowing in circuits can produce light, heat, sound, and magnetic effects.
PO 2. Investigate how forces can make things move without another thing touching them (e.g., magnets, static electricity).			PO 2. Describe how light behaves on striking objects that are: • transparent (clear plastic) • translucent (waxed paper) • opaque (cardboard)	PO 2. Construct series and parallel electric circuits.
PO 3. Sort materials according to whether they are or are not attracted by a magnet.			PO 3. Demonstrate that vibrating objects produce sound.	PO 3. Explain the purpose of conductors and insulators in various practical applications.
PO 4. Identify familiar everyday uses of magnets (e.g., in toys, cabinet locks, decoration).			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).	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).
				PO 5. State cause and effect relationships between magnets and circuitry.

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Concept 3: Transfer of Energy Understand that energy can be stored and transferred.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
	PO 1. Identify various ways in which electrical energy is generated using renewable and nonrenewable resources (e.g., wind, dams, fossil fuels, nuclear reactions).		
	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		

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Concept 3: Conservation of Energy and Increase in Disorder

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

High School

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.

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

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Concept 4: Chemical Reactions Investigate relationships between reactants and products in chemical reactions.
High School
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. 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.

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Concept 5: Interactions of Energy and Matter

Understand the interactions of energy and matter.

High School

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.

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.

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Concept 1: Properties of Earth Materials Identify the basic properties of Earth materials.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Identify rocks, soil, and water as basic Earth materials.	PO 1. Describe the following basic Earth materials: • rocks • soil • water		PO 1. Identify the layers of the Earth: • crust • mantle • core (inner and outer)	
PO 2. Compare physical properties (e.g., color, texture, capacity to retain water) of basic Earth materials.	PO 2. Compare the following physical properties of basic Earth materials: • color • texture • capacity to retain water		PO 2. Describe the different types of rocks and how they are formed: • metamorphic • igneous • sedimentary	
PO 3. Classify a variety of objects as being natural or man-made.	PO 3. Identify common uses (e.g., construction, decoration) of basic Earth materials (i.e., rocks, water, soil).		PO 3. Classify rocks based on the following physical properties: • color • texture	
PO 4. Identify ways some natural or man-made materials can be reused or recycled (e.g., efficient use of paper, recycle aluminum cans).	PO 4. Identify the following as being natural resources: • air • water • soil • trees • wildlife		PO 4. Describe fossils as a record of past life forms.	
	PO 5. Identify ways to conserve natural resources (e.g., reduce, reuse, recycle, find alternatives).		PO 5. Describe how fossils are formed.	

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Concept 1: Properties of Earth Materials Identify the basic properties of Earth materials.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
			PO 6. Describe ways humans use Earth materials (e.g., fuel, building materials, growing food).	

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Concept 1: Structure of the Earth

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

Grade 5	Grade 6	Grade 7	Grade 8
	PO 1. Describe the properties and the composition of the layers of the atmosphere.	PO 1. Classify rocks and minerals by the following observable properties: • grain • color • texture • hardness	
	PO 2. Explain the composition, properties, and structure of the Earth's lakes and rivers.	PO 2. Describe the properties and the composition of the following major layers of the Earth: • crust • mantle • core	
	PO 3. Explain the composition, properties, and structures of the oceans' zones and layers.	PO 3. Explain the following processes involved in the formation of the Earth's structure: • erosion • deposition • plate tectonics • volcanism	
	PO 4. Analyze the interactions between the Earth's atmosphere and the Earth's bodies of water (water cycle).	PO 4. Describe how the rock and fossil record show that environmental conditions have changed over geologic and recent time.	
	PO 5. Describe ways scientists explore the Earth's atmosphere and bodies of water. (See Strand 2 Concept 1)		

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Concept 1: Geochemical Cycles Analyze the interactions between the Earth's structures, atmosphere, and geochemical cycles.
High School
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. PO 7. Explain how the geochemical processes are responsible for the concentration of economically valuable minerals and ores in Arizona and worldwide.

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Concept 2: Objects in the Sky Identify objects in the sky.			
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**
	PO 1. Identify evidence that the Sun is the natural source of heat and light on the Earth (e.g., warm surfaces, shadows, shade).		
	PO 2. Compare celestial objects (e.g., Sun, Moon, stars) and transient objects in the sky (e.g., clouds, birds, airplanes, contrails).		
	PO 3. Describe observable changes that occur in the sky, (e.g., clouds forming and moving, the position of the Moon).		

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Concept 2: Earth's Processes and Systems Understand the processes acting on the Earth and their interaction with the Earth systems.				
Grade 4	**Grade 5**	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Identify the Earth processes that cause erosion.	PO 1. Describe how the Moon's appearance changes during a four-week lunar cycle.	PO 1. Explain how water is cycled in nature.	PO 1. Explain the rock cycle.	
PO 2. Describe how currents and wind cause erosion and land changes.	PO 2. Describe how Earth's rotation results in day and night at any particular location.	PO 2. Identify the distribution of water within or among the following: • atmosphere • lithosphere • hydrosphere	PO 2. Distinguish the components and characteristics of the rock cycle for the following types of rocks: • igneous • metamorphic • sedimentary	
PO 3. Describe the role that water plays in the following processes that alter the Earth's surface features: • erosion • deposition • weathering	PO 3. Distinguish between revolution and rotation.	PO 3. Analyze the effects that bodies of water have on the climate of a region.	PO 3. Analyze the evidence that lithospheric plate movements occur.	
PO 4. Compare rapid and slow processes that change the Earth's surface, including: • rapid – earthquakes, volcanoes, floods • slow – wind, weathering	PO 4. Describe the role of gravity as an attractive force between celestial objects.	PO 4. Analyze the following factors that affect climate: • ocean currents • elevation • location	PO 4. Explain lithospheric plate movement as a result of convection.	

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Concept 2: Earth's Processes and Systems Understand the processes acting on the Earth and their interaction with the Earth systems.				
Grade 4	**Grade 5**	**Grade 6**	**Grade 7**	**Grade 8**
PO 5. Identify the Earth events that cause changes in atmospheric conditions (e.g., volcanic eruptions, forest fires).		PO 5. Analyze the impact of large-scale weather systems on the local weather.	PO 5. Relate plate boundary movements to their resulting landforms, including: • mountains • faults • rift valleys • trenches • volcanoes	
PO 6. Analyze evidence that indicates life and environmental conditions have changed (e.g., tree rings, fish fossils in desert regions, ice cores).		PO 6. Create a weather system model that includes: • the Sun • the atmosphere • bodies of water	PO 6. Describe how earthquakes are measured.	

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Concept 2: Energy in the Earth System (Both Internal and External)
Understand the relationships between the Earth's land masses, oceans, and atmosphere.

High School

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.

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).

PO 13. Propose appropriate 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).

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Concept 2: Energy in the Earth System (Both Internal and External) Understand the relationships between the Earth's land masses, oceans, and atmosphere.
High School
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.

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Concept 3: Changes in the Earth and Sky Understand characteristics of weather conditions and climate.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
PO 1. Identify the following aspects of weather: • temperature • wind • precipitation • storms	PO 1. Identify the following characteristics of seasonal weather patterns: • temperature • type of precipitation • wind	PO 1. Measure weather conditions (e.g., temperature, precipitation). (See M02-S4C4-04 and M02-S4C4-05)		PO 1. Identify the sources of water within an environment (e.g., ground water, surface water, atmospheric water, glaciers).
PO 2. Describe observable changes in weather.	PO 2. Analyze how the weather affects daily activities.	PO 2. Record weather conditions (e.g., temperature, precipitation).		PO 2. Describe the distribution of water on the Earth's surface.
PO 3. Give examples of how the weather affects people's daily activities.		PO 3. Identify the following types of clouds: • cumulus • stratus • cirrus		PO 3. Differentiate between weather and climate as they relate to the southwestern United States.
		PO 4. Analyze the relationship between clouds, temperature, and weather patterns.		PO 4. Measure changes in weather (e.g., precipitation, wind speed, barometric pressure).
				PO 5. Interpret the symbols on a weather map or chart to identify the following: • temperatures • fronts • precipitation

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Concept 3: Changes in the Earth and Sky Understand characteristics of weather conditions and climate.				
Kindergarten	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
				PO 6. Compare weather conditions in various locations (e.g., regions of Arizona, various U.S. cities, coastal vs. interior geographical regions).

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Concept 3: Earth in the Solar System Understand the relationships of the Earth and other objects in the solar system.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 1. Identify the known planets of 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. Describe the distinguishing characteristics of the known planets in the solar system.		PO 2. Construct a model for the relative positions of the Earth, Sun, and Moon as they relate to corresponding eclipses.	
PO 3. Describe various objects in the sky (e.g., asteroids, comets, stars, meteors/shooting stars).		PO 3. Explain the interrelationship between the Earth's tides and the Moon.	
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 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.	
PO 5. Explain the apparent motion of the Sun and stars.		PO 5. Identify the following major constellations visible (seasonally) from the Northern Hemisphere: • Orion • Ursa Major (Great Bear) • Cygnus • Scorpius • Cassiopeia	

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Concept 3: Earth in the Solar System Understand the relationships of the Earth and other objects in the solar system.			
Grade 5	**Grade 6**	**Grade 7**	**Grade 8**
PO 6. Describe efforts to explore space (e.g., Apollo missions, space shuttles, Hubble space telescope, space probes). (See Strand 2)		PO 6. Explain the relationship among common objects in the solar system, galaxy, and the universe.	

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Concept 3: Origin and Evolution of the Earth System

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

High School

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.

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Concept 4: Origin and Evolution of the Universe Analyze the factors used to explain the origin and evolution of the universe.
High School
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.

Science Standard
Articulated by Grade Level
GLOSSARY

The purpose of this glossary is to help the user better understand and implement the Science Standard. It is not intended to be a study guide for the AIMS and is not a comprehensive list of all science terms.

abiotic	nonliving
absorb	to take up (e.g., plant roots absorb water)
adaptation	hereditary features of organisms that allow them to live in a particular environment
affect	to have an influence on
affluence	plentiful supply of material goods; wealth
applied science	research aimed at answering questions that have practical applications, e.g., determining the causes of diseases so that cures might be found
asteroid	small rocky body orbiting the Sun
atmosphere	gaseous envelope surrounding the Earth
atom	smallest particle of an element that retains the chemical nature of the element
barometric pressure	atmospheric pressure as indicated by a barometer, used especially in weather forecasting
basic science	research designed to describe or explain nature to satisfy one's curiosity
bias	statistical sampling or testing error caused by systematically favoring some outcomes over others
biodiversity	1. number and variety of organisms found within a specified geographic region 2. variability among organisms, including the variability within and between species and within and between ecosystems
biome	broad area of the Earth's surface characterized by distinctive vegetation and associated animal life; e.g., broad-leaf forest biome, grassland biome, desert biome
biotic	relating to life or living organisms
calorimetric	relating to the measurement of heat energy by means of temperature measurements
camouflage	concealment by disguise or protective coloring
carrying capacity	maximum number of individuals that a given environment can support for a sustained period of time
catalyst	substance, usually used in small amounts relative to the reactants, that modifies and increases the rate of a reaction without being consumed in the process
cellular respiration	metabolic processes which break down nutrients into usable energy
circuit	1. closed path followed or capable of being followed by an electric current 2. configuration of electrically or electromagnetically connected components or devices
cirrus	high-altitude cloud composed of narrow bands or patches of thin, generally white, fleecy parts
characteristic	distinguishing trait, feature, quality, or property
cladistics	system of classification that constructs evolutionary trees, showing how shared derived characters can be used to reveal degrees of evolutionary relationships between existing and extinct species
classification system	method of organization of objects or organisms using distinct characteristics or features
classify	to arrange or organize according to class or category

Science Standard
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GLOSSARY

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climate	average course or condition of the weather at a place usually over a period of years as exhibited by temperature, wind velocity and precipitation
comet	body of dust, ice, and gas, which orbits the Sun; the orbit is usually highly elliptical or even parabolic
community	group of plants and animals living and interacting with one another in a specific region under relatively similar environmental conditions
compound	substance formed from two or more elements chemically united in fixed proportions
conduction	process by which heat or electrical energy is transmitted through a material or body without gross motion of the medium itself
conifer	any of various mostly needle-leaved or scale-leaved, chiefly evergreen, cone-bearing gymnosperm trees or shrubs such as pines, spruces, and firs
conservation	**Life science:** the protection, preservation, management, or restoration of wildlife and of natural resources such as forests, soil, and water, to prevent exploitation, destruction or neglect **Physical science:** a unifying principle of constancy of a quantity under specified conditions
constellation	formation of stars perceived as a figure or design, especially one of 88 recognized groups named after characters from classical mythology and various common animals and objects
consumer	organisms requiring complex organic compounds for food, which is obtained by preying on other organisms or by eating particles of organic matter
contrail	artificial cloud created by an aircraft, caused either by condensation due to the reduction in air pressure above the wing surface, or by water vapor in the engine exhaust
controlled investigation	investigation in which all but one variable remain constant
convection	transfer of heat energy in a gas or liquid by the circulation of currents of matter from one region to another
cumulus	dense, white, fluffy, flat-based cloud with a multiple rounded top and a well-defined outline, usually formed by the ascent of thermally unstable air masses
data	factual information, from observations, organized for analysis
decomposer	organisms such as bacteria and fungi that feed and break down dead organisms, returning constituents of organic substances to the environment
deformation	alteration of shape, as by pressure or stress
deposition	1. act of depositing, especially the laying down of matter by a natural process 2. something deposited; a deposit

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GLOSSARY

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distinguish	to perceive or indicate differences; discriminate
dominant	of, relating to, or being an allele that produces the same phenotypic effect whether inherited with a homozygous or heterozygous allele
DNA	(Deoxyribonucleic acid) double strand of nucleotides that is a self-replicating molecule present in living organisms as the main constituent of chromosomes; contains the genetic code and transmits the heredity pattern
ecology	study of the interactions and relationships between and among organisms and their environment
ecosystem	all the organisms in a given area and the abiotic factors with which they interact
eclipse	partial or complete obscuring, relative to a designated observer, of one celestial body by another
e.g.	abbreviation for *for example*; precedes a non-exhaustive list of examples provided as options; other examples may be appropriate but not included (compare to i.e.)
electron	negatively charged fundamental particle in an atom
element	any of more than 100 fundamental substances that consist of atoms of only one atomic number and that singly or in combination constitute all matter
environment	sum of all external conditions affecting the life, development and survival of an organism, including the biotic (living) and abiotic (non-living) elements
erosion	group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the Earth's surface
eukaryotic	referring to a cell with a nucleus and other internal structure
experimentation	act of conducting a controlled test or investigation
extinct	no longer in existence
fertilization	1. act or process of initiating biological reproduction by insemination or pollination 2. union of male and female gametes to form a zygote
food chain	arrangement of the organisms of an ecological community according to the order of predation in which each uses the next as a food source
food web	totality of interacting food chains in an ecological community
force	**K-6:** push or pull that changes the motion or shape of an object **7- HS:** vector quantity that tends to produce an acceleration of a body in the direction of its application
formulate	to devise or invent
frequency	ratio of the number of times an event occurs in a series of trials of a chance experiment to the number of trials of the experiment performed; the number of cycles an oscillating system executes in one second
friction	force that resists relative motion between two bodies in contact
front (weather)	interface between air masses of different temperatures or densities

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gas	state of matter that does not have a definite shape or volume and is much less dense than a liquid because its molecules are far apart compared to their diameters
genotype	particular combination of genes in an organism
gravitation	universal force by which every body in the universe attracts every other body
gravity	attraction of the mass of the Earth, the Moon or a planet for bodies at or near its surface
greenhouse gas	atmospheric gas such as carbon dioxide, water vapor, and methane that allows incoming sunlight to pass through but absorbs infrared radiation radiated back from the Earth's surface, leading to the phenomenon whereby the Earth's atmosphere traps solar radiation
guided investigation	teacher-directed investigation
habitat	place or environment where a plant or animal naturally or normally lives and grows
hazardous waste	substance, such as nuclear waste or an industrial byproduct, that is potentially damaging to the environment and harmful to humans and other organisms
heredity	genetic transmission of characteristics from parent to offspring
heterogeneous	consisting of dissimilar elements or parts
homogeneous	uniform in structure or composition throughout
hydrosphere	aqueous envelope of the Earth, including the oceans, all lakes, streams, and underground waters, ice, and the aqueous vapor in the atmosphere
hypothesis	**K-5:** statement of an anticipated result of an investigation **6-HS:** proposed relationship among observable phenomena or an inferred explanation for those phenomena
i.e.	abbreviation for *that is*; precedes a specific list of items in which all of the items should be used (compare to e.g.)
igneous	relating to, resulting from, or suggestive of the intrusion or extrusion of magma or volcanic activity; rock formed from molten magma
inorganic	involving neither organic life nor the products of organic life **Chemistry:** of or relating to compounds not containing carbon
interdependence	state of organisms depending on each other and the environment for survival
interpretation	explanation
interrelationships	interactions between two or more objects or organisms
invertebrate	animal, such as an insect or mollusk, that lacks a backbone or spinal column
investigation	inquiry, research, or systematic examination
involuntary	not under the influence or control of the will; not voluntary; as, the involuntary movements of the body (involuntary muscle fibers)
isotope	any of two or more species of atoms of a chemical element with the same atomic number and nearly identical chemical behavior, but with differing atomic mass and mass number and different physical properties
law	statement that summarizes, identifies, or describes a relationship among observable phenomena

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lever	simple machine consisting of a rigid bar pivoted on a fixed point and used to transmit force, as in raising or moving a weight at one end by pushing down on the other
limiting factor	conditions or resources that control the size of a population
liquid	state of matter that does not hold a definite shape but occupies a definite volume because its molecules are in close contact
lithosphere	outer part of the Earth, consisting of the crust and upper mantle, approximately 100 km (62 mi.) thick
living	state of being alive
lunar	of, involving, caused by, or affecting the Moon
macroscopic	large enough to be perceived or examined by the unaided eye; large compared to a microscopic object
mass	property of a body that is a measure of its inertia and causes it to have weight in a gravitational field, that is commonly taken as a measure of the amount of material it contains
matter	anything that possesses mass and occupies volume
mean	average value of a set of numbers
meiosis	type of cell division that occurs during the reproduction of diploid organisms to produce the gametes. The double set of genes and chromosomes of the normal diploid cells is reduced during meiosis to a single haploid set in the gametes. Crossing-over and, therefore, recombination occur during a phase of meiosis
metamorphic	change in the constitution of rock; specifically, a pronounced change affected by pressure, heat and water that results in a more compact and more highly crystalline condition; a rock produced by these processes
meteor	bright trail or streak that appears in the sky when a meteoroid is heated to incandescence by friction with the Earth's atmosphere; also called falling star, meteor burst, shooting star
microscopic	too small to be seen by the unaided eye but large enough to be studied under a microscope; small compared to a macroscopic object
mimicry	resemblance of one organism to another or to an object in its surroundings for concealment and protection from predators
mitosis	cell division; cell division in multicellular organisms occurs by mitosis except for the special division called meiosis that generates the gametes
mixture	portion of matter consisting of two or more components in varying proportions that retain their own properties
model	schematic description or representation of a system, theory, or phenomenon that accounts for at least some of its known or inferred properties and may be used for further study of its characteristics
molecule	smallest particle of a chemical substance that retains all the properties of the substance and is composed of one or more atoms
mutation	change of the DNA sequence within a gene or chromosome of an organism
mutualism	close, prolonged association between organisms of two different species in which each member benefits; type of symbiotic relationship

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natural selection	process by which, in a given environment, individuals having characteristics that aid survival will produce more offspring, so the proportion of individuals having such characteristics will increase with each succeeding generation. Two mechanisms of natural selection include: • gradualism - slow genetic modification (evolution) of a population over long periods of time • punctuated equilibrium - relatively rapid evolution at a speciation event
neutron	uncharged elementary particle that has a mass a little greater than that of the proton and is present in most atomic nuclei
nonliving	objects that don't reproduce, grow, react, or use food
nonstandard units of measure	units of measurement based on everyday items (e.g., hands, feet, pace, candy, potato, paper clip) used as a precursor to learning and using standard units of measurement
mutualism	close, prolonged association between organisms of two different species in which each member benefits
nucleus	**Physical science:** central region of an atom, which contains more than 99% of the atom's mass **Life science:** cellular organelle in eukaryotes that contains most of the genetic material
observation	event that is experienced personally or enhanced through measurement or instruments
openness	mind set that allows a person to consider explanations of a phenomena
organic	of, relating to, or derived from living organisms **Chemistry:** having to do with carbon compounds
organism	living individual, such as a plant, animal, bacterium, protist, or fungus; a body made up of organs, organelles, or other parts that work together to carry on the various processes of life
periodic table	arrangement of the chemical elements by atomic number, starting with hydrogen in the upper left-hand corner and continuing in ascending order from left to right, arranged in columns according to similar chemical properties
pH	numerical measure of the acidity or alkalinity of a chemical solution; the negative of the logarithm of the hydrogen ion concentration
phenotype	physical or visible characteristics of an organism that are determined by its genotype
photosynthesis	chemical process by which chlorophyll-containing plants use light to convert carbon dioxide and water into carbohydrates, releasing oxygen as a byproduct
pitch	aurally perceived property of a sound, especially a musical tone, that is determined by the frequency of the waves producing it; highness or lowness of sound
plane	flat or level surface
plate tectonics	theory that explains the global distribution of geological phenomena such as seismicity, volcanism, continental drift, and mountain building in terms of the formation, destruction, movement, and interaction of the Earth's lithospheric plates; the theory that the earth's crust is broken into fragments (plates) which move in relation to one another, shifting continents, forming new crust, and causing volcanic eruptions
population	group of organisms of the same species living and reproducing in a particular habitat or geographic region

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population density	number of organisms per unit area
precipitation	any form of water, such as rain, snow, sleet, or hail, which falls to the Earth's surface
predict	to forecast a future occurrence based on past observations or the extension of an idea
prediction	statement of an expected (future) outcome of a planned test assuming that the hypothesis being tested is correct; to be compared with observed result to test the hypothesis
preservation	to keep in perfect or unaltered condition; maintain unchanged
probability	measure of the likelihood of an event occurring
procedures	series of steps taken to accomplish an end
producer	organisms (e.g., green plants) that produce their own organic compounds from simple precursors (such as carbon dioxide and inorganic nitrogen), many of which are food sources for other organisms
prokaryotic	referring to a cell with no nucleus (e.g., a bacterium)
property	characteristic attribute possessed by all members of a class
propose	to put forward for consideration, discussion, or adoption
proton	stable subatomic particle occurring in all atomic nuclei, with a positive electric charge equal in magnitude to that of an electron
pulley	simple machine consisting of a wheel with a grooved rim in which a pulled rope or chain can run to change the direction of the pull and thereby lift a load
pure science	science for the pursuit of scientific knowledge
qualitative	involving quality or kind
quantitative	involving the measurement of quantity or amount
radiation	**Physical science:** transfer of energy by electromagnetic radiation; process of emitting energy in the form of waves or particles (e.g., visible light, X-rays, alpha and beta radiation). **Life science:** the geographic spreading of a species
recessive	of, relating to, or designating an allele that does not produce a characteristic effect when present with a dominant allele
reflect	to throw or bend back (light, for example) from a surface
refract	to deflect from a straight path undergone by light or other wave in passing obliquely from one medium (e.g., air) into another (e.g., glass) in which its speed is different
reliability	to yield the same or compatible results in different clinical experiments or statistical trials
respiration	physical and chemical processes by which an organism supplies its cells and tissues with the oxygen needed for metabolism and relieves them of the carbon dioxide formed in energy-producing reactions
revolution	orbital motion about a point, especially as distinguished from axial rotation
RNA	(Ribonucleic acid) nucleic acids that contains ribose and uracil as structural components and is associated with the control of cellular chemical activities

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rotation	act or process of turning around a center or an axis; the turning of a body part about its long axis as if on a pivot
sedimentary	of or relating to rocks formed by the deposition of sediment
sexual	relating to, produced by, or involving reproduction characterized by the union of male and female gametes
simple investigation	investigation involving a single variable
solid	body of definite shape and volume; not liquid or gaseous
species	class of individuals or objects grouped by virtue of their common attributes and their ability to mate and produce fertile offspring, and assigned a common name; a division subordinate to a genus
spectrophotometer	instrument used to determine the intensity of various wavelengths in a spectrum of light
stimulus	object or event that causes a response
stratus	low-altitude cloud formation consisting of a horizontal layer of clouds
structures	way in which parts are arranged or put together to form a whole; makeup **Life science:** arrangement or formation of the tissues, organs, or other parts of an organism; an organ or other part of an organism
subsystem	component of a system (e.g., a solar system is a subsystem of a galaxy)
symbiotic relationship	close, prolonged association between organisms of two different species that may, but does not necessarily, benefit each member; includes mutualism, commensalisms, and parasitism
system	1. group of body organs that together perform one or more vital functions 2. organized group of devices, parts or factors that together perform a function or drive a process (e.g., weather system, mechanical system)
technology	application of science, especially to industrial or commercial objectives; tools and techniques
temperature	degree of hotness or coldness of a body or environment
theory	collection of statements (conditions, components, claims, postulates, propositions) that when taken together attempt to explain a broad class of related phenomena; inferred explanations for observable phenomena
transient	not regular or permanent
U.S. customary units	measuring system used most often in the United States (e.g., inches, pounds, gallons)
valid	correctly inferred or deduced from a premise
variable	characteristic with values (e.g., numbers, colors, sizes) that differ from one object, event, or situation in a group to the others; e.g., in a group of students, their heights differ, thus "height" is a variable • independent: manipulated variable in an experiment or study whose presence or quantity determines the change in the dependent variable • dependent: observed variable in an experiment or study whose changes are determined by the presence or quantity of one or more independent variables

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vector	representation of a quantity having both magnitude and direction, such as velocity or force
velocity	rate of change of position and direction with respect to time
Venn Diagram	representation that uses circles to show relationships between sets
vertebrate	having a backbone or spinal column
viable	capable of living, developing, or germinating under favorable conditions
volume	measure of the capacity of a three-dimensional figure or object, measured in cubic units
voluntary	normally controlled by or subject to individual volition, such as voluntary muscle contractions
weathering	effect of exposure to the action of the elements
wedge	piece of material, such as metal or wood, thick at one edge and tapered to a thin edge at the other for insertion in a narrow crevice, used for splitting, tightening, securing, or levering
wheel and axle	simple machine made up of two coaxial cylindrical objects of different size in which the axle (a small wheel) is attached to the center of a larger wheel; the wheel and axle must move together to be a simple machine; a wheel and axle lifts or moves loads

Processes

analyze	to examine methodically by separating into parts and studying their interrelations
classify	to arrange or organize according to category
compare	to examine in order to note the similarities or differences of
communicate	to convey information about; make known; express oneself in such a way that one is readily and clearly understood
conclusion	statement, or statements, that summarize the extent to which hypotheses have been supported or not supported
evaluate	to examine and judge carefully; appraise
infer	to conclude from evidence or premises
interpret	to explain the meaning of
justify	to demonstrate or prove to be just, right, or valid
measure	to ascertain the dimensions, quantity, or capacity of
observe	to be or become aware of, through one's senses, and may include qualitative or quantitative data
predict	to forecast a future occurrence based on past observation or the extension of an idea
question	to ask
result	quantity or expression obtained by calculation