



EarthComm Correlation to Arizona Earth and Space Science Standards, Grades 9-12

Strand 1: Inquiry Process

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

Concept	Performance Standards	Location/Page where Standard is found
Concept 1: Observations, Questions, and Hypotheses: Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.	PO 1. Evaluate scientific information for relevance to a given problem	Throughout, for example: G4-13, G14-22, G74-84, G95-104, G155-163, F2-12, R62-71, R72-83
	PO 2. Develop questions from observations that transition into testable hypotheses.	Throughout, for example: G4-13, G14-22, G74-84, G95-104, G155-163, F2-12, R62-71, R72-83
	PO 3. Formulate a testable hypothesis.	Throughout, for example: G4-13, G14-22, G74-84, G95-104, G155-163, F2-12, R62-71, R72-83

	PO 4. Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).	E125-129, R118-126, R184-195, G4-13, G14-22, G74-84, G122-130, G131-137, G155-163
Concept 2: Scientific Testing (Investigating and Modeling): Design and conduct controlled investigations.	PO 1. Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, organisms) and behavior in all science inquiry.	F4-12, F13-22, F77-87, F128-137, R25-34, R62-71
	PO 2. Identify the resources needed to conduct an investigation.	G4-13, G14-22, G74-84, G95-104, G155-163, F2-12, R62-71, R72-83
	PO 3. Design an appropriate protocol (written plan of action) for testing a hypothesis: <ul style="list-style-type: none"> • 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). 	G4-13, G14-22, G74-84, G95-104, G155-163, F2-12, R62-71, R72-83
	PO 4. Conduct a scientific investigation that is based on a research design.	G4-13, G14-22, G74-84, G95-104, G155-163, F2-12, R62-71, R72-83

	PO 5. Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.	U124-126, U131-134, R169-171, R172-176
Concept 3: Analysis, Conclusions, and Refinements: Evaluate experimental design, analyze data to explain results and propose further investigations. Design models.	PO 1. Interpret data that show a variety of possible relationships between variables, including: <ul style="list-style-type: none"> • positive relationship • negative relationship • no relationship 	G23-30, G62-73, G74-84, G131-137, U70-80, U90-99, F4-12, F128-137, F138-148, E96-104, E125-135
	PO 2. Evaluate whether investigational data support or do not support the proposed hypothesis.	G122-130, G155-163, E173-181
	PO 3. Critique reports of scientific studies (e.g., published papers, student reports).	G105-109, G110-117, R184-188, R189-195
	PO 4. Evaluate the design of an investigation to identify possible sources of procedural error, including: <ul style="list-style-type: none"> • sample size • trials • controls • analyses 	E28-36, E37-40, E41-46
	PO 5. Design models (conceptual or physical) of the following to represent "real world" scenarios: <ul style="list-style-type: none"> • carbon cycle • water cycle • phase change • collisions 	R43-52, R184-195, R146-155, E37-46, E125-135, F128-137

	<p>PO 6. Use descriptive statistics to analyze data, including:</p> <ul style="list-style-type: none"> • mean • frequency • range 	R62-71, R127-135, E37-46, E47-57, E125-135, F138-148
	PO 7. Propose further investigations based on the findings of a conducted investigation.	F13-22, F37-47, G155-163
Concept 4: Communication: Communicate results of investigations.	PO 1. For a specific investigation, choose an appropriate method for communicating the results.	U124-126, U131-134, R169-171, R172-176, R184-188, R189-195
	PO 2. Produce graphs that communicate data.	U124-126, U131-134, R169-171, R172-176, R184-188, R189-195
	PO 3. Communicate results clearly and logically.	U124-126, U131-134, R169-171, R172-176, R184-188, R189-195
	PO 4. Support conclusions with logical scientific arguments.	G122-130, G131-137, E173-181

Strand 2: History and Nature of Science

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

Concept	Performance Standards	Location/Page where Standard is found
Concept 1: History of Science as a Human Endeavor: Identify individual, cultural, and technological contributions to scientific knowledge.	PO 1. Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.	E80, R142, R203, F124
	PO 2. Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.	E80, R142, R203, F124
	PO 3. Analyze how specific changes in science have affected society.	F88-94, F113-123, E4-13, G131-137, G155-163, G164-171
	PO 4. Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.	E80, R142, R203, F124
Concept 2: Nature of Scientific Knowledge: Understand how science is a process for generating knowledge.	PO 1. Specify the requirements of a valid, scientific explanation (theory), including that it be: <ul style="list-style-type: none"> • logical • subject to peer review • public • respectful of rules of evidence 	G38-42, G62-67, G68-77, G105-116, F13-22, F37-47, F48-55, U57-65

	PO 2. Explain the process by which accepted ideas are challenged or extended by scientific innovation.	F45, E37-46, E74-77, G105-109, G110-116
	PO 3. Distinguish between pure and applied science.	F45, E37-46, E74-77, G105-109, G110-116
	PO 4. Describe how scientists continue to investigate and critically analyze aspects of theories.	F13-22, F23-36, F37-47, E117-124, U57-65, G105-109, G110-116

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	Performance Standards	Location/Page where Standard is found
Concept 1: Changes in Environments. Describe the interactions between human populations, natural hazards, and the environment.	PO 1. Evaluate how the processes of natural ecosystems affect, and are affected by, humans.	R4-15, R43-52, R53-61, R72-83, R184-195, R196-202, U113-119, U131-137, U155-162
	PO 2. Describe the environmental effects of the following natural and/or human-caused hazards: <ul style="list-style-type: none"> • flooding • drought • earthquakes • fires 	F48-55, F95-102, F113-123, F174-179, U138-145, G23-30, G31-37, G147-154, G155-163

	<ul style="list-style-type: none"> • pollution • extreme weather 	
	PO 3. Assess how human activities (e.g., clear cutting, water management, tree thinning) can affect the potential for hazards.	R43-52, F37-47, F48-55, F56-62, U163-170
	PO 4. Evaluate the following factors that affect the quality of the environment: <ul style="list-style-type: none"> • urban development • smoke • volcanic dust 	G31-37, G38-42, U131-137, R43-52, R127-135, E125-135, E136-143
	PO 5. Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity.	R43-52, F37-47, F48-55, F56-62
Concept 2: Science and Technology in Society. Develop viable solutions to a need or problem.	PO 1. Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems: <ul style="list-style-type: none"> • various forms of alternative energy • storage of nuclear waste • abandoned mines • greenhouse gases • hazardous wastes 	R35-42, R43-52, R72-83, R88-95, R118-126, R127-135, F37-47, F48-55, F56-62, E125-135, E136-145
	PO 2. Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.	E4-13, E125-135, E136-142, E182-188, F13-22, G105-119, U113-121
	PO 3. Support a position on a science or technology issue.	G164-172, U122-123, U163-170

	<p>PO 4. Analyze the use of renewable and nonrenewable resources in Arizona:</p> <ul style="list-style-type: none"> • water • land • soil • minerals • air 	<p>R4-15, R96-110, R146-155, R156-167, R169-176, R177-183, E125-135, E47-57, U155-162, U124-130</p>
	<p>PO 5. Evaluate methods used to manage natural resources (e.g., reintroduction of wildlife, fire ecology).</p>	<p>R4-15, R96-110, R146-155, R156-167, R169-176, R177-183, E125-135, E47-57, U155-162, U124-130</p>
<p>Concept 3: Human Population Characteristics Analyze factors that affect human populations.</p>	<p>PO 1. Analyze social factors that limit the growth of a human population, including:</p> <ul style="list-style-type: none"> • affluence • education • access to health care • cultural influences 	<p>R4-15, F56-61, E156-164, E165-172</p>
	<p>PO 2. Describe biotic (living) and abiotic (nonliving) factors that affect human populations.</p>	<p>R4-15, F56-61, E156-164, E165-172</p>
	<p>PO 3. Predict the effect of a change in a specific factor on a human population.</p>	<p>R4-15, F56-61, E156-164, E165-172</p>

Concept	Performance Standards	Location/Page where Standard is found
Concept 1: The Cell Understand the role of the cell and cellular processes.	PO 1. Describe the role of energy in cellular growth, development, and repair.	R25-34
	PO 2. Compare the form and function of prokaryotic and eukaryotic cells and their cellular components.	E182-188
	PO 3. Explain the importance of water to cells.	F56-62
	PO 4. Analyze mechanisms of transport of materials (e.g., water, ions, macromolecules) into and out of cells: <ul style="list-style-type: none"> • passive transport • active transport 	
	PO 5. Describe the purposes and processes of cellular reproduction.	
Concept 2: Molecular Basis of Heredity: Understand the molecular basis of heredity and resulting genetic diversity.	PO 1. Analyze the relationships among nucleic acids (DNA, RNA), genes, and chromosomes.	

	PO 2. Describe the molecular basis of heredity, in viruses and living things, including DNA replication and protein synthesis.	
	PO 3. Explain how genotypic variation occurs and results in phenotypic diversity.	E148-155, E165-172
	PO 4. Describe how meiosis and fertilization maintain genetic variation.	E148-155, E165-172, E173-181, E182-188
Concept 3: Interdependence of Organisms: Analyze the relationships among various organisms and their environment.	PO 1. Identify the relationships among organisms within populations, communities, ecosystems, and biomes.	E156-164, E165-172, E173-181, E182-188, F56-61, F180-188, R4-15
	PO 2. Describe how organisms are influenced by a particular combination of biotic (living) and abiotic (nonliving) factors in an environment.	E156-164, E165-172, F56-61, R4-15
	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.	E156-164, E165-172, F56-61, R4-15

<p>Concept 4: Biological Evolution Understand the scientific principles and processes involved in biological evolution.</p>	<p>PO 1. Identify the following components of natural selection, which can lead to speciation:</p> <ul style="list-style-type: none"> • 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 	<p>E148-155, E165-172, E173-181, E182-188</p>
	<p>PO 2. Explain how genotypic and phenotypic variation can result in adaptations that influence an organism's success in an environment.</p>	<p>E148-155, E165-172, E173-181, E182-188, F56-61</p>
	<p>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.</p>	<p>E148-155, E165-172, E173-181, E182-188, F56-61</p>
	<p>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.</p>	<p>E148-155, E165-172, E173-181, E182-188, F56-61, R4-15</p>
	<p>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.</p>	<p>E148-155, E165-172, E173-181, E182-188</p>

	PO 6. Analyze, using a biological classification system (i.e., cladistics, phylogeny, morphology, DNA analysis), the degree of relatedness among various species.	E182-188
Concept 5: Matter, Energy, and Organization in Living Systems (Including Human Systems): Understand the organization of living systems, and the role of energy within those systems.	PO 1. Compare the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products.	E148-155, R25-34
	PO 2. Describe the role of organic and inorganic chemicals (e.g., carbohydrates, proteins, lipids, nucleic acids, water, ATP) important to living things.	E148-155, F56-61
	PO 3. Diagram the following biogeochemical cycles in an ecosystem: <ul style="list-style-type: none"> • water • carbon • nitrogen 	R4-15, R43-61, R146-155, R184-195, E125-135
	PO 4. Diagram the energy flow in an ecosystem through a food chain.	R4-15, R43-61, R72-83, F56-61, E148-155, E156-164, E165-172
	PO 5. Describe the levels of organization of living things from cells, through tissues, organs, organ systems, organisms, populations, and communities to ecosystems.	E182-188

Strand 6: Earth and Space Science

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

Concept	Performance Standards	Location/Page where Standard is found
Concept 1: Geochemical Cycles Analyze the interactions between the Earth's structures, atmosphere, and geochemical cycles.	PO 1. Identify ways materials are cycled within the Earth system (i.e., carbon cycle, water cycle, rock cycle).	R4-15, R43-61, R146-155, R184-195, E125-135, U4-13, U14-22, U23-32, U33-38
	PO 2. Demonstrate how dynamic processes such as weathering, erosion, sedimentation, metamorphism, and orogenesis relate to redistribution of materials within the Earth system.	U4-13, U14-22, U23-32, U39-48, U49-56, U57-65, U70-80, U81-89, U90-99, U100-112, U146-154, U155-162, R111-117
	PO 3. Explain how the rock cycle is related to plate tectonics.	G74-84, G85-94, G95-104
	PO 4. Demonstrate how the hydrosphere links the biosphere, lithosphere, cryosphere, and atmosphere.	E117-124, E125-135, E136-143, G4-13, U131-137, F4-12, F23-36, F37-47, F48-55, F158-166, F167-173, F149-157, R146-155

	PO 5. Describe factors that impact current and future water quantity and quality including surface, ground, and local water issues.	R146-155, R156-168, R169-176, R177-183, R184-195, R196-202, U124-130, U100-112
	PO 6. Analyze methods of reclamation and conservation of water.	R156-168, R169-176, R177-183, R196-202
	PO 7. Explain how the geochemical processes are responsible for the concentration of economically valuable minerals and ores in Arizona and worldwide.	R111-117, R118-126
Concept 2: Energy in the Earth System (Both Internal and External): Understand the relationships between the Earth's land masses, oceans, and atmosphere.	PO 1. Describe the flow of energy to and from the Earth.	E47-57, E105-116, E117-124, E125-135, E136-143, E156-164, F4-12, F23-36, G85-94, U131-137
	PO 2. Explain the mechanisms of heat transfer (convection, conduction, radiation) among the atmosphere, land masses, and oceans.	E47-57, E105-116, E117-124, E125-135, E136-143, E156-164, F4-12, F23-36, G85-94, U131-137
	PO 3. Distinguish between weather and climate.	E84-95, E156-164, F48-55
	Internal Energy: PO 4. Demonstrate the relationship between the Earth's internal convective heat flow and plate tectonics.	G85-94, G95-104, G105-117
	PO 5. Demonstrate the relationships among earthquakes, volcanoes, mountain ranges, mid-oceanic ridges, deep sea trenches, and tectonic plates.	G4-13, G14-22, G62-74, G74-84, G85-94, G95-104, G105-117,
	PO 6. Distinguish among seismic S, P, and surface waves.	G131-137, G122-130, G138-146

	PO 7. Analyze the seismic evidence (S and P waves) used to determine the structure of the Earth.	G51-57, G62-73, G122-130, G131-137, G138-146, G147-154
	PO 8. Describe how radioactive decay maintains the Earth's internal temperature.	G85-94
	External Energy: PO 9. Explain the effect of heat transfer on climate and weather.	E84-95, E105-116, E117-124, E125-135, E136-143
	PO 10. Demonstrate the effect of the Earth's rotation (i.e., Coriolis effect) on the movement of water and air.	E105-116
	PO 11. Describe the origin, life cycle, and behavior of weather systems (i.e., air mass, front, high and low systems, pressure gradients).	F66-76, F77-87, F88-94, F103-112, F113-123
	PO 12. Describe the conditions that cause severe weather (e.g., hurricanes, tornadoes, thunderstorms).	F66-76, F77-87, F88-94, F103-112, F113-123
	PO 13. Propose appropriate safety measures that can be taken in preparation for severe weather.	F95-102, F1-3-112, F113-123
	PO 14. Analyze how weather is influenced by both natural and artificial Earth features (e.g., mountain ranges, bodies of water, cities, air pollution).	E84-95, E105-116, E117-124, E125-135, U131-137
	PO 15. List the factors that determine climate (e.g., altitude, latitude, water bodies, precipitation, prevailing winds, topography).	E84-95, E105-116, E117-124, E125-135, U131-137
	PO 16. Explain the causes and/or effects of climate changes over long periods of time (e.g., glaciation, desertification, solar activity, greenhouse effect).	E96-104, F138-148, F149-157, F158-166, F167-173, F180-188

	PO 17. Investigate the effects of acid rain, smoke, volcanic dust, urban development, and greenhouse gases, on climate change over various periods of time.	G31-37, G38-42, E125-135, E136-143, U131-137
Concept 3: Origin and Evolution of the Earth System Analyze the factors used to explain the history and evolution of the Earth.	Earth Origin/System: PO 1. Describe the scientific theory of the origin of the solar system (solar nebular hypothesis).	E4-13, E37-46, E58-68, E69-79
	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.	E14-27, E28-36, E37-46, E47-57, E58-68
	PO 3. Explain the phases of the Moon, eclipses (lunar and solar), and the interaction of the Sun, Moon, and Earth (tidal effect).	E14-22
	Earth History/Evolution: PO 4. Interpret a geologic time scale.	U49-56, U57-65, E148-155, E156-164, E172-181
	PO 5. Distinguish between relative and absolute geologic dating techniques.	E148-155, U49-56
	PO 6. Investigate scientific theories of how life originated on Earth (high temperature, low oxygen, clay catalyst model).	E148-155, E156-164, E165-172
	PO 7. Describe how life on Earth has influenced the evolution of the Earth's systems.	E148-155, E156-164, E182-188
	PO 8. Sequence major events in the Earth's evolution (e.g., mass extinctions, glacial episodes) using relative and absolute dating data.	E148-155, E156-164, E182-188, U49-56, U57-65

	PO 9. Analyze patterns in the fossil record related to the theory of organic evolution.	E148-155, E156-164,, E173-181, E182-188
Concept 4: Origin and Evolution of the Universe: Analyze the factors used to explain the origin and evolution of the universe.	PO 1. Describe the Big Bang Theory as an explanation for the origin of the universe.	E4-13
	PO 2. Describe the fusion process that takes place in stars.	E47-57, E69-79
	PO 3. Analyze the evolution of various types of stars using the Hertzsprung-Russell (HR) diagram	E69-79
	PO 4. Compare the evolution (life cycles) of stars of different masses (low and high mass).	E69-79
	PO 5. Explain the formation of the light elements in stars and the heavier elements (what astronomers call “metals”) in supernova explosions.	E69-79, E4-13
	PO 6. Explain the evolution and life cycles of galaxies.	E69-79, E4-13

Key:

G: Earth’s Dynamic Geosphere

U: Understanding Your Environment

F: Earth’s Fluid Sphere

R: Earth’s Natural Resources

E: Earth System Evolution