

# Arizona Science Standards - High School Essential Standards

Physical Science Standards	
<b>HS.P1U1.1</b>	Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed within the Periodic Table and describe how these models are revised with new evidence.
<b>HS.P1U1.2</b>	Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.
<b>HS.P1U1.3</b>	Ask questions, plan, and carry out investigations to explore the cause and effect relationship between reaction rate factors.
<b>HS.P1U3.4</b>	Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.
<b>HS.P2U1.5</b>	Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic).
<b>HS.P3U1.6</b>	Collect, analyze, and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws.
<b>HS.P3U2.7</b>	Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends.
<b>HS.P4U1.8</b>	Engage in argument from evidence that the net change of energy in a system is always equal to the total energy exchanged between the system and the surroundings.
<b>HS.P4U3.9</b>	Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.
<b>HS.P4U1.10</b>	Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.

Earth and Space Science Standards	
<b>HS.E1U1.11</b>	Analyze and interpret data to determine how energy from the Sun affects weather patterns and climate.
<b>HS.E1U1.12</b>	Develop and use models of the Earth that explains the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere).
<b>HS.E1U1.13</b>	Evaluate explanations and theories about the role of energy and matter in geologic changes over time.
<b>HS.E1U3.14</b>	Engage in argument from evidence about the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other.
<b>HS.E2U1.15</b>	Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star.
<b>HS.E2U1.16</b>	Construct an explanation of how gravitational forces impact the evolution of planetary motion, structure, surfaces, atmospheres, moons, and rings.
<b>HS.E2U1.17</b>	Construct an explanation of the origin, expansion, and scale of the universe based on astronomical evidence.

Life Science Standards	
<b>HS.L2U3.18</b>	Obtain, evaluate, and communicate about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem.
<b>HS.L2U1.19</b>	Develop and use models that show how changes in the transfer of matter and energy within an ecosystem and interactions between species may affect organisms and their environment.
<b>HS.L1U1.20</b>	Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
<b>HS.L2U1.21</b>	Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.
<b>HS.L1U1.22</b>	Construct an explanation for how cellular division (mitosis) is the process by which organisms grow and maintain complex, interconnected systems.
<b>HS.L1U3.23</b>	Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.
<b>HS.L3U1.24</b>	Construct an explanation of how the process of sexual reproduction contributes to genetic variation.
<b>HS.L3U1.25</b>	Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.
<b>HS.L3U3.26</b>	Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
<b>HS.L4U1.27</b>	Obtain, evaluate, and communicate evidence that describes how changes in frequency of inherited traits in a population can lead to biological diversity.
<b>HS.L4U1.28</b>	Gather, evaluate, and communicate multiple lines of empirical evidence to explain the mechanisms of biological evolution.



# Arizona Science Standards - High School Earth & Space Science Essential and Plus Standards

Earth and Space Science Standards	
<b>HS.E1U1.11</b>	Analyze and interpret data to determine how energy from the Sun affects weather patterns and climate.
HS+E.E1U1.1	Construct an explanation based on evidence for how the Sun's energy transfers between Earth's systems.
HS+E.E1U1.2	Develop and use models to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS+E.E1U1.3	Analyze geoscience data and the results from global climate models to make evidence-based predictions of current rate and scale of global or regional climate changes.
<b>HS.E1U1.12</b>	Develop and use models of the Earth that explains the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere).
HS+E.E1U1.4	Analyze and interpret geoscience data to make the claim that dynamic interactions with Earth's surface can create feedbacks that cause changes to other Earth systems.
HS+E.E1U1.5	Obtain, evaluate, and communicate information on the effect of water on Earth's materials, surface processes, and groundwater systems.

Essential standards are standards that will be assessed on the state exam and are intended for ALL students to have learned by the end of 3 credits of high school science courses.

Earth and space Plus (+) Standards HS+E are supporting standards designed to be used with the essential standards for students taking a high school earth and space (E) course.

Earth and Space Science Standards	
<b>HS.E1U1.13</b>	Evaluate explanations and theories about the role of energy and matter in geologic changes over time.
HS+E.E1U1.6	Obtain, evaluate, and communicate information of the theory of plate tectonics to explain the differences in age, structure, and composition of Earth's crust.
HS+E.E1U1.7	Engage in argument from evidence of ancient Earth materials, meteorites, and other planetary surfaces to explain Earth's formation and early history.
HS+E.E1U1.8	Develop and use models to illustrate how Earth's internal and surface processes operate over time to form, modify, and recycle continental and ocean floor features.
<b>HS.E1U3.14</b>	Engage in argument from evidence about the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other
HS+E.E1U3.9	Construct an explanation, based on evidence, for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
HS+E.E1U3.10	Ask questions, define problems, and evaluate a solution to a complex problem, based on prioritized criteria and tradeoffs, that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
HS+E.E1U3.11	Develop and use a quantitative model to illustrate the relationship among Earth systems and the degree to which those relationships are being modified due to human activity.

Earth and Space Science Standards	
<b>HS.E2U1.15</b>	Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star.
HS+E.E2U1.12	Obtain, evaluate, and communicate scientific information about the way stars, throughout their stellar stages, produce elements and energy
<b>HS.E2U1.16</b>	Construct an explanation of how gravitational forces impact the evolution of planetary motion, structure, surfaces, atmospheres, moons, and rings.
HS+E.E2U1.13	Analyze and interpret data showing how gravitational forces are influenced by mass, and the distance between objects.
HS+E.E2U1.14	Use mathematics and computational thinking to explain the movement of planets and objects in the solar system.
<b>HS.E2U1.17</b>	Construct an explanation of the origin, expansion, and scale of the universe based on astronomical evidence.
HS+E.E2U1.15	Obtain, evaluate, and communicate information on how the nebular theory explains solar system formation with distinct regions characterized by different types of planetary and other bodies.
HS+E.E2U1.16	Obtain, evaluate, and communicate information about patterns of size and scale of our solar system, our galaxy, and the universe.
HS+E.E2U2.17	Obtain, evaluate, and communicate the impact of technology on human understanding of the formation, scale, and composition of the universe.

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# Arizona Science Standards - High School Essential Standards and Elements

Earth and Space Science Standards
<p><b>HS.E1U1.11</b> Analyze and interpret data to determine how energy from the Sun affects weather patterns and climate.</p> <ul style="list-style-type: none"> <li>The foundation for Earth's global climate system is the electromagnetic radiation from the Sun as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems and this energy's reradiation into space.</li> </ul>
<p><b>HS.E1U1.12</b> Develop and use models of the Earth that explains the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere).</p> <ul style="list-style-type: none"> <li>Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.</li> <li>Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, and a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.</li> <li>The geologic record shows that changes to global and regional climate can be caused by interactions among changes in the Sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.</li> </ul> <p><i>Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and seafloor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion). This does not include memorization of the details of the formation of specific geographic features of Earth's surface. Emphasis is also on both a one dimensional model of Earth, with radial layers determined by density, and a three dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high pressure laboratory experiments.</i></p>

Earth and Space Science Standards
<p><b>HS.E1U1.13</b> Evaluate explanations and theories about the role of energy and matter in geologic changes over time.</p> <ul style="list-style-type: none"> <li>Continental rocks, which can be older than 4 billion years, are generally much older than rocks on the ocean floor, which are less than 200 million years old.</li> <li>The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.</li> </ul>
<p><b>HS.E1U3.14</b> Engage in argument from evidence about the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other.</p> <ul style="list-style-type: none"> <li>Resource availability has guided the development of human society.</li> <li>Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly over Earth's history. Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.</li> <li>Natural hazards and other geologic events have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations.</li> <li>The sustainability of human societies and biodiversity that supports them requires responsible management of natural resources.</li> </ul>
<p><b>HS.E2U1.15</b> Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star.</p> <ul style="list-style-type: none"> <li>Our Sun is one of many stars that make up the Universe, essentially made of hydrogen. The source of energy that the Sun and all stars radiate comes from nuclear reactions in their central cores.</li> <li>Nuclear fusion processes in the center of the Sun release the energy that ultimately reaches Earth as radiation.</li> <li>Other than hydrogen and helium formed at the time of the big bang, nuclear fusion within stars produce all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.</li> </ul>

Earth and Space Science Standards
<p><b>HS.E2U1.16</b> Construct an explanation of how gravitational forces impact the evolution of planetary motion, structure, surfaces, atmospheres, moons, and rings.</p> <ul style="list-style-type: none"> <li>Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the Sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.</li> <li>Cyclical changes in the shape of Earth's orbit around the Sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the Earth. These phenomena cause a cycle of ice ages and other gradual climate changes.</li> </ul> <p><i>Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and Moons.</i></p> <p><i>Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler's laws of orbital motions should not deal with more than two bodies, nor involve calculus.</i></p>
<p><b>HS.E2U1.17</b> Construct an explanation of the origin, expansion, and scale of the universe based on astronomical evidence.</p> <ul style="list-style-type: none"> <li>The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.</li> <li>The big bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.</li> </ul> <p><i>Clarification Statement: Emphasis is on the astronomical evidence of the redshift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the big bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the big bang theory (3/4 hydrogen and 1/4 helium).</i></p>

**The elements are not to be used as a check-off list, but rather a useful tool to help educators identify the specific pieces of knowledge and skill that make up the practice, crosscutting concept, or core idea at that grade-band.**



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