



Arizona Science Standards 2018 DRAFT

Arizona Department of Education
High Academic Standards for Students
DRAFT 2018 DRAFT

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. Scientific thinking enables Arizona students to strengthen skills that people use everyday: 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 testing possible explanations or design solutions. Active engagement in scientific investigation leads students to think critically and to develop reasoning skills that allow them to become independent, lifelong learners.~~ A fundamental goal of science education is to help students determine how the world works and make sense of phenomena in the natural world. Phenomena are events or situations that are observed to exist or happen, especially phenomena whose causes or explanations are in question. Science sense-making is a conceptual process in which a learner actively engages with phenomena in the natural world to construct logical and coherent explanations that incorporate their current understanding of science, or a model that represents it, and are consistent with the available evidence. To develop a scientific understanding of the natural world, students must be able to ask questions, gather information, reason about that information and connect it to scientific principles, theories, or models, and then effectively communicate their understanding and reasoning.

Design Purpose of the Arizona Science Standards

~~The Arizona Science Standards present a vision of what it means to be scientifically literate, and college and career ready. These standards define the knowledge, understanding, and skills that need to be effectively taught and learned for all students to be scientifically literate. The Arizona scientifically literate are ready to succeed in college entry courses, in the workplace, in military service, and engage in civic responsibilities related to science issues.~~ These Arizona Science standards outline what all students need to know, understand, and be able to do by the end of high school and reflect the following shifts for science education:

- Organize standards around fourteen core ideas and develop learning progressions to coherently and logically build scientific literacy from kindergarten through high school.
- Connect **core ideas**, **crosscutting concepts**, and **science and engineering practices**, to make sense of the natural world and understand how science and engineering are practiced and experienced.
- Focus on fewer, broader standards that allow for greater depth, more connections, deeper understanding, and more applications of content.

Commented [1]: moving to beginning

The standards are neither curriculum nor instructional practices.

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While the Arizona Science Standards serve as the basis for a district's or school's science curriculum, they are not the curriculum. Therefore, identifying the sequence of instruction at each grade – what will be taught and for how long – requires concerted effort and attention at the local level. Curricular tools, including textbooks, are selected by the district/school and adopted through the local governing board. The Arizona Department of Education defines standards, curriculum, and instruction as:

- **Standards** are what a student needs to know, understand, and be able to do by the end of each grade. They build across grade levels in a progression of increasing understanding and through a range of cognitive demand levels. Standards are adopted at the state level by the Arizona State Board of Education.
- **Curriculum** refers to resources used for teaching and learning the standards. Curricula are adopted at the local level.
- **Instruction** refers to the methods or methodologies used by teachers to teach their students. Instructional techniques are employed by individual teachers in response to the needs of the students in their classes to help them progress through the curriculum to master the standards. Decisions about instructional practice and techniques are made at a local level.

Three Dimensions of Science

Sense-making in science occurs with the integration of these three major-essential dimensions: each intersects with the others and plays an essential role. These dimensions are:

- **science and engineering practices** (shown as the outer ring in Figure 1)
- **crosscutting concepts** (shown as the middle section of Figure 1)
- **core ideas** (shown as the center circle in Figure 1)

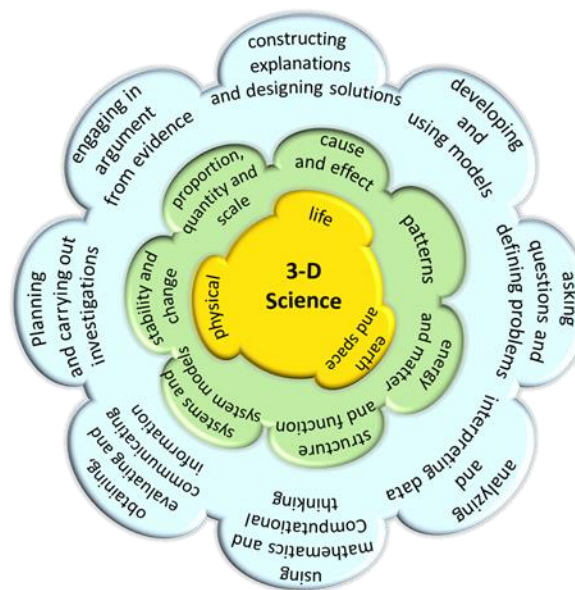


Figure 1: Three Dimensions of Science Instruction

Science and Engineering Practices

~~Formerly known as the scientific method,~~ The science and engineering practices⁴ describe a robust process for how scientists investigate and build models and theories of the natural world or how engineers design and build systems. Rather than a linear process from hypothesis to conclusion, these practices reflect science and engineering as they are practiced and experienced. As students conduct investigations, they engage in multiple practices as they gather information to solve problems, answer their questions, reason about how the data provide evidence to support their understanding, and then communicate their understanding of phenomena. Student investigations may be observational, experimental, use models or simulations, or use data from other sources. These eight practices identified in *A Framework for K-12 Science Education* are critical components of scientific literacy, not instructional strategies:

- ask questions and define problems
- develop and use models
- plan and carry out investigations
- analyze and interpret data
- use mathematics and computational thinking
- construct explanations and design solutions
- engage in argument from evidence
- obtain, evaluate, and communicate information

The science and engineering practices are ~~intended~~ ~~expected~~ to be ~~intertwined~~ ~~integrated~~ with the core ideas and crosscutting concepts across all grade levels and disciplines. See [Appendix 2](#) for more details on each of the science and engineering practices.

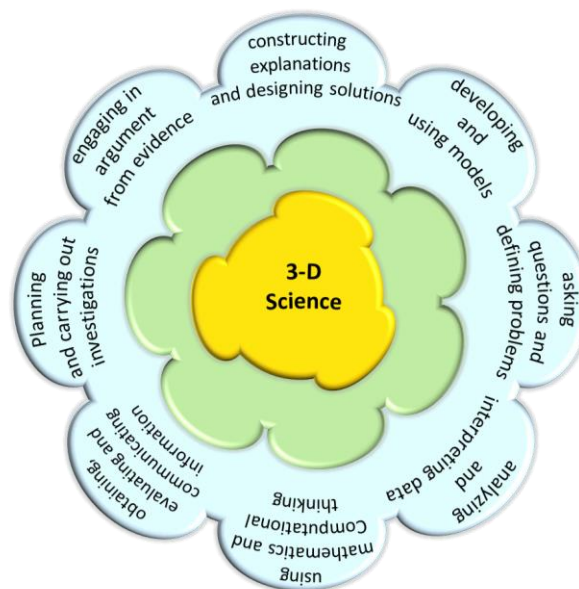


Figure 2: Science and engineering practices are used to investigate core ideas in science and develop scientific literacy

Crosscutting Concepts

Crosscutting concepts⁴ cross boundaries between science disciplines and provide an organizational framework to connect knowledge from various disciplines into a coherent and scientifically based view of the world. They bridge boundaries between science and other disciplines and connect core ideas and practices throughout the fields of science and engineering. Their purpose is to provide a lens to help students deepen their understanding of the core ideas as they make sense of phenomena in the natural and designed worlds. The crosscutting concepts identified in *A Framework for K-12 Science Education* are:

- patterns
- cause and effect
- structure and function
- systems and system models
- stability and change
- scale, proportion, and quantity
- energy and matter

The Arizona Science Standards are designed for students to develop their understanding of core ideas through the lens of one or multiple crosscutting concepts. Crosscutting concepts can be combined as students find and use patterns as evidence, determine cause and effect relationships, or define systems to investigate. Students must be provided structures and opportunities to make explicit connections between their learning and the crosscutting concepts. See [Appendix 1](#) for more details on each of the crosscutting concepts.

~~One example of a~~ The use of crosscutting concepts can be demonstrated seen within cause and effect relationships. For example, researchers investigate cause and effect mechanisms in the motion of a single object, specific chemical reactions, population changes in an ecosystem, and the development of holes in the polar ozone layers. ~~patterns. Patterns are present in all science disciplines and much of science is about explaining observed patterns. In life sciences, classification systems represent patterns. In physical sciences, atomic structure is a pattern. In earth and space sciences, tectonic processes follow a pattern.~~ Using data, graphs, charts, maps, and statistics in combination with the science and engineering practices, students can use their knowledge of ~~patterns~~ cause and effect relationships to formulate investigations, answer questions, and make informed predictions about observed phenomena.

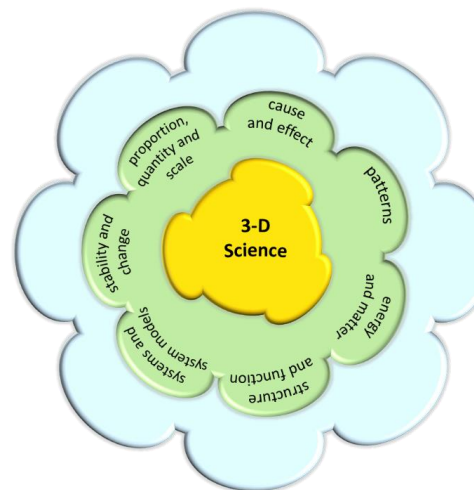


Figure 2: Crosscutting concepts provide a lens for understanding the core ideas

Commented [2]: Working group revised example based on public comment

Core Ideas

The Arizona Science Standards focus on fourteen core ideas in science and engineering, adapted from *Working with Big Ideas of Science Education*.² The ten core ideas for **Knowing Science** center on understanding the causes of phenomena in **physical, earth and space, and life science**. The four core ideas for **Using Science** connect scientific principles, theories, and models; engineering and technological applications; and societal implications to the content knowledge to support that understanding. The complexity of each core idea develops as students' progress through each grade band. Each standard is written at the intersection of two core ideas to help students understand both the process for knowing science and using science. These core ideas occur across grade levels and provide the background knowledge for students to develop sense-making around phenomena in the natural world. See [Appendix 3](#) for more details. The core ideas are listed below.

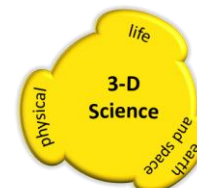


Figure 4: Core ideas for knowing science and using science develop scientific literacy through science content knowledge, understanding the nature of science, applications of science and engineering, and social implications

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>

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Design of the Arizona Science Standards

The Arizona Science Standards standards present a vision of what it means to be a scientifically literate person. These standards define the knowledge, understanding, and skills that need to be effectively taught and learned for all students to be scientifically literate. Students who are scientifically literate are ready to succeed in college-entry courses, in the workplace, in military service, and engage in civic responsibilities related to science issues.

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The Arizona Science Standards outline what all students need to know, understand, and be able to do by the end of high school and reflect the following shifts for science education:

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The Arizona Science Standards assume students have regular standards-based science instruction every year. The amount of time individual students need to learn these standards will vary. The chart below specifies the expected science instructional time necessary for students to ~~learn~~ master these standards.

The Arizona Science Standards have been designed so that these time assumptions provide adequate time to actively engage in all 3 dimensions of science instruction in order to master ~~for instruction and opportunities to learn~~ the standards for each grade level. Depending on local factors, schools may allocate more or less time when determining curriculum programming within a specific context. Instruction on the Arizona Science Standards may be a dedicated time in the school schedule or may be integrated with instruction of other subjects. See Appendix 45 and the Standards document for connections with other content areas.

These time recommendations do not explicitly address needs of students who are far below or far above the grade level.

No set of grade-specific standards can fully reflect the variety in abilities, needs, learning rates, and achievement levels of students in any given classroom. The Arizona Science Standards do not define the intervention methods to support students who are far below or far above grade level or do not speak English as their first language. See Appendix 54 for strategies to support equity and diversity in science.

Commented [4]: Moved this section to above the chart in hopes that users of this document will read this section first before reading the chart below. (addresses public comment related to "not enough time in K-5 to teach science")

Grade	Assumed Minutes per Week	Assumed Average Minutes per Day
K	90 minutes/week	18 minutes/day
1	150 minutes/week	30 minutes/day
2	150 minutes/week	30 minutes/day
3	200 minutes/week	40 minutes/day
4	225 minutes/week	45 minutes/day
5	225 minutes/week	45 minutes/day
6	250 minutes/week	50 minutes/day
7	250 minutes/week	50 minutes/day
8	250 minutes/week	50 minutes/day
HS (3 credits)	275 minutes/week	55 minutes/day

Safety Expectations

While there are no specific standards that address laboratory or field safety, it is a required part of science education to instruct and guide students in using appropriate safety precautions for all investigations. Reducing risk and preventing accidents in science classrooms begins with planning that meets all local, state, and federal requirements, including Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) requirements for safe handling and disposal of laboratory materials. The following four steps are recommended in carrying out a hazard and risk assessment for any investigation: (add citation, see references)

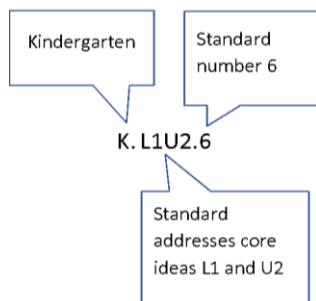
- 1) Identify hazards. Hazards may be physical, chemical, health, or environmental.
- 2) Evaluate the type of risk associated with each hazard.
- 3) Instruct students on all procedures and necessary safety precautions in such a way as to eliminate or reduce the risk associated with each hazard.
- 4) Prepare for any emergency that might arise despite all the required safety precautions.

Coding of the K-8 Science Standards

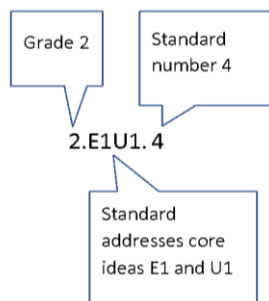
Each K-8 standard represents the intersection of core ideas for knowing science and using science. This intersection stresses that content in physical science, earth and space science, and life science is not learned independently from ideas about the nature of science, applications of science, or the social implications of using science. The coding of the standard captures this intersection. Students engage

in multiple practices as they gather information to solve problems, answer their questions, reason about how the data provide evidence to support their understanding, and then communicate their understanding of phenomena, applications, or social implications. They use the crosscutting concepts to support their understanding of patterns, cause and effect relationships, and systems thinking as they make sense of phenomena. The standard number at the end of the code is designed for recording purposes and does not imply instructional sequence or importance. **At left** are examples and descriptions of coding of the K-8 Standards.

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K.L1U2.6. Observe and explain the differences between and properties of living and nonliving things.



2.E1U1.4. Observe, describe, and predict how wind and water change the shape of the land resulting in a variety of landforms.

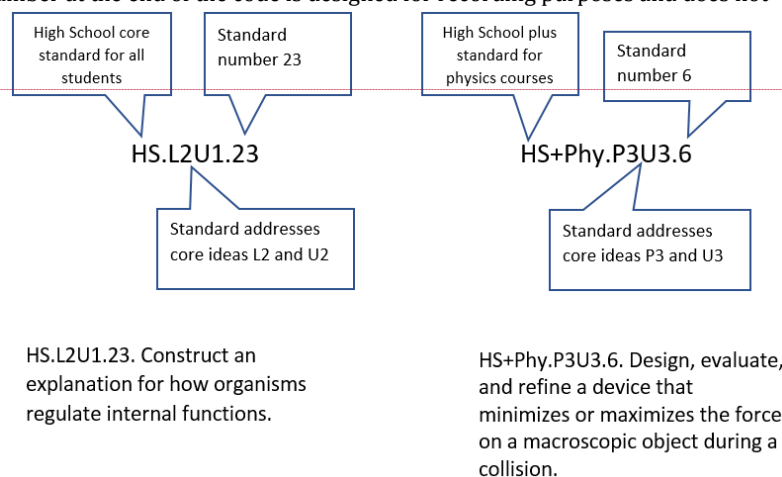
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Coding of the High School Science Standards

In Arizona, students are required to take 3 credits of high school science aligned to standards in physical, earth and space, and life sciences to meet graduation requirements, but there is no mandatory course sequence across the state. Because of this, the high school standards are written at two levels: essential and plus.

- All high school essential standards (HS) should be learned by every high school student regardless of the 3-credit course sequence they take. The full set of essential high school (HS) standards is designed to be taught over a 3-year period.
- The high school plus (HS+) standards are designed to enhance the rigor of general science courses by extending the essential standards within general chemistry (HS+C), physics (HS+Phy), earth and space sciences (HS+E), or biology (HS+B) courses. These HS+ standards are intended to provide the additional rigor of these courses to prepare students for college courses for science majors.

Like K-8, each high school standard represents the intersection of core ideas for knowing science and using science. This intersection stresses that content in physical science, earth and space science, and life science is not learned independently from ideas about the nature of science, applications of science, or the social implications of using science. The coding of the standard captures this intersection. Students engage in multiple practices as they gather information to solve problems, answer their questions, reason about how the data provide evidence to support their understanding, and then communicate their understanding of phenomena, applications, or social implications. They use the crosscutting concepts to support their understanding of patterns, cause and effect relationships, and systems thinking as they make sense of phenomena. The standard number at the end of the code is designed for recording purposes and does not imply instructional sequence or importance. **At right** are examples and descriptions of coding of the High School Science Standards.



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Grades K-2 Science Standards

The K-2 Science Standards are designed to provide opportunities for students to develop an understanding of all fourteen core ideas (see Appendix 3) across the K-2 grade band. ~~To provide opportunity opportunities for students~~ To sufficiently demonstrate knowledge, understanding, and performance of each standard, not every core idea is included in every grade.

~~Within each grade level,~~ Students engage in multiple science and engineering practices ~~(formerly known as the scientific method)~~ as they gather information to answer their questions or solve design problems by reasoning about how the data provide evidence to support their understanding, and then communicate their understanding of phenomena in physical, earth and space, and life sciences ~~(the knowing of science)~~. They Students apply their knowledge of the core ideas to understand ~~how scientists continue to build an understanding of~~ phenomena, ~~and see the impact, how people are impacted, by natural phenomena or to~~ construct technological solutions (using science). The crosscutting concepts support their understanding of patterns, cause and effect relationships, and systems thinking as students make sense of phenomena in the natural and designed worlds. ~~These~~ The practices, core ideas, and crosscutting concepts help students develop an understanding of skills and knowledge in order to transfer ~~them develop transferable skills and understandings from~~ one grade to the next and between content areas.

- In kindergarten, students use their senses to help them make observations about the world around them, recognizing patterns and causal relationships.
- In first grade, students develop an understanding of causal relationships as they investigate how objects can impact other objects from a distance or by contact with each other. They also develop systems thinking as they investigate how organisms interact with the Earth for survival, and how life systems have cycles.
- In second grade, students develop an understanding of systems and system models along with energy and matter. Students develop an understanding of observable properties of matter, how energy changes matter, the distribution and role of water and wind, and how life on Earth depends on an energy source. ~~as they relate to how water and wind helps change changing the surface features of Earth, how water cycles through the environment, and how water is a critical resource of life on Earth.~~

The organization of the standards within this document does not indicate instructional sequence or importance. Decisions about curriculum and instruction are made locally by individual school districts and classroom teachers; these standards can be sequenced, combined, or integrated with other content areas to best meet the local curriculum or student needs (See Appendices 4 and 5). ~~Suggestions for key concepts and connections to other content area standards are included to assist teachers when implementing the Science Standards and are not intended to be the minimum or maximum content limits.~~ It is suggested to use the metric system within measurement.

Commented [7]: On the HS standard, the call out box does not agree with the standard - U1 in standard, but U2 in callout box.

Commented [RB8R7]: When the standards are finished the images with the callout boxes will be fixed.

Kindergarten: Focus on Patterns; Structure and Function

By the end of Kindergarten, students learn to use their senses to help them make observations and predictions about the world and living things around them. In this grade level, students will ~~learn~~ investigate how the senses detect ~~are impacted by~~ light and sound, observe weather patterns and their influences on plants and animals, and differentiate between systems and structures of living and non-living things. Student investigations focus on collecting and making sense of observational data and simple measurements using the science and engineering practices: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, ~~engage in argument from use~~ evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in ~~this grade~~ Kindergarten focus on helping students understand phenomena through the crosscutting concepts of patterns and structure and function.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p><u>Physical Science</u></p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p><u>Earth and Space Science</u></p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p><u>Life Science</u></p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>

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Physical Sciences: Students explore how their senses can detect light, sound, and vibration and how technology can be used to extend their senses.

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
K.P2U2.1	
Investigate how the five senses and their associated body parts can detect light, sound, and vibrations even when they come from far away; use the collected evidence to develop and support an explanation .	People use their senses to learn about the world around them. Their eyes detect light, their ears detect sound, and they can feel vibrations by touch . People also use a variety of devices to communicate (send and receive information) over long distances. ⁴ (p. 137)
K.P2U3.2	
Design and evaluate a tool that helps people extend their senses	Objects can have an effect on other objects even when they are not in contact with them. For instance, light , affects the objects it reaches, including our eyes. Objects that are seen either give out or reflect light that human eyes can detect. Sound comes from things that vibrate and can be detected at a distance from the source because the air or other material around is made to vibrate. Sounds are heard when the vibrations in the air enter our ears. ² (p. 21) Crosscutting Concepts: patterns ; cause and effect; energy and matter; structure and function ⁴

Commented [9]: Overwhelming amount of public comment on this topic. .PS should not be mixed with LS

Coped from working group: Changed: cognitive level of the how of the body functions is not K appropriate. FW 137 PSC.4 Took out the five because light, sound, and vibrations focus on only three of the senses.

Earth and Space Sciences: Students develop an understanding of patterns to understand changes in local weather, seasonal cycles, and daylight.

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
KE1U1.3	
Observe, record, and ask questions about temperature, precipitation, and other weather data to identify patterns or changes in local weather.	There is air all around the Earth's surface, but there is less and less further away from the surface (higher in the sky). Weather is determined by the conditions and movement of the air. The temperature, pressure, direction, speed of movement and the amount of water vapor in the air combine to create the weather. Measuring these properties over time enables patterns to be found that can be used to predict the weather a short time ahead. ² (p. 24)

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KE1U1.4	Crosscutting Concepts: patterns ; cause and effect; energy and matter; structure and function ; stability and change ⁴
Observe, describe, ask questions, and predict seasonal weather patterns; understand and how those patterns impact plants and animals (including humans).	
KE2U1.5	
Observe and ask questions about patterns of the motion of the sun, moon, and stars in the sky.	Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. At night one can see the light coming from many stars with the naked eye, but telescopes make it possible to see many more and to observe them and the moon and planets in greater detail. ⁴ (p. 174) Crosscutting Concepts: patterns ; cause and effect; structure and function ; stability and change ⁴

Commented [10]: Standard added to DRAFT. After reviewing scientific literacy standards, this concept was missing from the K-2 band.

Copied from working group:

page 17 of "Core Content from Framework and Big Ideas" documents.

Life Sciences: Students develop an understanding that the world is comprised of living and non-living things. They investigate the relationship between structure and function in living things; and how plants and animals use specialized external parts to help them meet their needs and survive.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
KL1U1.6	
Obtain, evaluate, and communicate information about the systems of the human body which carry out life processes how organisms use different body parts for survival.	All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air . Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive, grow, and produce more plants. ⁴ (p. 144) Animals have body parts that capture and convey different kinds of information needed for growth and survival —for example, eyes for light, ears for sounds, and skin for temperature or touch. Animals respond to these inputs with behaviors that help them survive (e.g., find food, run from a predator) ⁴ (p. 149)
K.L4U2.7 KL1U2.7	
Observe, ask questions about and explain how specialized structures found on a variety of plants and animals (including humans) help them sense and respond to their environment.	Crosscutting Concepts: patterns ; cause and Effect ; Structure and function ⁴

Commented [11]: This number sequence has been changed due to the addition of the earth/space science standard. Please be aware if you are comparing the March DRAFT to this draft.

Commented [12]: My note:

[Note: Best match I could make from Framework or Big Ideas going with a L4 and staying in K-2 or 5-7 bands. Maybe decide if this is really a L1 or make a stronger link to L4? Thoughts?

Working group: Changed to K.L1U2.7 instead of L4]

Commented [RB13R12]: Working group decided this standard fit better in a L1 category vs. an L4 category

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K.L2U2.8	
Observe, ask questions about and explain the differences between the characteristics of living and nonliving things.	There is a wide variety of living things (organisms), including plants and animals . They are distinguished from non-living things by their ability to move, reproduce and react to certain stimuli . ² Crosscutting Concepts: patterns; structure and function ⁴

Kindergarten Connections to Other Academic Disciplines

Commented [14]: Per public comment and working group discussion this information will become an appendix in this document

Connection to the Arizona Health Standards for Grade Band Pre-K to 2

- Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts
 - Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being
 - Concept 3: Understanding personal health; PO 1 describe ways to prevent communicable diseases
 - Concept 3: Understanding personal health; PO 2 identify that foods are classified into food groups and that a variety of food is needed for personal health, growth, and development
 - Concept 3: Understanding personal health; PO 3 identify that physical activity is integral to good health
- Strand 7: Ability to Practice Health-Enhancing Behaviors
 - Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors to maintain or improve personal health
 - Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks

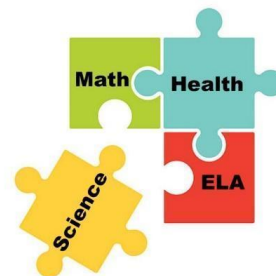
Connection to the Arizona English Language Arts Standards for Kindergarten

- Use age-appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards

Connection to the Arizona Mathematics Standards for Kindergarten

- Standards for Mathematical Practices
 - Make sense of problems and persevere in solving them
 - Use appropriate tools strategically
 - Look for and make use of structure
 - Look for and express regularity in repeated reasoning
- Counting and Cardinality
 - Develop competence with counting and cardinality
 - Develop understanding of addition and subtraction within 10
- Measurement and Data
 - Describe and compare measurable attributes
 - Classify objects and count the number of objects in each category

See also Appendix 4



First Grade: Focus on Cause and Effect; Stability and Change (cycles)

By the end of first grade, students make observations to understand connections between earth materials and the ability for the Earth to sustain a variety of organisms. ~~In this grade level,~~ Students learn how **objects can impact other objects from a distance or by contact with each other**, ~~how light and sound waves interact within the environment~~, how organisms interact with earth materials for survival, and how life systems have cycles. Student investigations focus on collecting and making sense of observational data and simple measurements using the science and engineering practices: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, ~~engage in argument from~~ use evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in first grade focus on helping students understand phenomena through cause and effect and stability and change.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>

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Physical Sciences: Students develop an understanding of the effects of forces and waves, and how they can impact or be impacted by objects near and far away. They explore the relationships between sound and vibrating materials, and between ~~as well as~~ light and materials including ~~its~~ the ability of sound and light to travel from place to place.

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
1.P2U1.1	
Plan and carry out investigations demonstrating the effect of placing objects made with different materials in the path of a beam of light and predict how objects with similar properties will affect the beam of light. Concepts taught in <u>K.P2U2.1</u>	Some materials allow light to pass through them, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them (i.e., on the other side from the light source), where the light cannot reach. Mirrors and prisms can be used to redirect a light beam. ⁴ (p. 134-135) Light and sound are wavelike phenomena. Sound can make matter vibrate , and vibrating matter can make sound. ⁴ (p. 130)
1.P2U2.2	
Use models to provide evidence that vibrating matter creates sound and sound can make matter vibrate. Concepts taught in <u>K.P2U2.1</u>	Crosscutting Concepts: cause and effect ; systems and system models; stability and change ⁴
1.P3U1.3	
Plan and carry out investigations which demonstrate how equal forces can balance objects and how unequal forces can push, pull, or twist objects, making them change their speed, direction, or shape.	Forces can push, pull or twist objects, making them change their motion or shape. Forces act in particular directions. Equal forces acting in opposite directions in the same line cancel each other and are described as being in balance . The movement of objects is changed if the forces acting on them are not in balance . ² (p. 22) Crosscutting Concepts: cause and effect ; systems and system models; energy and matter; stability and change ⁴
1.P4U3.4	
Design and evaluate ways to increase or reduce heat from friction between two objects.	When two objects rub against each other, this interaction is called friction . Friction between two surfaces can warm of both of them (e.g., rubbing hands together). There are ways to reduce the friction between two objects. ⁴ (p. 129) Crosscutting Concepts: cause and effect ; systems and system models; energy and matter; stability and change ; ⁴

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Earth and Space Sciences: Students develop an understanding that organisms depend on earth materials and other living organisms for survival.

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
1.E1U1.5	
Obtain, evaluate, and communicate information about the properties of Earth materials and investigate the properties of earth materials and how humans use resources in everyday life.	<p>Wind and water can change the shape of the land. The resulting landforms, together with the materials on the land, provide homes for living things. ⁴ (p. 180)</p> <p>Humans use natural resources for everything they do: for example, they use soil and water to grow food, wood to burn to provide heat or to build shelters, and materials such as iron or copper (minerals) extracted from Earth to make cooking pans. ⁴ (p. 192)</p> <p>Crosscutting Concepts: cause and effect; systems and system models; energy and matter; stability and change; ⁴</p>

Life Sciences: Students develop an understanding that the Earth has supported, and continues to support, a large variety of organisms. ~~which~~ These organisms can be distinguished by their physical characteristics, life cycles, and their different resource needs for survival. Different types of organisms live where there are different earth resources such as food, air, and water.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
1.L1U1.6	
Observe, describe, and predict life cycles of animals and plants.	<p>Plants and animals have predictable characteristics at different stages of development. Plants and animals grow and change. Adult plants and animals can have young.⁴ All will at some stage carry out the life processes of respiration, reproduction, feeding, excretion, growth and developments, and all will eventually die. ⁴ (p. 146)</p> <p>Crosscutting Concepts: cause and effect; systems and system models; energy and matter; structure and function; stability and change ⁴</p>

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1.L2U2.7	
Develop and use models about how living things use resources to grow and survive; design and evaluate habitats for organisms using earth materials.	Animals depend on their surroundings to get what they need, including food , water , shelter , and a favorable temperature . Animals depend on plants or other animals for food. They use their senses to find food and water, and they use their body parts to gather, catch, eat, and chew the food. Plants depend on air , water, minerals (in the soil), and light to grow. Animals can move around, but plants cannot, and they often depend on animals for pollination or to move their seeds around. Different plants survive better in different settings because they have varied needs for water, minerals, and sunlight ⁴ (.151)
1.L2U1.8	
Construct an explanation describing how organisms obtain resources from the environment including materials that are used again by other organisms. Concepts taught in <u>K.L1U1.5</u> , <u>K.L4U2.7</u>	Crosscutting Concepts: cause and effect ; systems and system models; energy and matter; structure and function; stability and change ⁴
1.L3U2.9	
Obtain, evaluate, and communicate information to support an evidence-based explanation that plants and animals produce offspring of the same kind, but offspring are generally not identical to each other or their parents.	Living things produce offspring of the same kind, but offspring are not identical with each other or with their parents . Plants and animals, including humans, resemble their parents in many features because information is passed from one generation to the next. ² (p. 22)
	Crosscutting Concepts: cause and effect ; systems and system models; energy and matter; structure and function; stability and change ⁴
1.L4U2.10	
Develop a model to describe how animals and plants are classified into groups and subgroups according to their similarities.	There are many different kinds of plants and animals in the world today and many kinds that once lived but are now extinct . We know about these from fossils . Animals and plants are classified into groups and subgroups according to their similarities . ²
1.L4U4.11	Some kinds of plants and animals that once lived on Earth (e.g., dinosaurs) are no longer found anywhere, although others now living (e.g., lizards) resemble them in some ways. ⁴ (p. 162)
Engage in argument from Use evidence to support a claim about the factors that cause organisms or entire species to go extinct and analyze how humans can positively or negatively impact those factors.	Crosscutting Concepts: cause and effect ; systems and system models; energy and matter; structure and function; stability and change ⁴

Commented [15]: When an organism dies, it just dies. Only a species can go extinct.

Organism: an individual animal, plant, or single-celled life form. ← Can die; cannot go extinct

First Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band Pre-K to 2

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well being
- Concept 2: Understanding multiple dimensions of health; PO 1 recognize what the human body is and what it means to be healthy
- Concept 3: Understanding personal health; PO 1 describe ways to prevent communicable diseases
- Concept 3: Understanding personal health; PO 2 identify that foods are classified into food groups and that a variety of food is needed for personal health, growth, and development
- Concept 5: Understanding use of health care; PO 1 describe why it is important to seek health care

Strand 5: Use of Decision-Making Skills to Enhance Health

- Concept 1: Influences on healthy decision making; PO 1 identify circumstances that can help or hinder healthy decision making

Strand 6: Use of Goal-Setting Skills to Enhance Health

- Concept 2: Health-related goal setting; PO 1 identify a short-term personal health goals and take action toward achieving the goal

Strand 7: Ability to Practice Health-Enhancing Behaviors

- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks

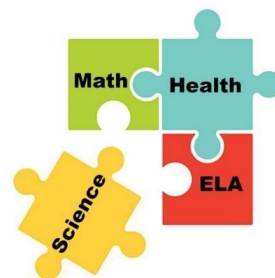
Connection to the Arizona English Language Arts Standards for First Grade

- Use age appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards.

Connection to the Arizona Mathematics Standards for First Grade

- Standards for Mathematical Practice
 - Make sense of problems and persevere in solving them
 - Use appropriate tools strategically
 - Construct viable arguments and critique the reasoning of others
 - Attend to precision
 - Look for and make use of structure
 - Look for and express regularity in repeated reasoning
- Measurement and Data
 - Measure lengths indirectly and by iterating length units
 - Represent and interpret data
- Geometry
 - Reason with shapes and their attribute

See also [Appendix 4](#)



Commented [16]: Per public comment and working group discussion this information will become an appendix in this document

Second Grade: Focus on Systems and System Models; Energy and Matter

By the end of second grade, students understand the basic concept that energy can ~~transform~~ **change the phase of matter** and is necessary for life. **In this grade level**, Students begin ~~constructing understanding of~~ **to understand** energy and matter, the formation of **the** Earth's surface features, water cycles and energy flow, ~~changing~~ **changes in the environment**, ~~and~~ patterns in the sky, and the conditions necessary for life on the Earth. Student investigations focus on collecting and making sense of observational data and simple measurements using the science and engineering practices: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, engage in argument from evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in second grade focus on helping students understand phenomena through systems and system models and energy and matter. **It is suggested to use the metric system within measurement.**

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and /or political implications.</p>

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Physical Sciences: Students develop an understanding of observable properties of matter and how changes in energy (heating or cooling) can affect matter or materials.

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
2.P1U2.1	
Plan and carry out an investigation to determine that matter has mass, takes up space, and is recognized by its observable properties; use the collected evidence to develop and support an explanation .	All the ‘stuff’ encountered in everyday life, including air , water and different kinds of solid substances , is called matter because it has mass , and therefore weight on Earth, and takes up space. Different materials are recognizable by their properties, some of which are used to classify them as being in the solid, liquid or gas state . ² (p. 20)
2.P1U2.2	Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models ; energy and matter ; structure and function; stability and change ⁴
Plan and carry out investigations to gather evidence to support an explanation on how heating or cooling can cause a transformation phase change in matter (solid, liquid, gas) .	
2.P4U1.3	
Gather, reason, Obtain, Evaluate and communicate information about ways heat energy can cause change in objects or materials.	There are various ways of causing an event or bringing about change in objects or materials. Heating can cause change , as in cooking, melting solids or changing water to vapor . ² (p. 23) Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models ; energy and matter ; structure and function; stability and change ⁴

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Earth and Space Sciences: Students develop an understanding of the distribution and role of water and wind in weather, shaping the land, and where organisms live. ~~and changing environments. In addition to~~ Wind and water can also change environments. ~~They and students learn that as well as~~ humans and other organisms can change environments too. Students ~~also~~ develop an understanding of changing patterns in the sky including the position of Sun, Moon, and stars, and the apparent shape of the Moon.

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
2.E1U1.4	
Observe, describe, and predict, and investigate how wind and water change the shape of the land resulting in a variety of landforms.	Wind and water can change the shape of the land. The resulting landforms , together with the materials on the land, provide homes for living things. ^{4(p. 180)} Water is found in the ocean, rivers, lakes, and ponds . Water exists as solid ice and in liquid form. It carries soil and rocks from one place to another and determines the variety of life forms that can live in a particular location. ^{4(p. 184)}
2.E1U2.5	
Develop and use models to represent that water can exist in different states and is found in oceans, glaciers, lakes, rivers, ponds, and the atmosphere. (water cycle)	Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change ⁴
2.E1U3.6	
Analyze patterns in weather conditions of various regions of the world and design, test, and refine solutions to protect humans from severe weather conditions. Concepts first taught in <u>K.E1U1.3</u> , <u>K.E1U1.4</u>	Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. ^{4(p. 188)} Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change ⁴
2.E1U4.7	
Construct an argument from evidence regarding positive or negative changes in water and land systems that impact humans and the environment.	Plants and animals (including humans) depend on the land, water, and air to live and grow. They in turn can change their environment (e.g., the shape of land, the flow of water). ⁴ Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change ⁴

Commented [17]: Copied from working group: Took out water cycle -it is in the 3-5 grade band Framework 185

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2.E2U1.8	
Analyze and interpret data Observe and explain the Earth's Sun's position in relation to the Sun at different times during a twenty-four-hour period and changes in the apparent shape of the Moon from one night to another.	<p>There are patterns in the position of the Sun seen at different times of the day and in the shape of the Moon from one night to another.^{2(p. 25)}</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [18]: Copied from working group: The Earth remains the same distance from the Sun in a twenty-four-hour period. The Sun appears to travel across the sky in a 24 hour period because the Earth is revolving.

Life Sciences: Students develop an understanding that life on Earth depends on ~~the energy from the Sun or the energy from other organisms~~ ~~(food)~~ to survive.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
2.L2U1.9	
Obtain, analyze, and communicate evidence that organisms need a source of energy, air, water, and certain temperature conditions to survive.	All living things need food as their source of energy as well as air, water and certain temperature conditions. Plants containing chlorophyll can use sunlight to make the food they need and can store food that they do not immediately use. Animals need food that they can break down, which comes either directly by eating plants (herbivores) or by eating animals (carnivores) which have eaten plants or other animals. Animals are ultimately dependent on plants for their survival. The relationships among organisms can be represented as food chains and food webs . ^{2 (p. 27)}
2.L2U1.10	
<p>Construct a model representing how life on Earth depends on energy from the Sun and energy from other organisms.</p> <p>Review of and continuation of content taught in <u>K.P2U2.1</u>, <u>K.L1U1.5</u></p>	<p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Second Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band Pre-K to 2

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- ~~Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being~~
- ~~Concept 3: Understanding personal health; PO 2 identify that foods are classified into food groups and that a variety of food is needed for personal health, growth, and development~~
- ~~Concept 3: Understanding personal health; PO 3 identify that physical activity is integral to good health~~

Strand 6: Use of Goal Setting Skills to Enhance Health

- ~~Concept 2: Health-related goal setting; PO 1 identify a short-term personal health goals and take action toward achieving the goal~~

Strand 7: Ability to Practice Health-Enhancing Behaviors

- ~~Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors to maintain or improve personal health~~
- ~~Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks~~

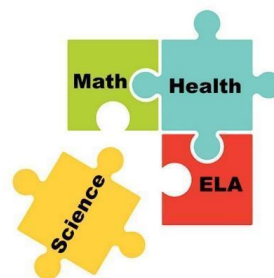
Connection to the Arizona English Language Arts Standards for Second Grade

- ~~Use age-appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards.~~

Connection to the Arizona Mathematics Standards for Second Grade

- ~~Standards for Mathematical Practice~~
 - ~~Make sense of problems and persevere in solving them~~
 - ~~Use appropriate tools strategically~~
 - ~~Construct viable arguments and critique the reasoning of others.~~
 - ~~Attend to precision~~
 - ~~Look for and make use of structure~~
 - ~~Look for and express regularity in repeated reasoning~~
- ~~Operations and Algebraic Thinking~~
 - ~~Represent and solve problems involving addition and subtraction~~
- ~~Number and Operations in Base Ten~~
 - ~~Use place value understanding and properties of operations to add and subtract~~
- ~~Measurement and Data~~
 - ~~Represent and interpret data~~

See also [Appendix 4](#)



Commented [19]: Per public comment and working group discussion this information will become an appendix in this document

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Distribution of K-2 Standards

	U1: Science's purpose is to find the cause or causes of phenomena in the natural world.	U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.	U3: The knowledge produced by science is used in engineering and technologies to create products.	U4: Applications of science often have both positive and negative ethical, social, economic, and political implications.
P1: All matter in the Universe is made of very small particles.		2.P1U2.1 2.P1U2.2		
P2: Objects can affect other objects at a distance.	1.P2U1.1	K.P2U2.1 1.P2U2.2	K.P2U3.2	
P3: Changing the movement of an object requires a net force to be acting on it.	1.P3U1.3			
P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	2.P4U1.3		1.P4U3.4	
E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	K.E1U1.3 K.E1U1.4 1.E1U1.5 2.E1U1.4	2.E1U2.5	2.E1U3.6	2.E1U4.7
E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.	K.E2U1.5 2.E2U1.8			
L1: Organisms are organized on a cellular basis and have a finite life span.	K.L1U1.6 1.L1U1.6	K.L2U2.7		
L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	1.L2U1.8 2.L2U1.9 2.L2U1.10	K.L2U2.8 1.L2U2.7		
L3: Genetic information is passed down from one generation of organisms to another.		1.L3U2.9		
L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.		1.L4U2.10		1.L4U4.11

Commented [20]: Anytime changes are made to the standards this chart needs to be updated.

Grades 3-5 Science Standards

The Grades 3-5 Science Standards are designed to provide opportunities for students to develop understanding of all fourteen core ideas (see [Appendix 3](#)) across the 3-5 grade band. ~~To provide opportunity for students~~ To sufficiently demonstrate knowledge, understanding, and performance of each standard, not every core idea is included in every grade.

Within each grade [level](#), students engage in multiple science and engineering practices ~~(formerly known as the scientific method)~~ as they gather information to answer their questions or solve design problems [by reasoning about](#) how the data provide evidence to support their understanding, and then communicate their understanding of phenomena in physical, earth and space, and life science [\(the knowing of science\)](#). ~~They~~ Students apply their knowledge of [the](#) core ideas to understand ~~how scientists continue to build an understanding of~~ phenomena, ~~and see the impact, how people are impacted, by natural phenomena or to~~ construct technological solutions (using science). The crosscutting concepts support their understanding of patterns, cause and effect relationships, and systems thinking as students make sense of phenomena in the natural and designed worlds. ~~These~~ The practices, core ideas, and crosscutting concepts help students develop an understanding of skills and knowledge in order to transfer them ~~develop transferable skills and understandings~~ from one grade to the next and between content areas.

- In [third grade](#), students [develop understanding of systems and system models along with structure and function use cause and effect relationships](#) involving energy and matter. ~~as they investigate properties of light and sound waves. to understand how the Sun provides the primary source of energy for supporting life on Earth.~~
- In [fourth grade](#), students apply systems and system models ~~thinking~~ as they ~~understand~~ investigate how energy and the availability of resources affects the Earth systems (geosphere and biosphere). They also develop understanding of stability and change with regards to how populations of organisms, and the Earth have changed over time. ~~that Earth systems are impacted by different forms of energy.~~
- In [fifth grade](#), students apply their understanding of scale at micro levels as they investigate changes in matter and at macro levels as they investigate patterns [of genetic information and movement between the Earth and Moon.](#)

The organization of the standards within this document does not indicate instructional sequence or importance. Decisions about curriculum and instruction are made locally by individual school districts and classroom teachers; these standards can be sequenced, combined, or integrated with other content areas to best meet the local curriculum or student needs (See [Appendices 4 and 5](#)).

~~Suggestions for key concepts and connections to other content area standards are included to assist teachers when implementing the Science Standards and are not intended to be the minimum or maximum content limits.~~ It is suggested to use the metric system within measurement.

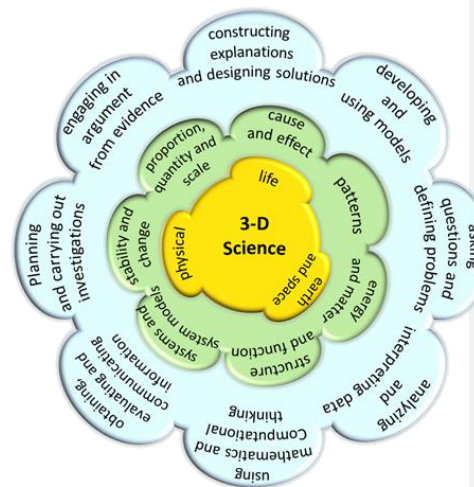


Figure 1: Three Dimensions of Science Instruction

Commented [21]: Copied from working group:
In fourth grade, students apply systems thinking as they investigate how energy the availability of resources affects Earth systems (geosphere and biosphere)
Not sure what word is missing between "energy...the availability". Maybe it needs to be looked at again. I did my best guess to the left.

Commented [RB22R21]: 7/9 Working groups fixed the verbiage.

Third Grade: Focus on **Systems and System Models; Structure and Function** ~~Cause and Effect;~~ **Energy and Matter**

By the end of third grade, students will gain understanding of how the Sun provides energy for life on Earth. ~~In this grade level,~~ Students apply their understanding of light and sound waves, how they travel, are detected, and transfer energy. Students learn that organisms have different structures and functions which increase their chances of survival. Student investigations focus on collecting and making sense of observational data and simple measurements using the science and engineering practices: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, engage in argument from evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in third grade focus on helping students understand phenomena through systems and system models and structure and function. ~~cause and effect and energy and matter.~~ It is suggested to use the metric system within measurement.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p><u>Physical Science</u></p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p><u>Earth and Space Science</u></p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p><u>Life Science</u></p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and <u>technologies to solve problems and/or</u> create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>

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Physical Sciences: Students develop an understanding of the sources, properties, and characteristics of energy along with and types of waves, the relationship between energy transfer and the human body, and how waves can transfer energy

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
3.P2U1.1	
<p>Ask questions and investigate the relationship between light, objects, lenses, and parts of and the human eye.</p> <p>Concepts taught in <u>1.P2U1.1</u></p>	<p>Light is seen because it affects the objects it reaches, including our eyes. Sources give out light, which travels from them in various directions and is detected when it reaches and enters our eyes. Objects that are seen either give out or reflect light that human eyes can detect. Sound comes from things that vibrate and can be detected at a distance from the source because the air or other material around is made to vibrate. Sounds are heard when the vibrations in the air enter our ears. ² (p. 21).</p>
3.P2U2.2	
<p>Collect data and construct arguments based on evidence Plan and carry out an investigation to explain explore how sound waves affect objects at varying distances. and parts of the human ear.</p>	<p>An object can be seen when light reflected from its surface enters the eyes; the color people see depends on the color of the available light sources as well as the properties of the surface. Because lenses bend light beams, they can be used, singly or in combination, to provide magnified images of objects too small or too far away to be seen with the naked eye. ⁴ (p. 135)</p> <p>Crosscutting Concepts: cause and effect; system and system models; energy and matter; structure and function; stability and change⁴</p>
3.P4U1.3	
<p>Develop and use a model to construct an explanation of how light and sound waves transfer energy.</p> <p>Connects to 3.E1U1.4</p>	<p>The faster a given object is moving, the more energy it possesses. Energy can be moved from place to place by moving objects or through sound or light. (Boundary: At this grade level, no attempt is made to give a precise or complete definition of energy.)⁴ (p. 122) Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. Light also transfers energy from place to place. For example, energy radiated from the sun is transferred to Earth by light. When this light is absorbed, it warms Earth's land, air, and water and facilitates plant growth. ⁴ (p. 125)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

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Earth and Space Sciences: Students develop an understanding of how the Sun provides light and energy for the Earth systems.

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
3.E1U1.4	
<p>Construct an explanation describing how the Sun is the primary source of energy impacting Earth systems. for the Earth.</p> <p>Connects to 3.P4U1.3</p>	<p>All Earth processes are the result of energy flowing and matter cycling within and among Earth's systems. This energy originates from the sun and from Earth's interior. ⁴⁽¹⁷⁹⁻¹⁸⁰⁾ Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. Rainfall helps shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. ⁴⁽¹⁸¹⁾</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [23]: I found these from the framework. I didn't see a strong connection between Framework citation p. 125, 148 that was noted by the working groups. But if there is feel free to add to ... or move this learning progression.

Life Sciences: Students develop an understanding **of the flow of energy in a system beginning with the Sun to and among organisms** ~~that light provides the source of energy for plants, and plants provide the source of energy for animals~~. They also understand that plants and animals (including humans) have specialized internal and external structures, and can respond to stimuli to increase survival.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
3.L1U1.5	
<p>Obtain, evaluate, and communicate that the human body has different systems which carry out life processes.</p> <p>Review of content taught in <u>2.L2U1.10; 3.P2U1.1; 3.P2U2.2</u></p>	<p>Animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (Boundary: Stress at this grade level focus is on understanding the macroscale systems and their function, not microscopic processes.) ^{4(p. 144)}</p>

Commented [24]: This was crossed out on this document, but still on the poster of "cut-outs". Does this standard stay or go? I thought I remembered conversation that it stays.

Copied from working group for 3.L1U2.6: Framework citation p. 144, 146, 148 (in standard 3.L2U1.8 below), 164

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3.L1U2.6	
<p>Develop and use models to explain that plants and animals have internal and external structures that serve various functions that aid in growth, survival, behavior, and reproduction.</p>	<p>Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. Animals engage in characteristic behaviors that increase the odds of reproduction. Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features (such as attractively colored flowers) for reproduction. Plant growth can continue throughout the plant’s life through production of plant matter in photosynthesis. Genetic factors as well as local conditions affect the size of the adult plant. The growth of an animal is controlled by genetic factors, food intake, and interactions with other organisms, and each species has a typical adult size range. (Boundary: Reproduction is not treated in any detail here; for more specifics about grade level, see LS3.A.) ⁴(p. 146)</p> <p>Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. Animals obtain food from eating plants or eating other animals. Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. In most animals and plants, oxygen reacts with carbon containing molecules (sugars) to provide energy and produce carbon dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not require oxygen. ⁴(p. 164)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
3.L2U2.7	
<p>Plan and carry out investigations to demonstrate ways plants and animals react to stimuli.</p>	<p>Different sense receptors are specialized for particular kinds of information, which may then be processed and integrated by an animal’s brain, with some information stored as memories. Animals are able to use their perceptions and memories to guide their actions. Some responses to information are instinctive—that is, animals’ brains are organized so that they do not have to think about how to respond to certain stimuli. ⁴(p. 149)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

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3.L2U1.8	
<p>Design and use system models to describe the flow of energy from the Sun to and among living organisms.</p> <p>Concepts taught in <u>2.L2U1.10</u> Connects to 3P4U1.3 Framework citation p. 125, 129, 151-152</p>	<p>Animals and plants alike generally need to take in air and water, animals must take in food, and plants need light and minerals; anaerobic life, such as bacteria in the gut, functions without air. Food provides animals with the materials they need for body repair and growth and is digested to release the energy they need to maintain body warmth and for motion. Plants acquire their material for growth chiefly from air and water and process matter they have formed to maintain their internal conditions (e.g., at night). ⁴(p. 148)</p>
3.L2U3.9	
<p>Design, test, and refine a solution to reduce damaging effects of sunlight on plants or animals.</p> <p>Standard is too specific. Students investigation reaction to stimuli in 3.L2U2.7 Connects to 3P4U1.3</p>	<p>The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Either way, they are “consumers.” Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil for plants to use. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. ⁴(p. 151-152)</p>
3.L2U3.9	
<p>Construct an argument from evidence that organisms are interdependent.</p>	<p>Animals need food that they can break down, which comes either directly by eating plants (herbivores) or by eating animals (carnivores) which have eaten plants or other animals. Animals are ultimately dependent on plants for their survival. The relationships among organisms can be represented as food chains and food webs. Some animals are dependent on plants in other ways as well as for food, for example for shelter and, in the case of human beings, for clothing and fuel. Plants also depend on animals in various ways. For example, many flowering plants depend on insects for pollination and on other animals for dispersing their seeds. ²(p. 27)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [25]: Old standard: ~~Use food chains as system models to describe the exchange of energy between the Sun, plants, and animals.~~

Working groups dramatically reworded this standard to make it broader.

Note: This will change the sequence of numbering for the rest of grade 3 standards. Please be aware of this change as you edit the draft standards document and compare it to the March 2018 DRAFT.

Commented [26]: Standard deleted.
Copied from working group: Standard is too specific. Students investigation reaction to stimuli in 3.L2U2.7
Connects to 3P4U1.3 add learning progression information from Big Ideas p. 27

Third Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band 3 to 5

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- ~~Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being~~
- ~~Concept 3: Understanding personal health; PO 2 describe the key nutrients contained in the food groups and how these nutrients affect health and learning~~
- ~~Concept 3: Understanding personal health; PO 3 describe how physical activity impacts health~~

Strand 6: Use of Goal-Setting Skills to Enhance Health

- ~~Concept 2: Health-related goal setting; PO 1 set a personal health goal and track progress towards its achievement~~

Strand 7: Ability to Practice Health-Enhancing Behaviors

- ~~Concept 2: Healthy practices and behaviors; PO 1 demonstrate a variety of healthy practices and behaviors to maintain or improve personal health~~
- ~~Concept 2: Healthy practices and behaviors; PO 2 demonstrate a variety of behaviors that avoid or reduce health risks~~

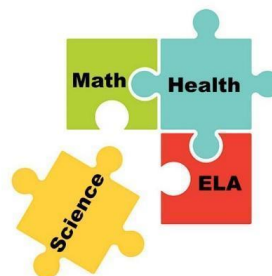
Connection to the Arizona English Language Arts Standards for Third Grade

- ~~Use age-appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards.~~

Connection to the Arizona Mathematics Standards for Third Grade

- ~~Standards for Mathematical Practice~~
 - ~~Make sense of problems and persevere in solving them~~
 - ~~Reason abstractly and quantitatively~~
 - ~~Construct viable arguments and critique the reasoning of others~~
 - ~~Use appropriate tools strategically~~
 - ~~Attend to precision~~
 - ~~Look for and make use of structure~~
 - ~~Look for and express regularity in repeated reasoning~~
- ~~Operations and Algebraic Thinking~~
 - ~~Represent and solve problems involving addition and subtraction~~
- ~~Number and Operations in Base Ten~~
 - ~~Use place value understanding and properties of operations to perform multi-digit arithmetic~~
- ~~Number and Operations—Fractions~~
 - ~~Understand fractions as numbers~~
- ~~Measurement and Data~~
 - ~~Solve problems involving measurement~~
 - ~~Represent and interpret data~~

~~See also [Appendix 4](#)~~



Commented [27]: Per public comment and working group discussion this information will become an appendix in this document

Fourth Grade: Systems and System Models; **Energy and Matter**; Stability and Change

~~By the end of fourth grade, students understand that Earth systems are impacted by different forms of energy. In this grade level, students expand their understanding of electricity and magnetism. Students also understand how weather, climate, human interactions, and geological systems change and shape the Earth and the factors impacting organism diversity.~~

By the end of fourth grade, students expand on the idea that energy from the Sun interacts with Earth systems and explore other forms of energy we use in everyday life. Students apply their understanding of the various Earth systems (geosphere, hydrosphere, atmosphere, biosphere) and how they interact with each other and heat from the Sun. Students understand how geological systems change and shape the planet and provide resources. Students also develop an understanding how Earth processes and human interactions can change environments impacting the ability for organisms to survive. Student investigations focus on collecting and making sense of observational data and simple measurements using the science and engineering practices: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, engage in argument from evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in fourth grade focus on helping students understand phenomena through systems and system models, energy and matter and stability and change. It is suggested to use the metric system within measurement.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and <u>technologies to solve problems and/or</u> create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>

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Physical Sciences: Students develop an understanding of how Earth's resources can be transformed into different forms of energy. Students develop a better understanding of electricity and magnetism. ~~and how they are forms of energy.~~

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
4.P4U2.1	
<p>Develop and use a model to demonstrate how a system transfers energy from one object to another even when the objects are not touching.</p> <p>Concepts taught in 2.P4U1.3 Connects to 4.E1U2.8</p>	<p>Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. Light also transfers energy from place to place. For example, energy radiated from the sun is transferred to Earth by light. When this light is absorbed, it warms Earth's land, air, and water and facilitates plant growth. Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy (e.g., moving water driving a spinning turbine which generates electric currents). ⁴ (p. 125)</p>
4.P4U2.2	
<p>Develop and use a model that demonstrates explains how energy is moved from place to place through electric and magnetic currents.</p> <p>Framework citation p. 125, 129 Concepts taught in <u>1.P3U1.3</u></p>	<p>The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use—for example, the stored energy of water behind a dam is released so that it flows downhill and drives a turbine generator to produce electricity. Food and fuel also release energy when they are digested or burned. When machines or animals "use" energy (e.g., to move around), most often the energy is transferred to heat the surrounding environment. The energy released by burning fuel or digesting food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (Boundary: The fact that plants capture energy from sunlight is introduced at this grade level, but details of photosynthesis are not.) It is important to be able to concentrate energy so that it is available for use where and when it is needed. For example, batteries are physically transportable energy storage devices, whereas electricity generated by power plants is transferred from place to place through distribution systems. ⁴ (p. 129)</p>
4.P2U1.3	
<p>Develop and use a model to demonstrate magnetic forces.</p> <p>Concepts taught in 1.P3U1.3 Framework citation p. 117, 127</p>	<p>The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use—for example, the stored energy of water behind a dam is released so that it flows downhill and drives a turbine generator to produce electricity. Food and fuel also release energy when they are digested or burned. When machines or animals "use" energy (e.g., to move around), most often the energy is transferred to heat the surrounding environment. The energy released by burning fuel or digesting food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (Boundary: The fact that plants capture energy from sunlight is introduced at this grade level, but details of photosynthesis are not.) It is important to be able to concentrate energy so that it is available for use where and when it is needed. For example, batteries are physically transportable energy storage devices, whereas electricity generated by power plants is transferred from place to place through distribution systems. ⁴ (p. 129)</p>
4.P4U4.4	
<p>Construct an explanation and Engage in an argument from evidence on the use and impact of renewable and nonrenewable resources to provide energy. generate electricity.</p>	<p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [28]: Removed magnetic "currents" – should be forces to its own standard below based on public feedback:

Working group created a new standard to separate electric currents and magnetic forces per public comment. Revisited due to comments (4th grade tab) 89, 145, 2642, 143, 145, 1276, 1305, 1538, 2642

Commented [29]: Working group created a new standard to separate electric currents and magnetic forces per public comment. Revisited due to comments (4th grade tab) 89, 145, 2642, 143, 145, 1276, 1305, 1538, 2642

Note: This will change the sequence of numbering for the rest of grade 3 standard. Please be aware of this change as you edit the draft standards document and compare it to the March 2018 DRAFT.

Commented [30]: Copied from working group: Framework citation p. 125, 129, 192

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Earth and Space Sciences: Students develop an understanding of the different Earth systems and how they interact with each other. They understand how geological systems change and shape the Earth and the evidence that is used to understand these changes. They also understand how weather, climate, and human interactions can impact the environment.

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
4.E1U2.5	
<p>Use models to explain seismic waves and their effect on the Earth.</p> <p>Connections to 4.P4U2.1 Framework citation p. 132</p>	<p>Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. Rainfall helps shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. Human activities affect Earth's systems and their interactions at its surface. 4(p. 181)</p>
4.E1U1.6	
<p>Plan and carry out an investigation to explore the interactions between Earth's major systems and the impact on Earth's surface materials and processes.</p> <p>Framework citation p. 119, 178, 181, 183, 185, 190</p>	<p>Earth has changed over time. Understanding how landforms develop, are weathered (broken down into smaller pieces), and erode (get transported elsewhere) can help infer the history of the current landscape. Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. 4(p. 178)</p>
4.E1U2.7X take out	
<p>Obtain, analyze, and communicate information that to support an argument on whether the locations of fossils, rocks, mountain ranges, volcanoes, deep ocean trenches, and ocean floor structures provides evidence of past plate movements.</p>	<p>Weather is the minute-by-minute to day-by-day variation of the atmosphere's condition on a local scale. Scientists record the patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. Climate describes the ranges of an area's typical weather conditions and the extent to which those conditions vary over years to centuries. 4(p. 188)</p>
4.E1U2.7	
<p>Develop and/or revise a model using various rock types, fossils location, and landforms to show evidence that Earth's surface has changed over time.</p> <p>Connections to 4.E1U2.6</p>	<p>Water is found almost everywhere on Earth: as vapor; as fog or clouds in the atmosphere; as rain or snow falling from clouds; as ice, snow, and running water on land and in the ocean; and as groundwater beneath the surface. The downhill movement of water as it flows to the ocean shapes the</p>

Commented [31]: Working groups reviewed this standard due to comment (4th grade tab) 1278, 1929

Commented [32]: Remove this standard.

Deleted. Similar to 4.E1U2.8 and there was no need for two very similar standards. 4.E1U2.8 was reworded to merge the two standards together and renamed 4.E1U2.7.

Note: This will change the sequence of numbering for the rest of grade 4 standard. Please be aware of this change as you edit the draft standards document and compare it to the March 2018 DRAFT. Standard revisited due to comments (4th Grade tab) 1092, 1538, 2156, 2559

Framework citation p. 119, 188

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Framework citation p. 162, 178, 183, 185	appearance of the land. Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. ⁴ (p. 185)
4.E1U2.8	Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models ; energy and matter ; structure and function; stability and change ⁴
Collect, analyze, and interpret data to explain weather and climate patterns. Complementary standard to 4.P4U2.1 Connections to concepts taught in <u>2.E1U3.6</u>	
4.E1U4.9	
Construct and support an evidence-based argument about the impact of water <u>availability of water and its impact on life.</u> Connections to concepts taught in <u>2.E1U2.5</u>	
4.E1U3.10	
<u>Define problem(s) and design solution(s) to minimize the effects of natural hazards.</u>	<p>A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions, severe weather, floods, coastal erosion). Humans cannot eliminate natural hazards but can take steps to reduce their impacts. ⁴(p. 193)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [33]: Slightly reworded. Copied from working group: Framework citation p. 181 (in E1 section above so I merged the learning progression chart), 185

Revisited due to comment (4th Grade tab) 1538 and 2559

Commented [34]: Reworded standard from: Identify the causes and effects of natural disasters, define the problem(s), and design solution(s) to minimize those effects on humans.

Per public comment. (4th Grade tab) comment 265 and 2559

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Life Sciences: Students develop an understanding of the diversity of past and present organisms, factors impacting organism diversity, and evidence of change of organisms over time.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
4.L4U2.11	
Analyze and interpret environmental data that demonstrate that species either adapt and survive or go extinct over time.	When the environment changes in ways that affect a place's physical characteristics, temperature , or availability of resources , some organisms survive and reproduce , others move to new locations, yet others move into the transformed environment, and some die . ⁴ (p. 155)
4.L4U4.12	
Engage in argument from evidence to support a claim about the factors that cause species to go extinct and how humans can impact those factors.	<p>Fossils provide evidence about the types of organisms (both visible and microscopic) that lived long ago and also about the nature of their environments. Fossils can be compared with one another and to living organisms according to their similarities and differences. ⁴(p. 162)</p> <p>Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. ⁴(p. 165)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [35]: Merged learning progression box to match the connections found by the working groups.

FW . 119 is a physical science learning progression. Will look for a connection in the document to link to another standard.

Copied from working group:
4.L4U2.11 Framework citation p. 119, 155, 162
4.L4U4.12 Framework citation p. 119, 155

Fourth Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band 3 to 5

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being

Strand 6: Use of Goal Setting Skills to Enhance Health

- Concept 2: Health-related goal setting; PO 1 set a personal health goal and track progress towards its achievement

Strand 7: Ability to Practice Health-Enhancing Behaviors

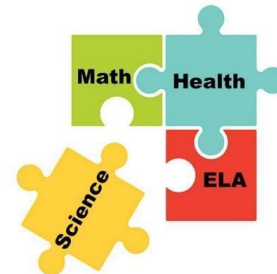
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate a variety of healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate a variety of behaviors that avoid or reduce health risks

Connection to the Arizona English Language Arts Standards for Fourth Grade

- Use age-appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards.

Connection to the Arizona Mathematics Standards for Fourth Grade

- Standards for Mathematical Practice
 - Make sense of problems and persevere in solving them
 - Construct viable arguments and critique the reasoning of others
 - Use appropriate tools strategically
 - Attend to precision
 - Look for and make use of structure
 - Look for and express regularity in repeated reasoning
- Operations and Algebraic Thinking
 - Generate and analyze patterns
- Number and Operations in Base Ten
 - Use place value understanding and properties of operations to perform multi
- Number and Operations – Fractions
 - Understand decimal notation for fractions and compare decimal fractions
- Measurement and Data
 - Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit
 - Represent and interpret data



See also Appendix 4

Commented [36]: Per public comment and working group discussion this information will become an appendix in this document

Fifth Grade: Patterns; Scale, Proportion, and Quantity

~~By the end of fifth grade, students apply their understanding of scale at macro (time and space) and micro (particles of matter) levels to understand patterns and scale across life, earth and space, and physical sciences. In this grade level, students will develop a basic understanding of conservation of matter, forces, patterns of Sun, moon, and stars, and genetic inheritance.~~

By the end of fifth grade, students apply their understanding of scale at macro (time and space) and micro (particles of matter) levels to understand patterns and scale across life, earth and space, and physical sciences. ~~In this grade level,~~ Students will develop an understanding of forces, conservation of matter, and that genetic information can be passed down from parent to offspring. Student investigations focus on collecting and making sense of observational data and measurements using the science and engineering practices: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, engage in argument from evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in fifth grade focus on helping students understand phenomena through patterns and scale, proportion and quantity and patterns. It is suggested to use the metric system within measurement.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and <u>technologies to solve problems and/or</u> create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and <u>and/or</u> political implications.</p>

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Physical Sciences: Students develop an understanding that changes can occur to matter/objects on Earth or in space, but both energy and matter **follow the pattern of being** ~~are~~ conserved during those changes.

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
5.P1U1.1	
Analyze and interpret data to explain that matter of any type can be subdivided into particles too small to see (atom) and, in a closed system , if properties change or chemical reactions occur, the amount of matter stays the same.	Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means (e.g., by weighing or by its effects on other objects). For example, a model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects (e.g., leaves in wind, dust suspended in air); and the appearance of visible scale water droplets in condensation, fog, and, by extension, also in clouds or the contrails of a jet. The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish (e.g., sugar in solution, evaporation in a closed container). Measurements of a variety of properties (e.g., hardness, reflectivity) can be used to identify particular materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) ⁴ (p. 108)
5.P1U1.2	When two or more different substances are mixed , a new substance with different properties may be formed; such occurrences depend on the substances and the temperature . No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) ⁴ (pp. 110-111) Other substance simply mix without changing permanently and can often be separated again. At room temperature, some substances are in the solid state, some in the liquid state and some in the gas state. The state of many substances can be changed by heating or cooling them. The amount of matter does not change when a solid melts or a liquid evaporates . ² (p. 20) Crosscutting Concepts: patterns ; cause and effect; scale, proportion and quantity ; system and system models; energy and matter; structure and function; stability and change ⁴

Commented [37]: Working group revisited this standard based on public comment. (Tab: 5th grade) 143, 145, 218, 265, 1297, 2156, 2487

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5.P2U1.3	
<p>Construct an explanation using evidence to demonstrate that objects can affect other objects even when they are not touching.</p> <p>Concepts taught in 2.P4U1.3, <u>4.P4U2.2</u>, 5.E2U1.7, 5.E2U2.8</p>	<p>Gravity is the universal attraction between all objects, however large or small, although it is only apparent when one of the objects is very large. This gravitational attraction keeps the planets in orbit around the Sun, the Moon round the Earth and their moons round other planets. On the Earth it results in everything being pulled down towards the center of the Earth. We call this downward attraction the weight of an object. ²(p. 21)</p> <p>Objects in contact exert forces on each other (friction, elastic pushes and pulls). Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact-for example, magnets push pull at a distance. ⁴(117)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
5.P3U1.4	
<p>Obtain, analyze, and communicate evidence of the effects that balanced and unbalanced forces have on the motion of objects.</p>	<p>Each force acts on one particular object and has both a strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) The patterns of an object's motion in various situations can be observed and measured; when past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) ⁴(p. 115)</p> <p>How quickly an object's motion is changed depends on the force acting and the object's mass. The greater the mass of an object, the longer it takes to speed it up or slow it down, a property of mass described as inertia. ²(p. 22)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
5.P3U3.5	
<p>Apply scientific ideas to define problems and design solutions pertaining to force and motion.</p> <p>Application of key concepts outlined in <u>5.P3U1.4</u></p>	

Commented [38]: Copied from working group:)
Framework citation p. 115 (added), 117 (above in 5.P2U1.3

Merged P3's together.

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5.P4U1.6	
<p>Analyze and interpret data to determine whether how and where energy is present and can be transferred whenever there are moving objects, when objects move.</p>	<p>The faster a given object is moving, the more energy it possesses. Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (Boundary: At this grade level, no attempt is made to give a precise or complete definition of energy.) ^{4(p. 122)} Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. Light also transfers energy from place to place. For example, energy radiated from the sun is transferred to Earth by light. When this light is absorbed, it warms Earth's land, air, and water and facilitates plant growth. Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy (e.g., moving water driving a spinning turbine which generates electric currents). ^{4(p. 125)}</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [39]: Standard revised based on comment (Tab: 5th Grade) 1538

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Earth and Space Sciences: Students develop an understanding of the how forces (gravity) in space cause observable patterns due to the position of the Earth, Sun, Moon, and stars.

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
5.E2U1.7	
<p>Develop and use models based on evidence to construct explanations about the movement of the Earth and Moon within our solar system.</p> <p>Concepts taught in 5.P2U1.3</p>	<p>The Earth moves round the Sun taking about a year for one orbit. The Moon orbits the Earth taking about four weeks to complete an orbit. The Sun, at the center of the solar system, is the only object in the solar system that is a source of visible light. The Moon reflects light from the Sun and as it moves round the Earth only those parts illuminated by the Sun are seen. The Earth rotates about an axis lying north to south and this motion makes it appear that the Sun, Moon and stars are moving round the Earth.</p> <p>The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. Some objects in the solar system can be seen with the naked eye. Planets in the night sky change positions and are not always visible from Earth as they orbit the sun. Stars appear in patterns called constellations, which can be used for navigation and appear to move together across the sky because of Earth's rotation. ⁴(p. 176)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
5.E2U2.8	
<p>Obtain, analyze, and communicate evidence to support an explanation that the gravitational force of Earth on objects is directed toward the planet's center down. (towards the center of the spherical Earth).</p> <p>Concepts taught in 5.P2U1.3</p>	<p>Gravity is the universal attraction between all objects, however large or small, although it is only apparent when one of the objects is very large. On the Earth it results in everything being pulled down towards the center of the Earth. We call this downward attraction the weight of an object. ²(p. 21)</p> <p>The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. ⁴(p. 117)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [40]: This standard was reviewed by the working group based on comments (Tab: 5th Grade) 354

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Life Sciences: Students develop an understanding of patterns and how genetic information is passed from generation to generation. They also develop the understanding of how genetic information and environmental features impact the survival of an organism.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
5.L3U1.9	
Obtain, evaluate, and communicate information about patterns between the offspring of plants and animals (including humans) and construct an explanation of how genetic information is passed from one generation to the next.	Many characteristics of organisms are inherited from their parents. Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. ⁴ (p. 158)
5.L3U2.10	The environment also affects the traits that an organism develops—differences in where they grow or in the food they consume may cause organisms that are related to end up looking or behaving differently. ⁴ (p. 158)
Construct an explanation based on evidence that changes in an environment can affect the development of the traits in a population of organisms. Concepts taught in <u>4.L4U2.11</u>	When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (p. 155) Offspring acquire a mix of traits from their biological parents. Different organisms vary in how they look and function because they have different inherited information. In each kind of organism there is variation in the traits themselves, and different kinds of organisms may have different versions of the trait. The environment also affects the traits that an organism develops—differences in where they grow or in the food they consume may cause organisms that are related to end up looking or behaving differently. ⁴ (p. 160) Crosscutting Concepts: patterns ; cause and effect; scale, proportion and quantity ; system and system models; energy and matter; structure and function; stability and change ⁴

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5.L4U4.11	
<p>Obtain, evaluate, and communicate evidence about how natural and human caused changes to habitats or climate can impact populations.</p> <p>Concepts taught in <u>4.L4U4.12</u>, 4.L4U2.11</p>	<p>Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.</p> <p>Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (p. 165)</p> <p>Scientists have identified and classified many plants and animals. Populations of organisms live in a variety of habitats, and change in those habitats affects the organisms living there. Humans, like all other organisms, obtain living and nonliving resources from their environments. (p. 165)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
5.L4U4.12	
<p>Construct an argument based on evidence that behavioral characteristics can involve inheritance and/or environmental conditions.</p>	<p>Many characteristics of organisms are inherited from their parents. Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. ⁴ (p. 158)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [41]: Agree that these also match the standard. But they are listed above...

Copied from working group:
Framework citation p. 155,

E/S 196, 198 ← maybe some connections?

Commented [42]: Missing this concepts from the 3-5 progression. Working groups added a standard.

Fifth Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band 3 to 5

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being

Strand 6: Use of Goal-Setting Skills to Enhance Health

- Concept 2: Health-related goal setting; PO 1 set a personal health goal and track progress towards its achievement

Strand 7: Ability to Practice Health-Enhancing Behaviors

- Concept 2: Healthy practices and behaviors; PO 1 demonstrate a variety of healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate a variety of behaviors that avoid or reduce health risks

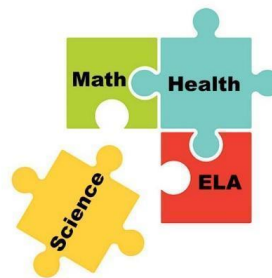
Connection to the Arizona English Language Arts Standards for Fifth Grade

- Use age-appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards.

Connection to the Arizona Mathematics Standards for Fifth Grade

- Standards for Mathematical Practice
 - Make sense of problems and persevere in solving them
 - Reason abstractly and quantitatively
 - Construct viable arguments and critique the reasoning of others
 - Model with mathematics
 - Use appropriate tools strategically
 - Attend to precision
 - Look for and make use of structure
 - Look for and express regularity in repeated reasoning
- Operations and Algebraic Thinking
 - Write and interpret numerical expressions
 - Analyze patterns and relationships
- Measurement and Data
 - Convert like measurement units within a given measurement system
 - Represent and interpret data
 - Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit
 - Geometric measurement; understand concepts of volume and relate volume to multiplication and division

See also [Appendix 4](#)



Commented [43]: Per public comment and working group discussion this information will become an appendix in this document

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Distribution of Grades 3-5 Standards

	U1: Science's purpose is to find the cause or causes of phenomena in the natural world.	U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.	U3: The knowledge produced by science is used in engineering and technologies to create products.	U4: Applications of science often have both positive and negative ethical, social, economic, and political implications.
P1: All matter in the Universe is made of very small particles.	5.P1U1.1 5.P1U1.2			
P2: Objects can affect other objects at a distance.	3.P2U1.1 4.P2U1.3 5.P2U1.3	3.P2U2.2		
P3: Changing the movement of an object requires a net force to be acting on it.	5.P3U1.4		5.P3U3.5	
P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	3.P4U1.3 5.P4U1.6	4.P4U2.1 4.P4U2.2		44.P4U4.4
E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	3.E1U1.4 4.E1U1.6	4.E1U2.5 4.E1U2.7 4.E1U2.8	4.E1U3.10	4.E1U4.9
E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.	5.E2U1.7	5.E2U2.8		
L1: Organisms are organized on a cellular basis and have a finite life span.	3.L1U1.5	3.L1U2.6		
L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	3.L2U1.8	3.L2U2.7	3.L2U3.9	
L3: Genetic information is passed down from one generation of organisms to another.	5.L3U1.9	5.L3U2.10		
L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.		4.L4U2.11		4.L4U4.12 5.L4U4.11 5.L4U4.12

Grades 6-8 Science Standards

The Grades 6-8 Science Standards are designed to provide opportunities for students to develop understanding of all fourteen core ideas (see Appendix 3) across the 6-8 grade band. To sufficiently demonstrate knowledge, understanding, and performance of each standard, not every core idea is included in every grade.

Within each grade level, students engage in multiple science and engineering practices (formerly known as the scientific method) as they gather information to answer their questions or solve design problems by reasoning about how the data provide evidence to support their understanding, and then communicate their understanding of phenomena in physical, earth and space, and life science (the knowing of science). They apply their knowledge of the core ideas to understand how scientists continue to build an understanding of phenomena, and see the impact, how people are impacted, by natural phenomena or to construct technological solutions (using science). The crosscutting concepts support their understanding of patterns, cause and effect relationships, and systems thinking as students make sense of phenomena in the natural and designed worlds. These practices, core ideas, and crosscutting concepts help students develop an understanding of skills and knowledge in order to transfer them develop transferable skills and understandings from one grade to the next and between content areas.

- In sixth grade, students apply their understanding of the cycling of matter, energy flow, structure, and function and scale, as it relates to from the very small scale in atoms, and molecules, and cells to the very large scale, geosphere, and the solar system, and ecosystems.
- In seventh grade, students will explore investigate the relationship between how forces and the cause changes in motion, how energy is transferred in impacts geologic and atmospheric processes, and the structure and function of cells, and environmental processes.
- In eighth grade, students will describe how cause-and-effect interact with the constant interaction of stability and change to and the process of cause-and-effect influence the natural world.

The organization of the standards within this document does not indicate instructional sequence or importance. Decisions about curriculum and instruction are made locally by individual school districts and classroom teachers; these standards can be sequenced, combined, or integrated with other content areas to best meet the local curriculum or student needs (See Appendices 4 and 5). Suggestions for key concepts and connections to other content area standards are included to assist teachers when implementing the Science Standards and are not intended to be the minimum or maximum content limits. It is suggested to use the metric system within measurement.

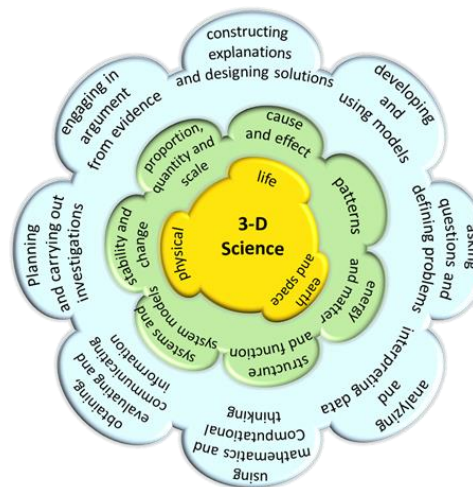


Figure 1: Three Dimensions of Science Instruction

Sixth Grade: Focus on Patterns; Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

By the end of sixth grade, students apply their understanding of how matter and energy relate to atoms, the solar system, and ecosystems. ~~In this grade level~~ Students will develop an understanding of the nature of matter and the role of energy transformation. Students will also deepen their understanding of scales, patterns, and properties of matter, the solar system, and ecosystems. Student investigations focus on collecting and making sense of observational data and measurements using the science and engineering practices: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, engage in argument from evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in sixth grade focus on helping students understand phenomena through patterns; scale, proportion, and quantity; systems and system models; and energy and matter. ~~scale, proportion, and quantity; systems and system models; and patterns~~. It is suggested to use the metric system within measurement.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>

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Physical Sciences: Students develop an understanding of forces and energy and how energy can transfer from one object to another or be converted from one form to another. They also develop an understanding of the nature of matter, and the role of energy in transformations.

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
6.P1U1.1	
Analyze and interpret data to show how that changes in states of matter are caused by different rates of movement of atoms in solids, liquids, and gases (Kinetic Theory).	<p>If a substance could be divided into smaller and smaller pieces it would be found to be made of very, very small particles, smaller than can be seen even with a microscope. These particles are not in a substance; they are the substance. All the particles of a particular substance are the same and different from those of other substances. The particles are not static but move in random directions. The speed at which they move is experienced as the temperature of the material. The differences between substances in the solid, liquid or gas state can be explained in terms of the speed and range of the movement of particles and the separation and strength of the attraction between neighboring particles. All materials, anywhere in the universe, living and non-living, are made of a very large number of basic 'building blocks' called atoms, of which there are about 100 different kinds. The properties of different materials can be explained in terms of the behavior of the atoms and groups of atoms of which they are made. ^{2 (p. 20)}</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
6.P1U1.2	
Plan and carry out an investigation to demonstrate how that variations in temperature and/or pressure affect changes in state of matter.	
6.P1U2.3	
Develop and use models to demonstrate represent that matter is made up of smaller particles called atoms.	
6.P3U2.4	
<p>Plan and carry out an investigation that can support an evidence-based explanation of how objects on Earth are affected by gravitational forces.</p> <p>Concepts taught in <u>5.P2U1.3, 5.P3U1.4, 5.P3U3.5, 5.E2U2.8</u> Grade level connection to <u>6.E1U1.7, 6.E1U2.11</u></p>	<p>All objects on the Earth are affected by gravitational forces. An object which stays at rest on the surface of the Earth has one or more forces acting on it is counterbalancing the force of gravity. A book lying on a table does not fall because the atoms in the table are pushing upwards on the book with a force equal to the downward force of gravity. An object floating in a liquid or in air does not move because there is an upward force balancing the downward force of gravity. The upward force is equal to the weight of the fluid displaced so heavy objects can float if they are</p>

Commented [44]: Grammar changed per technical review. (how → that)

Commented [45]: Per public comment: Moved this standard to 7th grade.

Note: This will change the sequence of numbering for the rest of grade 4 standard. Please be aware of this change as you edit the draft standards document and compare it to the March 2018 DRAFT.

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	<p>hollowed out to displace a large weight of water.²</p> <p>Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; Patterns; stability and change; cause and effect; structure and function⁴</p>
6.P2U2.4	
Develop and use a model to predict how forces act on objects at a distance.	<p>Gravity is the universal attraction between all objects, however large or small, although it is only apparent when one of the objects is very large. This gravitational attraction keeps the planets in orbit around the Sun, the Moon round the Earth and their moons round other planets. The effect of gravity on an object on the Moon is less than that on Earth because the Moon has less mass than the Earth, so a person on the Moon weighs less than on Earth even though their mass is the same. The pull of the Earth on the Moon keeps it orbiting the Earth while the pull of the Moon on the Earth gives rise to tides.² (p. 21)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
6.P4U3.5	
Analyze how humans use technology to store (potential) and/or use (kinetic) energy.	<p>The chemicals in the cells of a battery store energy which is released when the battery is connected so that an electric current flows, transferring energy to other components in the circuit and on to the environment.² (p. 23)</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>

Commented [46]: Per working groups: Duplicated this standards from 7th grade to focus on Earth/Moon/Tides also in place of 6.E2U1.6. Matched with P2 in Working with Big Ideas much better.

Commented [47]: Per working group: Have Chemical to electrical energy in the learning progression.

Earth and Space Sciences: Students develop an understanding of the scale and properties of objects in the solar system and how forces (gravity) and energy cause observable patterns in the Sun-Earth-Moon system.

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Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
6.E1U1.6	
<p>Investigate and construct an explanation demonstrating howthat radiation from the Sun provides energy and is absorbed to warm the Earth's surface and atmosphere.</p> <p>Extension of those taught in <u>4.P4U2.1, 4.E1U1.5</u></p>	<p>The layer of air at the Earth's surface is transparent to most of the radiation coming from the Sun, which passes through. The radiation that is absorbed at its surface is the Earth's external source of energy. The radiation from the Sun absorbed by the Earth warms the surface which then emits radiation of longer wavelength (infrared) that does not pass through the atmosphere but is absorbed by it, keeping the Earth warm. This is called the greenhouse effect because it is similar to the way the inside of a greenhouse is heated by the Sun. ^{2 (p. 24)}</p> <p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
6.E2U1.7	
<p>Use ratios and proportions to analyze and interpret data related to scale, properties, and relationships among objects in our solar system.</p> <p>Gravity on moon vs Earth, planetary distances, Complementary Standard: 6.P2U2.4</p>	<p>The Earth rotates about an axis lying north to south and this motion makes it appear that the Sun, Moon and stars are moving round the Earth. This rotation causes day and night as parts of the The Earth's surface turn to face towards or away from the Sun. It takes a year for the Earth to pass round the Sun. The Earth's axis is tilted relative to the plane of its orbit around the Sun so that the length of day varies with position on the Earth's surface and time of the year, giving rise to the seasons. The Earth is one of eight (so far known) planets in our solar system which, along with many other smaller bodies, orbit the Sun, in roughly circular paths, at different distances from the Sun and taking different times to complete an orbit. The distances between these bodies are huge – Neptune is 4.5 billion km from the Sun, 30 times further than Earth. As seen from Earth, planets move in relation to the positions of the stars which appear fixed relative to each other. ^{2 (p. 25)}</p>
6.E2U2.8	
<p>Develop and use models to explain how constellations and other night sky patterns appear to move due to Earth's rotation and revolution.</p> <p>Complementary Standard: 6.P2U2.4</p>	
6.E2U3.10	

Commented [48]: Per working groups
Possibly move to 5th grade

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<p>Construct an explanation from evidence that correlates patterns in the night sky to human navigation and agricultural practices. (remove)</p> <p>Per technical reviewer: Can be curriculum addition to standard 6.E2U2.9</p>	<p>The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. This model of the solar system can explain tides, eclipses of the sun and the moon, and the motion of the planets in the sky relative to the stars. Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. ⁴ (p. 176)</p>
6.E2U2.9	
<p>Develop and use models to construct an explanation of how eclipses, moon phases, and tides occur within the Sun-Earth-Moon system.</p> <p>Concepts taught in <u>4.E1U2.4</u> Complementary Standard: 6.P2U2.4</p>	<p>Crosscutting Concepts: patterns; cause and effect; scale, proportion and quantity; system and system models; energy and matter; structure and function; stability and change⁴</p>
6.E2U1.10	
<p>Use a model to show how the tilt of Earth's axis causes variations in the length of the day and gives rise to seasons.</p>	

Life Sciences: ~~Students develop an understanding of purposes the function of internal cell structures and their roles in life processes. Students develop an understanding of how energy from the Sun is transferred through ecosystems and how organisms' internal structures and processes maintain homeostasis.~~

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
6.L2U4.11	
<p>Use evidence to construct an argument regarding the impact of human activities on the environment and how they positively and negatively affect the competition for energy and resources in ecosystems.</p>	<p>Interdependent organisms living together in particular environmental conditions form an ecosystem. In a stable ecosystem there are producers of food (plants), consumers (animals) and decomposers, (bacteria and fungi which feed on waste products and dead organisms). The decomposers produce materials that help plants to grow, so the molecules in the organisms are</p>
6.L2U2.12	

Commented [49]: 7th life to 6th life.

Moved to 7th:
Develop and use a model to explain the organizational levels of structures in multicellular organisms consisting of organ systems, organs, tissues, and cells.

Concepts taught in 3.L1U1.5
*Removed and re-wrote this standard.
It was removed because it was too narrow to be a standard. Also wanted to include homeostasis (internal conditions). Also allowed to focus on the human body systems along with hierarchy from cells → organ systems.
Made it more rigorous

Commented [50]: 7th life to 6th life.

Moved to 7th:
Develop and use a model to explain the organizational levels of structures in multicellular organisms consisting of organ systems, organs, tissues, and cells.

Concepts taught in 3.L1U1.5
*Removed and re-wrote this standard.
It was removed because it was too narrow to be a standard. Also wanted to include homeostasis (internal conditions). Also allowed to focus on the human body systems along with hierarchy from cells → organ systems.
Made it more rigorous

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<p>Develop and use models to demonstrate the interdependence of organisms and their environment including biotic and abiotic factors.</p> <p>Concepts taught in 2.L2U2.10</p>	
<p>6.L2U2.13</p>	
<p>Construct a model that shows the cycling of matter and flow of energy in ecosystems.</p> <p>Concepts taught in 6.E1U1.6</p>	<p>constantly re-used. At the same time, energy resources pass through the ecosystem. When food is used by organisms for life processes some energy is dissipated as heat but is replaced in the ecosystem by radiation from the Sun being used to produce plant food. In any given ecosystem there is competition among species for the energy resources and the materials they need to live. The persistence of an ecosystem depends on the continued availability in the environment of these energy resources and materials. Plant species have adaptations to obtain the water, light, minerals and space they need to grow and reproduce in particular locations characterized by climatic, geological and hydrological conditions.² (p. 27)</p> <p>Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with nonliving factors. Growth of organisms and population increases are limited by access to resources. In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival.⁴ (p. 152)</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Systems and System Models; Energy and Matter; Stability and change⁴</p>
<p>6.L2U1.16</p>	
<p>Construct an explanation for how some cells use light energy through the process of photosynthesis.</p> <p>Construct an explanation for how some plant cells convert light energy into food energy.</p>	<p>Plant growth can continue throughout the plant's life through production of plant matter in photosynthesis. Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis,</p>

Commented [51]: To make a better flow of life science in bands 6 move 7th life to 6th life.

Moved to 7th:

Construct an explanation to demonstrate the relationship between major cell structures and cell functions (plant and animal).

Grade level connection to 6.L1U1.14
6.L1U2.1513 moved to 7th grade.

6.L2U2.13
*This used to be 7.E1U2.4. But upon further review it fit better as a life science standard and that basis was on its connection to ecosystems and the standards already included in life science ecosystems.

Commented [52]: To make a better flow of life science in bands 6 move 7th life to 6th life.

Moved to 7th: 6.L2U1.16
Construct an explanation for how some cells use light energy through the process of photosynthesis.

Construct an explanation for how some plant cells convert light energy into food energy.

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	<p>which also releases oxygen. These sugars can be used immediately or stored for growth or later use. ⁴ Radiation from the Sun provides the energy that enables plants containing chlorophyll to make glucose through the process of photosynthesis. ²</p> <p>Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; Patterns; stability and change; cause and effect; structure and function⁴</p>
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Sixth Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band 6 to 8

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 analyze the relationship between healthy behaviors and personal health
- Concept 3: Understanding personal health; PO 2 analyze how food provides energy and nutrients for growth and development, that nutrition requirements vary from person to person, and how food intake affects health

Strand 6: Use of Goal Setting Skills to Enhance Health

- Concept 2: Health related goal setting; PO 1 develop a goal to adopt, maintain, or improve a personal health practice

Strand 7: Ability to Practice Health Enhancing Behaviors

- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors that will maintain or improve the health of self and others
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks to self and others

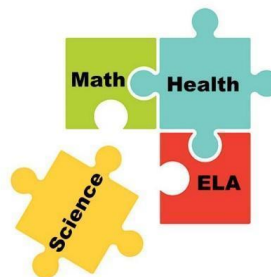
Connection to the Arizona English Language Arts Standards for Sixth Grade

- Use age appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards.

Connection to the Arizona Mathematics Standards for Sixth Grade

- Standards for Mathematical Practice
 - Make sense of problems and persevere in solving them
 - Reason abstractly and quantitatively
 - Construct viable arguments and critique the reasoning of others
 - Model with mathematics
 - Use appropriate tools strategically
 - Attend to precision
 - Look for and make use of structure
 - Look for and express regularity in repeated reasoning
- Ratios and Proportional Relationships
 - Understand ratio concepts and use ratio reasoning to solve problems
- Expressions and Equations
 - Represent and analyze quantitative relationships between dependent and independent variable
- Geometry
 - Solve mathematical problems and problems in real world context involving area, surface area, and volume

See also [Appendix 4](#)



Commented [53]: Per public comment and working group discussion this information will become an appendix in this document

Seventh Grade: Focus on Patterns; Cause and Effect; Structure and Function

By the end of seventh grade, students will explore how forces cause changes in motion and how energy is transferred in geologic, atmospheric, and environmental processes. ~~In this grade level,~~ Students investigate **force** and motion in a wide variety of systems, model how heat energy drives cycles in weather and climate, and explain **the structure and function of cells**. ~~how ecosystems maintain structure and stability.~~ Student investigations focus on collecting and making sense of observational data and measurements using the **science and engineering practices**: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, engage in argument from evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in seventh grade focus on helping students understand phenomena through **patterns**, **cause and effect**, and **structure and function**. *It is suggested to use the metric system within measurement.*

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and /or political implications.</p>

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Physical Sciences: Students will explore how **cause and effect** **how force and motion** take place within and between a wide variety of **force and motion systems** from forces on individual objects to the forces that shape our Earth.

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
7.P2U1.1	
Collect and analyze data demonstrating how that how electromagnetic electric and magnetic forces can be attractive or repulsive and can vary in strength. Concepts taught in 4.P4U2.2	Electric and magnetic (electromagnetic) forces can be attractive or repulsive , and their sizes depend on the magnitudes of the charges, currents , or magnetic strengths involved and on the distances between the interacting objects. Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass —for example, Earth and the sun. Long-range gravitational interactions govern the evolution and maintenance of large-scale systems in space, such as galaxies or the solar system, and determine the patterns of motion within those structures. Forces that act at a distance (gravitational, electric, and magnetic) can be explained by force fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively). ⁴ (pp. 117-118) On the Earth it [gravity] results in everything being pulled down towards the center of the Earth. We call this downward attraction the weight of an object. The object pulls the Earth as much as the Earth pulls the object, but because the Earth's mass is much bigger, we observe the resulting motion of the object, not of the Earth. ² (p. 21)
7.P2U2.2	
Develop and use a model to predict how forces act on objects at a distance. Concepts taught in 6.E2U2.11	
7.P3U2.3	
Plan and carry out an investigation that can support an evidence-based explanation of how objects on Earth are affected by gravitational force. Concepts taught in 5.P2U1.3 , 5.P3U1.4 , 5.P3U3.5 , 5.E2U2.8 Grade level connection to 6.E1U1.7 , 6.E1U2.11	Crosscutting Concepts: Patterns ; Cause and effect ; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴
7.P3U2.4	
Use non-algebraic mathematics and computational thinking to explain	For any pair of interacting objects, the force exerted by the first

Commented [54]: Copied from working groups:
6/28- Not found in P2 (working with big ideas)
7/02 - The committee agrees this IS P2. The essence of the standard is in Big Idea P2 and it is also part of the 6-8 progression documented in the Framework

Commented [55]: Copied from working group:
-6/28 committee recommends having this standard in both 6th and 7th

Commented [56]: Moved from 6th to 7th

Note: This will change the sequence of numbering for the rest of grade 4 standard. Please be aware of this change as you edit the draft standards document and compare it to the March 2018 DRAFT.

Commented [57]: 6/14 committee - To address public concern, move to 8th grade
-(6/28 committee group recommends keeping this standard in 7th)

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<p>Newton's laws of motion.</p> <p>Concepts taught in 6.P1U1.1, 6.P4U3.5</p>	<p>object on the second object is equal in strength to the force that the second object exerts on the first but in the opposite direction. The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. Forces on an object can also change its shape or orientation. All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. ⁴ (pp. 115-116)</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>
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Earth and Space Sciences: Students develop an understanding of the ~~results~~ **patterns of energy flowing along with and** ~~matter~~ **cycling within and among the Earth's systems**. ~~role of heat energy in warming the Earth and driving cycles in weather and climate.~~

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
<p>7.E1U2.5</p> <p>Construct a model that shows the cycling of matter and flow of energy in the atmosphere, hydrosphere, and geosphere.</p> <p>Concepts taught in 6.E1U1.6</p>	<p>Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and All physical changes in Earth's materials and living organisms. ⁴ (p. 181)</p> <p>Radioactive decay of material inside the Earth since it was formed is its internal source of energy. Radiation from the Sun provides the energy that enables plants containing chlorophyll to make glucose through the process of photosynthesis [Boundary: Not expected to teach photosynthesis in Earth, left in to show big picture]. ²(p. 24)</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>

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7.E1U2.6	
<p>Analyze and interpret data Construct a model to explain on the distribution of fossils and rocks, continental shapes, and seafloor structures to provides evidence of the past plate motions.</p> <p>Concepts taught in <u>4.E1U2.6</u>, <u>4.E1U2.7</u>, <u>4.L4U2.11</u></p>	<p>Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geological history. Plate movements are responsible for most continental and ocean floor features and for the distribution of most rocks and minerals within Earth's crust. Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. ⁴ (p. 183)</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>
7.E1U3.7	
<p>Analyze and interpret data to construct an explanation for how the technology scientists use to predict weather and to explore Earth has evolved over time. has improved weather prediction.</p>	<p>Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. Because these patterns are so complex, weather can be predicted only probabilistically. The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. Greenhouse gases in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, thereby regulating Earth's average surface temperature and keeping it habitable. ⁴(p. 188)</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>

Commented [58]: Copied from working groups:

6/14 committee: Move to 8th
6/28 committee: keep in 7th

Analyze and interpret data to construct an explanation for how technology has improved weather prediction.

As per public's concerns.

of how the technology scientists use to predict weather and to explore Earth has evolved over time.

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Life Sciences: ~~Students develop an understanding of how energy from the Sun is transferred through ecosystems and how organisms' internal structures and processes maintain homeostasis.~~ Students develop an understanding of the structure and function of cells.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
7.L1U2.8	
Obtain, evaluate, and communicate information to provide evidence that all living things are made of cells, cells come from existing cells, and cells are the basic structural and functional unit of all living things.	All living organisms are made of one or more cells , which can be seen only through a microscope . All the basic processes of life are the results of what happens inside cells. Cells divide to replace aging cells and to make more cells in growth and in reproduction . Some cells in multicellular organisms, as well as carrying out the functions that all cells do, are specialized ; for example, muscle, blood and nerve cells carry out specific functions within the organism. Cells are often aggregated into tissues , tissues into organs , and organs into organ systems . In the human body, systems carry out such key functions as respiration, digestion, elimination of waste and temperature control . The circulatory system takes material needed by cells to all parts of the body and removes soluble waste to the urinary system. Stem cells , which are not specialized, are capable of repairing tissues by being programmed for different functions. Both single celled and multicellular organisms have mechanisms to maintain temperature and acidity within certain limits that enable the organism to survive. ² (p. 26)
7.L1U2.9	
Construct an explanation to demonstrate the relationship between major cell structures and cell functions (plant and animal).	Crosscutting Concepts: Patterns ; Cause and effect ; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴
7.L1U2.10	
Develop and use a model to explain how cells, tissues, and organ systems maintain life (animals).	Interdependent organisms living together in particular environmental conditions form an ecosystem . In a stable ecosystem there are producers of food (plants), consumers (animals) and decomposers , (bacteria and fungi which feed on waste products and dead organisms). The decomposers

Commented [59]: The life science standards have been moved from 6th to 7th and reorganized. Most wording has stayed the same. There was one addition of a standard to focus on systems of the body.

One standard from this section was deleted: Obtain and evaluate information about devices developed to help humans maintain homeostasis. Delete Homeostasis is covered in a similar standard.

7.L1U2.8 – wording exactly the same

Note: This will change the sequence of numbering for the rest of grade 4 standard. Please be aware of this change as you edit the draft standards document and compare it to the March 2018 DRAFT.

Commented [60]: No change in wording. Moved from 6th.

Commented [61]: Added standard to address systems of the body (animal or human).

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7.L1U1.11	produce materials that help plants to grow, so the molecules in the organisms are constantly re-used. At the same time, energy resources pass through the ecosystem. When food is used by organisms for life processes some energy is dissipated as heat but is replaced in the ecosystem by radiation from the Sun being used to produce plant food. In any given ecosystem there is competition among species for the energy resources and the materials they need to live. The persistence of an ecosystem depends on the continued availability in the environment of these energy resources and materials. 2 (p. 27)
Explain how organisms maintain internal stability and evaluate the effect of the external factors on organisms' internal stability.	
7.L2U1.12	Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with nonliving factors. Growth of organisms and population increases are limited by access to resources . In any ecosystem, organisms and populations with similar requirements for food, water, oxygen , or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction . Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. 4 (p. 152)
Construct an explanation for how some plant cells convert light energy into food energy.	
Connects to 6.E1U1.6	Crosscutting Concepts: Patterns; Cause and effect ; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function 4

Commented [62]: Wording the same. Stayed in 7th but numbering changed due to re-organization.

This standard takes the place of the other "homeostasis" standard.

Commented [63]: Wording stayed the same. Moved from 6th to 7th.

Seventh Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band 6 to 8

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 analyze the relationship between healthy behaviors and personal health
- Concept 3: Understanding personal health; PO 2 analyze how food provides energy and nutrients for growth and development, that nutrition requirements vary from person to person, and how food intake affects health

Strand 6: Use of Goal Setting Skills to Enhance Health

- Concept 2: Health related goal setting; PO 1 develop a goal to adopt, maintain, or improve a personal health practice

Strand 7: Ability to Practice Health-Enhancing Behaviors

- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors that will maintain or improve the health of self and others
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks to self and others

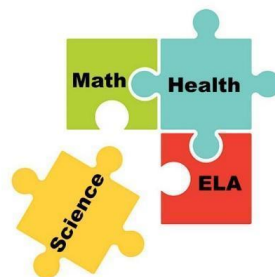
Connection to the Arizona English Language Arts Standards for Seventh Grade

- Use age appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards.

Connection to the Arizona Mathematics Standards for Seventh Grade

- Standards for Mathematical Practice
 - Make sense of problems and persevere in solving them
 - Reason abstractly and quantitatively
 - Construct viable arguments and critique the reasoning of others
 - Model with mathematics
 - Use appropriate tools strategically
 - Attend to precision
 - Look for and make use of structure
 - Look for and express regularity in repeated reasoning
- Statistics and Probability
 - Use random sampling to draw inferences about a population
 - Draw informal comparative inferences about two populations
 - Investigate chance processes and develop, use, and evaluate probability models

See also Appendix 4



Commented [64]: Per public comment and working group discussion this information will become an appendix in this document

Eighth Grade: Focus on Cause and Effect; Energy and Matter; Stability and Change

By the end of eighth grade, students will describe how the constant interaction of stability and change and the process of cause and effect influence changes in the natural world. ~~In this grade level~~ Students will apply energy principles to chemical reactions, explore changes within the Earth and understand how genetic information is passed down to produce variation among the populations. Student investigations focus on collecting and making sense of observational data and measurements using the science and engineering practices: ask questions and define problems, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, engage in argument from evidence, and obtain, evaluate, and communicate information. While individual lessons may include connections to any of the crosscutting concepts, the standards in eighth grade focus on helping students understand phenomena through cause and effect, energy and matter and stability and change. It is suggested to use the metric system within measurement.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>

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Physical Sciences: Students **apply stability and change to** explore chemical properties of matter and chemical reactions to further understand energy and matter.

Physical Science Standards	Key concepts include but are not limited to:
8.P1U2.1	
<p>Develop and use a model to demonstrate how that atoms and molecules can be combined or rearranged in chemical reactions to form new compounds with the total number of each type of atom conserved.</p> <p>Concepts introduced in <u>6.P1U1.1</u>, and <u>6.P1U2.3</u></p>	<p>All materials, anywhere in the universe, living and non-living, are made of a very large numbers of basic 'building blocks' called atoms, of which there are about 100 different kinds. Substances made of only one kind of atom are called elements. Atoms of different elements can combine together to form a very large number of compounds. A chemical reaction involves a rearrangement of the atoms in the reacting substances to form new substances, while the total amount of matter remains the same. The properties of different materials can be explained in terms of the behavior of the atoms and groups of atoms of which they are made. 2 (p. 20)</p>
8.P1U3.2	
<p>Develop solutions to problems based on chemical and physical properties of a substance.</p>	<p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function 4</p>
8.P4U1.3	
<p>Construct an explanation on how energy can be transferred from one energy store to another.</p>	<p>Energy can be stored by lifting an object higher above the ground. When it is released and falls, this energy is stored in its motion. When an object is heated it has more energy than when it is cold. An object at a higher temperature heats the surroundings or cooler objects in contact with it until they are all at the same temperature. How quickly this happens depends on the kind of material which is heated and on the materials between them (the extent to which they are thermal insulators or conductors). The chemicals in the cells of a battery store energy which is released when the battery is connected so that an electric current flows, transferring energy to other components in the circuit and on to the environment. Energy can be transferred by radiation, as sound in air or light in air or a vacuum. Many processes and phenomena are described in terms of energy exchanges, from the growth of plants to the weather. The transfer of energy in making things happen almost always results in</p>
8.P4U1.4	
<p>Evaluate how energy affects wave characteristics and interactions using mathematical models.</p> <p>Concepts taught in <u>7.E1U2.4</u></p>	

Commented [65]: Major re-wording of this standard.

Old version: Obtain and evaluate information regarding how scientists use technology to identify substances based on unique physical and chemical properties.

Some standards moved from one grade to the next:
Note: This will change the sequence of numbering for the rest of grade 4 standard. Please be aware of this change as you edit the draft standards document and compare it to the March 2018 DRAFT.

Commented [66]: Copied from Working Group

-6/14 Move to 7th grade

-6/28 committee group recommends keeping this standard where it is located as it is written
As per public's comments. This change supports the progression of this topic within grade levels.

Commented [67]: 6/14 - Move to 7th grade

-6/28 committee group recommends keeping this standard where it is located as it is written.
As per public's comments. This change supports the progression of this topic within grade levels.

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8.P4U3.5	some energy being shared more widely, heating more atoms and molecules and spreading out by conduction or radiation. The process cannot be reversed and the energy of the random movement of particles cannot as easily be used. Thus, some energy is dissipated . ² (p. 23)
Develop a solution to increase efficiency when transferring energy from one source to another.	Crosscutting Concepts: Patterns; Cause and effect ; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter ; Stability and change ; Structure and function ⁴

Earth and Space Sciences: Students explore natural and human-induced **cause-and-effect changes in Earth systems over time.**

Earth and Space Standards	Key concepts include but are not limited to:
8.E1U1.6	
Analyze and interpret data Develop and use a model of about the Earth's geological column to communicate relative ages of rock layers and fossils. Concepts taught in <u>7.E1U2.5</u>	Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geological history. Plate movements are responsible for most continental and ocean floor features and for the distribution of most rocks and minerals within Earth's crust . Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. ⁴ (p. 183)
8.E1U3.7	
Obtain, evaluate, and communicate information about technologies that use data and historical patterns to predict natural hazards and other geological events .	Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude , altitude , and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. Because these patterns are so complex, weather can be predicted only probabilistically. The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.
8.E1U4.8	Greenhouse gases in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, thereby regulating Earth's average surface temperature and keeping it habitable . ⁴ (p. 188)
Construct and support an argument about how human consumption of limited resources impacts the geosphere.	Evolution is shaped by Earth's varying geological conditions. Sudden changes in conditions (e.g., meteor impacts , major volcanic eruptions) have caused mass extinctions , but these changes, as well as more gradual ones, have ultimately

Commented [68]: It was discussed that this standard is very similar to 7.E1U3.6

It was decided the top was ok to have in both grade levels.

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8.E1U3.9	allowed other life forms to flourish. The evolution and proliferation of living things over geological time have in turn changed the rates of weathering and erosion of land surfaces, altered the composition of Earth's soils and atmosphere , and affected the distribution of water in the hydrosphere . ⁴ (p. 190)
Construct an explanation for how scientists predict weather and explore Earth with technology that has evolved over time.	Crosscutting Concepts: Patterns; Cause and effect ; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter ; Stability and change ; Structure and function ⁴

Commented [69]: Note on document says this standard stays here in 8th grade...

Standard is removed from "idea board".

Does this standard stay or go?

Note: This will change the sequence of numbering for the rest of grade 4 standard. Please be aware of this change as you edit the draft standards document and compare it to the March 2018 DRAFT.

Life Sciences: Students develop an understanding of patterns and how genetic information is passed from generation to generation. They also develop the understanding of how traits within populations change over time.

Life Science Standards	Key concepts include but are not limited to:
8.L3U1.10	
Explain how the transfer of genetic information from each parent to produce s variations in offspring that are inherited or from mutations .	Genes are located in the chromosomes of cells , with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of a specific protein , which in turn affects the traits of the individual (e.g., human skin color results from the actions of proteins that control the production of the pigment melanin). Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. Sexual reproduction provides for transmission of genetic information to offspring through egg and sperm cells . These cells, which contain only one chromosome of each parent's chromosome pair, unite to form a new individual (offspring). Thus offspring possess one instance of each parent's chromosome pair (forming a new chromosome pair). Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited or (more rarely) from mutations. (Boundary: The stress here is on the impact of gene transmission in reproduction, not the mechanism.) ⁴ (pp. 158-159)
8.L3U4.11	
Communicate how advancements in technology have furthered the field of genetic research and use evidence to support an argument about the positive and negative effects of genetic research on human lives.	In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in

Commented [70]: The movement of one standard above increased the numbering of the LS standards by 1

Example: 8.L3U1.10 used to be 8.L3U1.9

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	<p>changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. <small>4.(p. 160)</small></p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>
8.L4U2.12	
Develop and use a model to explain how natural selection may lead to increases and decreases of specific traits in populations over time.	Genetic variations among individuals in a population give some individuals an advantage in surviving and reproducing in their environment. This is known as natural selection. It leads to the predominance of certain traits in a population and the suppression of others. In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. <small>4.(p. 164)</small>
8.L4U2.13	
<p>Gather and communicate evidence on the processes by which a species may change over time in response to environmental conditions.</p> <p>concepts taught in <u>5.L3U2.10</u></p>	<p>Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. In separated populations with different conditions, the changes can be large enough that the populations, provided they remain separated (a process called reproductive isolation), evolve to become separate species. <small>4.(p. 165)</small></p> <p>Biodiversity is the wide range of existing life forms that have adapted to the variety of conditions on Earth, from terrestrial to marine ecosystems. Biodiversity includes genetic variation within a species, in addition to species variation in different habitats and ecosystem types (e.g., forests, grasslands, wetlands). Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. <small>4.(p. 167)</small></p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>

Eighth Grade Connections to Other Academic Disciplines

Commented [71]: Per public comment and working group discussion this information will become an appendix in this document

Life Science Connections to the Arizona Health Standards for Grade Band 6 to 9

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 analyze the relationship between healthy behaviors and personal health
- Concept 3: Understanding personal health; PO 2 analyze how food provides energy and nutrients for growth and development, that nutrition requirements vary from person to person, and how food intake affects health

Strand 6: Use of Goal-Setting Skills to Enhance Health

- Concept 2: Health-related goal setting; PO 1 develop a goal to adopt, maintain, or improve a personal health practice

Strand 7: Ability to Practice Health-Enhancing Behaviors

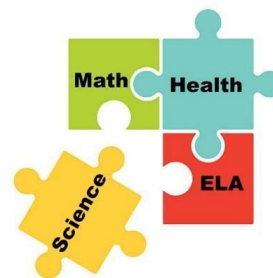
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors that will maintain or improve the health of self and others
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks to self and others

Connection to the Arizona English Language Arts Standards for Eighth Grade

- Use age-appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards.

Connection to the Arizona Mathematics Standards for Eighth Grade

- Standards for Mathematical Practice
 - Make sense of problems and persevere in solving them
 - Reason abstractly and quantitatively
 - Construct viable arguments and critique the reasoning of others
 - Model with mathematics
 - Use appropriate tools strategically
 - Attend to precision
 - Look for and make use of structure
 - Look for and express regularity in repeated reasoning
- Expressions and Equations
 - Understand the connections between proportional relationships, lines, and linear functions
- Functions
 - Use functions to model relationships between quantities
- Statistics and Probability
 - Investigate patterns of association in bivariate data
 - Investigate chance processes and develop, use, and evaluate probability models



See also Appendix 4

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Distribution of the Grades 6-8 Standards

	U1: Science's purpose is to find the cause or causes of phenomena in the natural world.	U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.	U3: The knowledge produced by science is used in engineering and technologies to create products.	U4: Applications of science often have both positive and negative ethical, social, economic, and political implications.
P1: All matter in the Universe is made of very small particles.	6.P1U1.1 6.P1U1.2	6.P1U2.3 8.P1U2.1	8.P1U3.2	
P2: Objects can affect other objects at a distance.	7.P2U1.1	6.P2U2.4 7.P2U2.2		
P3: Changing the movement of an object requires a net force to be acting on it.		7.P3U2.3 7.P3U2.4		
P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	8.P4U1.3 8.P4U1.4		6.P4U3.5 8.P4U3.5	
E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	6.E1U1.6 8.E1U1.6	7.E1U2.5 7.E1U2.6	7.E1U3.7 8.E1U3.7 8.E1U3.9	8.E1U4.8
E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.	6.E2U1.7 6.E2U1.10	6.E2U2.8 6.E2U2.9		
L1: Organisms are organized on a cellular basis and have a finite life span.	7.L1U1.11	7.L1U2.8 7.L1U2.9 7.L1U2.10		
L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	7.L2U1.12	6.L2U2.12 6.L2U2.13		6.L2U4.11
L3: Genetic information is passed down from one generation of organisms to another.	8.L3U1.10			8.L3U4.11
L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.		8.L4U2.12 8.L4U2.13		

High School Science Standards

In Arizona, students are required to take 3 credits of high school science to meet graduation requirements, but there is no mandatory course sequence across the state. Because of this, the high school standards are written at two levels: essential and plus.

- All high school essential standards (HS) should be learned by every high school student regardless of the 3-credit course sequence they take. The full set of high school (HS) essential standards should be taught over that 3-year period. Essential High School Science Standards are designed to provide opportunities for students to develop understanding of all 14 core ideas (see page 4) across three credits of high school science.
- The High School Plus (HS+) standards are designed to enhance the rigor of general science courses by extending the essential standards within chemistry (HS+C), physics (HS+Phy), earth and space sciences (HS+E), or biology (HS+B) to prepare students for entry level college courses.

Throughout grades K through 8, students are engaged in multiple science and engineering practices (formerly known as the scientific method) as they gather information to answer their questions or solve design problems, reason about how the data provide evidence to support their understanding, and then communicate their understanding of phenomena in physical, earth and space, and life science (knowing science). The High School standards continue this pattern, and educators should seek ways to integrate the science and engineering practices, as students apply their knowledge of core ideas to understand how scientists continue to build understanding of phenomena and see how people are impacted by natural phenomena or to construct solutions (using science). The crosscutting concepts support their understanding of patterns, cause and effect relationships, and systems thinking as students make sense of phenomena in the natural and designed worlds. In all disciplines, educators should incorporate scientific measurement skills appropriate to that discipline such as the international system of units, scientific notation, conversion factors, and significant figures, as well as the importance of scientific research and peer review.

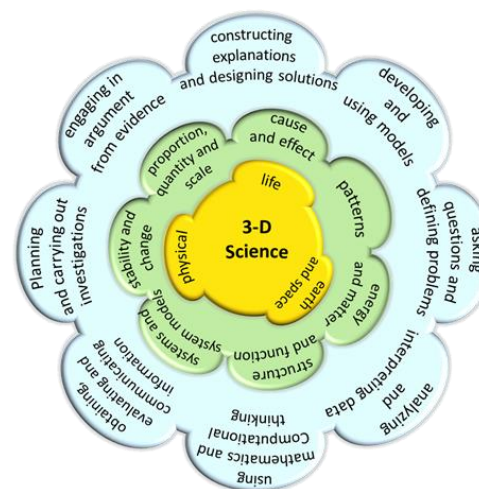


Figure 1: Three Dimensions of Science Instruction

The organization of the standards within this document does not indicate instructional sequence or importance. Decisions about curriculum and instruction are made locally by individual school districts and classroom teachers; these standards can be sequenced, combined, or integrated with other content areas to best meet the local curriculum or student needs (See Appendices 4 and 5). Suggestions for key concepts and connections to other content area standards are included to assist teachers when implementing the Science Standards and are not intended to be the minimum or maximum content limits. It is suggested to use the metric system within measurement.

High School Physical Sciences



Physical science encompasses physical and chemical subprocesses that occur within systems. At the high school level, students gain an understanding of these processes at both the micro and macro levels through the intensive study of matter, energy, and forces.⁴ Students are expected to apply these concepts to real-world phenomena to gain a **deeper understanding of causes, effects, and solutions for physical processes in the real world**. The essential standards are those that every high school student is expected to know and understand. Plus standards in chemistry and physics are designed to extend the concepts learned in the essential standards to prepare students for entry level college courses. **It is suggested to use the metric system within measurement.**

Note:

- The standard number is designed for recording purposes and does not imply instructional sequence or importance.
- In all disciplines, educators should incorporate scientific measurement skills appropriate to that discipline.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>

Please be aware high school number has been changed significantly. Look for standard verbiage when comparing the March Draft to the current Draft!

Chemistry – Structure and Properties of Matter	Physical Science Essential Standards HS Essential Standards are intended for ALL students to have learned by the end of 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
	<i>Essential HS.P1U2.1</i>		
	<i>Use the structure of atoms and their properties to explain patterns in the Periodic Table and describe how these models are revised with new evidence.</i> <i>Connections: 6.P1U2.3, HS.E2U1.15, HS.L2U1.25</i>		Each atom has a charged substructure consisting of a nucleus , which is made of protons and neutrons , surrounded by electrons . The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states . The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. Stable forms of matter are those in which the electric and magnetic field energy is minimized. ⁴ (p. 109) Atoms of each element emit and absorb characteristic frequencies of light, and nuclear transitions have distinctive gamma ray wavelengths. These characteristics allow identification of the presence of an element, even in microscopic quantities. ⁴ (p. 134) Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴
	Physical Science Plus (+) Standard s HS+ Standards are designed for students taking a high school chemistry (C) or honors chemistry	Plus HS+C.P1U1.1	
		Use the various historical and recent models of the atom to explain how valence electrons can be used to predict properties and behaviors of elements and compounds.	
		Plus HS+C.P1U2.2	
		Use a historical model of the atom to evaluate qualitatively the Obtain, evaluate, and communicate the qualitative evidence supporting claims about how atoms absorb and emit energy in the form of electromagnetic radiation.	
Plus HS+C.P1U1.3			
Plan and conduct investigations to gather evidence of Analyze and interpret data to develop and support an explanation for the relationships between kinetic molecular theory and gas laws.			

Chemistry – Chemical Reactions	Physical Science Essential Standards HS Essential Standards are intended for ALL students to have learned by the end of 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
	Essential HS.P1U1.2		
	Describe patterns in <i>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.</i> Connections: 5.P1U1.2 , 8.P1U1.2 , HS.E2U1.15 , HS.L2U1.25		Chemical processes , their rates , and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, that are matched by changes in kinetic energy . In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. The fact that atoms are conserved , together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. Chemical processes and properties of materials underlie many important biological and geophysical phenomena . ⁴ (p. 111)
	Essential HS.P1U1.3		
	<i>Ask questions, plan, and carry out investigations to explore the cause and effect relationship between reaction rate factors.</i> Connections: 8.P1U2.1 , HS.E2U1.15		
	Physical Science Plus (+) Standards	Plus HS+C.P1U2.4	
Develop and use models to predict and explain forces within and between molecules.			
Plus HS+C.P1U2.5			
			Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴

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	<p>rds HS+ Standards are designed for students taking a high school chemistry (C) or honors chemistry</p>	<p>Develop and use models to explain Plan and conduct an investigation to construct an explanation for the differences between chemical compounds using patterns as a method for identification.</p>	
		Plus HS+C.P1U1.6	
		Plan and conduct investigations to test predictions of the outcomes of various chemical reactions, based on patterns of physical and chemical properties.	
		Connection: <u>HS.P1U2.1</u>	
		Plus HS+C.P1U3.7	
		Construct an explanation, design a solution, or refine the design of a chemical system in equilibrium to maximize production.	
Chemistry – Nuclear Process	<p>Physical Science Essential Standards HS Essential Standards are intended for ALL students to have learned by the end of 3 credits of high school science courses and are on the state assessment.</p>	Essential HS.P1U4.4	<p>Learning Progressions, Key Terms and Crosscutting Concepts</p>

esse s and Appl icati ons of Chemist ry	<i>Engage in argument from evidence about how the use of chemistry has positive and negative ethical, social, economic, and/or political implications.</i>		<p>The total number of neutrons plus protons does not change in any nuclear process. Strong and weak nuclear interactions determine nuclear stability and processes. Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials from the isotopic ratios present. Normal stars cease producing light after having converted all of the material in their cores to carbon or, for more massive stars, to iron. Elements more massive than iron are formed by fusion processes but only in the extreme conditions of supernova explosions, which explains why they are relatively rare. ⁴</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>
	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school chemistry (C) or honors chemistry	Plus HS+C.P1U4.9 Engage in argument, from evidence, regarding the ethical, social, economic, and/or political benefits and liabilities of fission, fusion, and radioactive decay. to explain how changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay have been used to positively and negatively serve human ends. Connection: <u>8.E1U1.6</u> , <u>HS.E1U2.13</u>	

Commented [72]: Copied from working group:
(Moved from physics section to chemistry section)

Physics – Motion & Stability – Forces & Interactions	Physical Science Essential Standards HS Essential Standards are intended for ALL students to have learned by the end of 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
	Essential HS.P2U1.5		
	<i>Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic).</i> Connections: <u>4.P4U2.2</u> , <u>5.P3U1.4</u> , <u>7.P2U1.1</u> , <u>7.P2U2.2</u> , <u>HS.E2U2.16</u>		Newton's second law accurately predicts changes in the motion of macroscopic objects, but it requires revision for subatomic scales or for speeds close to the speed of light. Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved . If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitation and electrostatic forces between distant objects. Forces at a distance are explained by fields permeating space that can transfer energy through space. Magnets or changing electric field cause magnetic fields; electric charges or changing magnetic fields cause electric fields. ⁴ (p. 116)
	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics course	Plus HS+Phy.P2U1.1 Design, build, and refine a device that works within given constraints to demonstrate that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	
		Plus HS+Phy.P2U3.2 Design, build, and refine a device that works within given constraints to demonstrate that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	
	Essential HS.P2U3.6 <i>Investigate and communicate how fields (electric, gravitational, magnetic) are utilized and how they influence the structure and function of different technologies.</i> Connections: <u>8.P4U1.3</u> , <u>HS.E2U2.16</u>		Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴

Commented [RB73]: Copied from working groups: *One comment stated that teachers/schools may struggle with this, but we wondered in what way - we think it is easily doable. One member of the revision team said that they do this in 4th grade. If that is true, should it be here?

Commented [RB74]: *Recommend removal of this standard - doesn't seem essential for all students, and essential pieces are covered in previous essential standard.

Essential HS.P3U2.7	
<i>Collect, analyze and interpret data regarding the change in motion of an object or system in <u>one dimension</u>, to construct an explanation using <u>Newton's Laws</u>. Develop a mathematical model, using Newton's laws, to predict the change in motion of an object or system in <u>one dimension</u>.</i>	
Connections: 6.P3U2.4, 7.P3U2.3, HS.E2U2.16	
Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics course	Plus HS+Phy.P3U2.3
	Develop a mathematical model, using Newton's laws, to predict the change in motion of an object or system in <i>two dimensions</i> (projectile and circular motion).
	Plus HS+Phy.P3U1.4
	Develop and use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic forces between objects.
	Plus HS+Phy.P3U1.5
	Engage in an argument, from evidence, regarding the claim that the total momentum of a system is conserved when there is no net force on the system.
Essential HS.P3U3.8	
<i>Use mathematics and computational thinking to explain Analyze mathematically how Newton's laws are used in engineering and technologies to create products to serve human ends.</i>	

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	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics course	HS+Phy.P3U3.6	
		Design, evaluate, and refine a device that minimizes or maximizes the force on a macroscopic object during a collision.	

Physics – Energy	Physical Science Essential Standards HS Essential Standards are intended for ALL students to have learned by the end of 3 credits of high school science courses and are on the state assessment.	Learning Progressions, Key Terms and Crosscutting Concepts
	<i>Essential HS.P4U1.9</i>	
	<i>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.</i> <i>Connections: 7.E1U2.4, 7.L2U2.10, 8.P4U1.3</i>	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved , even as, within the system, energy is continually transferred from one object to another and between its various possible forms. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion , sound , light , and thermal energy . “ Mechanical energy ” generally refers to some combination of motion and stored energy in an operating machine. “ Chemical energy ” generally is used to mean the energy that can be released or stored in chemical processes, and “ electrical energy ” may mean energy stored in a battery or energy transmitted by electric currents . Historically, different units and names were used for the energy present in these
	<i>Essential HS.P4U4.10</i>	
	<i>Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.</i>	

Commented [RB75]: Copied from working group:
*One comment felt this was misplaced (wouldn't be taught in Physics), but it certainly fits within P4. It is up to the LEA to determine which course teaches this essential.

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	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics course	Plus HS+Phy.P4U1.7	different phenomena, and it took some time before the relationships between them were recognized. Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. The availability of energy limits what can occur in any system. Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴
		Analyze and interpret data to quantitatively describe changes in energy within a system and/or energy flows in and out of a system.	
		Plus HS+Phy.P4U1.8	
		Analyze and interpret data...? Plan and conduct investigations to determine the power and efficiency in the change of energy storage modes within various systems.	
		Plus HS+Phy.P4U3.9	
		Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	
		Plus HS+Phy.P4U1.10	
		Explore the graphical and mathematical relationships between power, current, voltage, and resistance. Connection: <u>4.P4U2.2</u>	

Commented [RB76]: Copied from working group:
*Physics expert needs to look at this. Not quite sure what the original standard was trying to achieve. We believe that "power and efficiency" relate to work, which is not energy storage, but energy use. Since the next standard deals with energy transfer/work, we feel that this one should related to storage.

Commented [RB77]: Copied from working group:
*Physics expert needs to look at this. Not quite sure what the original standard was trying to achieve. We believe that "work" is not energy storage, but energy use. If students are designing a device, it should be to do work.

DRAFT - Arizona Science Standards - DRAFT

Physics – Waves and Their Applications	Physical Science Essential Standards HS Essential Standards are intended for ALL students to have learned by the end of 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
	<u>Essential HS.P4U3.11</u>		
	HS.P4U3.11 Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.		<p>The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. The reflection, refraction, and transmission of waves at an interface between two media can be modeled on the basis of these properties. Combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information. Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. Resonance is a phenomenon in which waves add up in phase in a structure, growing in amplitude due to energy input near the natural vibration frequency. Structures have particular frequencies at which they resonate. This phenomenon (e.g., waves in a stretched string, vibrating air in a pipe) is used in speech and in the design of all musical instruments.⁴ (p. 132-133)</p> <p>All electromagnetic radiation travels through a vacuum at the same speed, called the speed of light. Its speed in any other given medium depends on its wavelength and the properties of that medium. When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. Photovoltaic materials emit electrons when they absorb light of a high-enough frequency. ⁴ (p. 134)</p> <p>Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. Knowledge of quantum physics enabled the development of semiconductors, computer chips, and lasers, all of</p>
	Physical Science Plus (+) Standards – HS+ Standards are designed for students taking a high school physics (P) or honors physics course	Plus HS+Phy.P4U1.11	
		Explore the graphical and mathematical relationships among the frequency, wavelength, and speed of waves traveling in various media. *Reworded this standard and made an essential.	
		Plus HS+Phy.P4U3.10	
		Engage in argument from evidence, that electromagnetic radiation can be described either by a wave model or a particle model, and, that for some situations in engineering and technology, one model is more beneficial than the other. *Recommend removal of this standard - too complex for HS..	

Commented [RB78]: Physics teacher worded an essential standard for waves.

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			<p>which are now essential components of modern imaging, communications, and information technologies. (Boundary: Details of quantum physics are not formally taught at this grade level.) ⁴ (p. 137)</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>
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High School Earth and Space Sciences



Earth and space science encompass processes that occur on Earth while also addressing Earth's place within our solar system and galaxy. At the high school level, students gain an understanding of these processes through a wide scale: unimaginably large to invisibly small.¹ Earth and Space Sciences, more than any other discipline, are rooted in other scientific disciplines. Students, through the close study of earth and space, will find clear applications for their knowledge of gravitation, energy, magnetism, cycles, and biological processes. Educators should use the "connections" designations within these standards to assist students in making connections between scientific disciplines. Additionally, students are expected to apply these concepts to real-world phenomena to gain a [deeper understanding of causes, effects, and solutions for physical processes in the real world](#). The essential standards are those that every high school student is expected to know and understand. Plus standards in earth and space science are designed to extend the concepts learned in the essential standards to prepare students for entry level college courses. [It is suggested to use the metric system within measurement.](#)

Note:

- The standard number **a** is designed for recording purposes and does not imply instructional sequence or importance.
- In all disciplines, educators should incorporate scientific measurement skills appropriate to that discipline.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p><u>Physical Science</u></p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p><u>Earth and Space Science</u></p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p><u>Life Science</u></p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and /or political implications.</p>

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Earth and Space Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
Essential HS.E1U1.11		
Obtain , analyze and interpret data to determine how energy from the Sun affects weather patterns and climate. Connections: <u>7.E1U2.6</u> , <u>8.P4U1.3</u> , <u>HS.P4U1.9</u>		<p>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. Climate change can occur when certain parts of Earth’s systems are altered. Geological evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere; longer term changes (e.g., ice ages) due to variations in solar output, Earth’s orbit, or the orientation of its axis; or even more gradual atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years.^{4 (188)}</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change⁴</p>
Earth and Space Science Plus (+) Standards HS+ Standards are designed for students taking a high school earth and space (E) or honors earth and space.	Plus HS+E.E1U1.1 Construct an evidence-based explanation for how the Sun’s energy transfers between Earth’s systems. Connection: <u>8.E1U1.6</u> , <u>HS.E1U2.13</u>	
	Plus HS+E.E1U1.2 Develop and use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate.	
	Plus HS+E.E1U2.3 Analyze geoscience data and the results from global climate models to make evidence-based predictions of the current rate and scale of global or regional climate changes.	

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Earth and Space	Earth and Space Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
	Essential HS.E1U2.12		
	HS.E1U2.12 Develop and use a model of the Earth that explains the role of energy in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere). Connections: 7.E1U2.4 , HS.L2U4.18		Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts. 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 , a solid mantle and crust . The top part of the mantle, along with the crust, forms structures known as tectonic plates (link to ESS2.B). 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 the gravitational movement of denser materials toward the interior. The geological 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. ⁴ (p. 181) The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of rocks. ⁴ 185-186)
	Earth and Space Science Plus (+) Standards HS+ Standards are designed for students taking a high school earth and space (E) or honors earth and space.	Plus 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.	
		Plus HS+E.E1U2.5	
		Develop and use a model based on the characteristics of Earth's interior to describe the cycling of matter.	
		Plus HS+E.E1U1.6	
Obtain, evaluate and communicate Plan and conduct investigations findings on the effect of water on Earth's materials, surface processes, and groundwater systems.			
HS+E.E1U2.7			
Develop and use a quantitative model to describe the cycling of matter among the hydrosphere, atmosphere, geosphere, and biosphere.		Crosscutting Concepts: Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change ⁴	

Commented [RB79]: Copied from working group: *This standard appears to be redundant with the Essential and +E 5. Also, how would one develop a "quantitative" model for this?

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Earth and Space Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
Essential HS.E1U2.13		
Evaluate explanations and theories about the role of energy and matter in geologic changes over time. Connections: 7.E1U2.4 , 7.L2U2.9 , 8.E1U1.6		<p>Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time. 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. Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches. Although active geological processes, such as plate tectonics (link to ESS2.B) and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. ¹ (pp. 178-179)</p> <p>Beneath the Earth's solid crust is a hot layer called the mantle. The mantle is solid when under pressure but melts (and is called magma) when the pressure is reduced. In some places there are cracks (or thin regions) in the crust which can allow magma to come to the surface, for example in volcanic eruptions. The Earth's crust consists of a number of solid plates which move relative to each other, carried along by movements of the mantle. Where plates collide, mountain ranges are formed and there is a fault line along the plate boundary where earthquakes are likely to occur and there may also be volcanic activity. The Earth's surface changes slowly over time, with mountains being eroded by weather, and new ones produced when the crust is forced upwards. ² (p. 24)</p> <p>Crosscutting Concepts: Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change ⁴</p>
Earth and Space Science Plus (+) Standards HS+ Standards are designed for students taking a high school earth and space (E) or honors earth and space.	Plus HS+E.E1U1.8	
	Obtain, evaluate, and communicate evidence of the theory of plate tectonics to explain the differences in age, structure, and composition of Earth's crust.	
	Plus HS+E.E1U2.9	
	Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to explain Earth's formation and early history.	
	Plus HS+E.E1U2.10	
	Construct an argument, based on evidence, about the impact of changes in Earth's systems on the biosphere.	

Commented [80]: Working groups deleted HS+ Standard:

HS+E.E1U1.11
Construct an argument, based on evidence, about the impact of changes in Earth's systems on the biosphere.

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Earth and Space Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
Earth and Space	Essential HS.E1U4.14	
	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.	Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate (link to ESS3.D). ^{4 (188)}
	Connections: <u>5.L4U4.11</u> , <u>8.E1U3.7</u> , <u>HS.L2U4.18</u> , <u>HS.L2U2.24</u> , <u>HS.L2U4.25</u>	
	Note: The topic of natural resources provides the teacher an opportunity to integrate content with Social Sciences through supply/demand considerations and the tendency of organisms to populate areas near water and other resources	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 humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts. Through computer simulations and other studies, important discoveries are still being made about how the ocean , the atmosphere , and the biosphere interact and are modified in response to human activities, as well as to changes in human activities. Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences—for humanity as well as for the rest of the planet. ^{4 (198)}
	Plus HS+E.E1U4.11	Materials important to modern technological societies are not uniformly distributed across the planet (e.g., oil in the Middle East, gold in California). Most elements exist in Earth's crust at concentrations too low to be extracted, but in some locations—
	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 influence changes in climate.	where geological processes have concentrated them— extraction is economically viable. Historically, humans have populated regions that are climatically, hydrologically, and geologically advantageous for fresh water availability, food production via agriculture, commerce, and other aspects of civilization. Resource availability affects geopolitical relationships and can limit development. As the global human population increases and people's demands for better living conditions increase, resources considered readily available in the past, such as land for agriculture or drinkable water, are becoming scarcer and more valued. All forms of resource extraction and land use have associated economic, social, environmental, and geopolitical costs and risks , as well as benefits .
	Plus HS+E.E1U4.12	
	Plus HS+E.E1U4.13	
	Develop and use Design a quantitative model to illustrate the relationships among Earth systems and the degree to which those relationships are being modified due to human activity.	

Commented [81]: Working groups deleted HS + Standard HS+E.E1U3. Ask questions, define problems, and evaluate competing design solutions for developing, managing, and utilizing mineral resources.

This has changed the numbering sequence of the rest of the + standards for earth and space.

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			<p>New technologies and regulations can change the balance of these factors—for example, scientific modeling of the long-term environmental impacts of resource use can help identify potential problems and suggest desirable changes in the patterns of use. Much energy production today comes from nonrenewable sources, such as coal and oil. However, advances in related science and technology are reducing the cost of energy from renewable resources, such as sunlight, and some regulations are favoring their use. As a result, future energy supplies are likely to come from a much wider range of sources. ^{4 (191-192)}</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴</p>
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Earth and Space	Earth and Space Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
	Essential HS.E2U1.15		
	Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star. Connections: HS.P1U1.1 , HS.P1U2.2 , HS.P1U1.3		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. The Sun is one of millions of stars that together make up a galaxy called the Milky Way (p. 25)
	(+) Standards HS+ Standards are designed for students taking a high school earth and space (E)	Plus HS+E.E2U2.14 Develop and use a model to relate the role of nuclear fusion in the Sun's core to the life cycles of stars.	Nearly all observable matter in the universe is hydrogen or helium, which formed in the first minutes after the Big Bang. Elements

Commented [82]: Numbering of HS + standards changed

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	Plus HS+E.E2U1.15	other than these remnants of the Big Bang continue to form within the cores of stars. ⁴ (p. 173) [add last two sentences] Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴
	Obtain, evaluate, and communicate scientific ideas about the way stars, throughout their stellar stages, produce elements and energy.	

Earth and Space	Earth and Space Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
	Essential HS.E2U2.16		
	Construct an explanation of how gravitational forces impact the evolution of planetary structure, surfaces, atmospheres, moons, and rings.		[Add learning progression] Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴
	Earth and Space Science Plus (+) Standards HS+ Standards are designed for students taking a high school earth and space (E) or honors earth and space.	Plus HS+E.E2U1.16	
		Analyze and interpret data showing how gravitational forces are influenced by mass, density, and radius.	
		HS+E.E2U1.17	
	Apply mathematical and/or computational representations of Kepler's laws as they relate to the movement of planets and objects in the solar system. Connections: <u>6.P3U2.4</u> , <u>HS.P2U1.5</u> , <u>HS.P2U3.6</u> , <u>HS.P2U2.7</u>		

Commented [83]: Copied from working group: Reversed essential and plus standard because plus standard is more big picture and the essential standard was more specific.

Commented [84]: Copied from working group: Reversed essential and plus standard because plus standard is more big picture and the essential standard was more specific.

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Earth and Space	Earth and Space Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses and are on the state assessment.		Learning Progressions, Key Terms and Crosscutting Concepts
	Essential HS.E2U2.17		
	Analyze, interpret, and critique theories related to the scale and expansion of the universe.		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. The Sun is one of millions of stars that together make up a galaxy called the Milky Way. The next nearest star is much further away than the distance of the furthest planet, Neptune. The distances between and within galaxies are so great that they are measured in 'light years', the distance that light can travel in a year. There are billions of galaxies in the universe, almost unimaginably vast distances apart and perceived as moving rapidly away from each other. This apparent movement of galaxies indicates that the Universe is expanding from an event called a 'big bang', about 13.7 billion years ago.
	Earth and Space Science Plus (+) Standards HS+ Standards are designed for students taking a high school earth and space (E) or honors earth and space.	HS+E.E2U1.18	
		Analyze how the nebular theory explains solar system formation with distinct regions characterized by different types of planetary and other bodies.	
		HS+E.E2U1.19	
		Obtain, evaluate, and communicate information about patterns of size and scale of the solar system, our galaxy, and the Universe.	
		HS+E.E2U3.20	
	Obtain, evaluate, and communicate the impact of technology on human understanding of the formation, scale, and composition of the Universe.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴	

High School Life Sciences



Life science focuses on the patterns, processes, and relationships of living organisms. At the high school level, students apply concepts learned in earlier grades to real-world situations and investigations using the science and engineering practices to fully explore phenomena and to develop solutions to societal problems related to food, energy, health, and environment. The field of life science is rapidly advancing and new technology and information related to the study of life processes is being developed daily. Students in high school should have access to up-to-date information in the field while simultaneously gaining understanding of the historical developments which shaped today's understandings within the field. The Standards for life science encompass the areas of cells and organisms; ecosystems, interactions, energy and dynamics; heredity; and biological diversity. Like earth and space sciences and physical sciences, "connections" with the life science standards allow educators to make connections across scientific disciplines. The essential standards are those that every high school student is expected to know and understand. Plus standards in life science are designed to extend the concepts learned in the essential standards to prepare students for entry level college courses. [It is suggested to use the metric system within measurement.](#)

Note:

- The standard number is designed for recording purposes and does not imply instructional sequence or importance.
- In all disciplines, educators should incorporate scientific measurement skills appropriate to that discipline.

Core Ideas for Knowing Science	Core Ideas for Using Science
<p>Physical Science</p> <p>P1: All matter in the Universe is made of very small particles.</p> <p>P2: Objects can affect other objects at a distance.</p> <p>P3: Changing the movement of an object requires a net force to be acting on it.</p> <p>P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.</p> <p>Earth and Space Science</p> <p>E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.</p> <p>E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.</p> <p>Life Science</p> <p>L1: Organisms are organized on a cellular basis and have a finite life span.</p> <p>L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.</p> <p>L3: Genetic information is passed down from one generation of organisms to another.</p> <p>L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.</p>	<p>U1: Science's The purpose of science is to find the cause or causes of phenomena in the natural world.</p> <p>U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.</p> <p>U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.</p> <p>U4: Applications of science often have both positive and negative ethical, social, economic, and or political implications.</p>

This section has had significant changes to reduce the breadth of standards. This entire sections should be blue. To make it easier to read all comments are in bubbles to the right of this document. All comments are copied and pasted from the working group in their words. The CODING for this section (U1 – U4) MUST be looked at!

Ecosystems	Life Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.		Learning Progressions, Key Terms and Crosscutting Concepts
	HS.L2U4.18		
	Obtain, evaluate, and communicate information about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem. Connections: 5.L4U4.11 , HS.E1U2.12 , HS.E1U4.14		A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution , introduction of invasive species , overexploitation , and climate change —can disrupt an ecosystem and threaten the survival of some species . ⁴ (pp. 155-156) Ecosystems have carrying capacities , which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation , competition , and disease . Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite . This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. ⁴ (p. 152) Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Biological extinction, being irreversible, is a critical factor in
	Life Science Plus (+) Standards HS+ Standards are designed for students taking a high school Biology or honors biology course.	HS+B.L2U2.1	
		Develop a model showing the relationship between limiting factors and carrying capacity, and use the model to make predictions on how environmental changes impact biodiversity.	
		HS+B.L4U1.2	
	Evaluate evidence supporting claims that changes in environmental conditions or human interventions may change species diversity in an ecosystem and design solutions to mitigate negative impacts .		

Commented [85]: *Combination of B+ 1 & 2: 1 & 2 were very similar and were consolidated. Graph and model the relationship between limiting factors and carrying capacity in ecosystems.

HS+B.L2U1.2 ← deleted see comment
*Combined with B+ 1: 1 & 2 were very similar and were consolidated.
Predict how changes to an environment impact biodiversity and carrying capacity.

Commented [86]: HS+B.L2U3.3 ← deleted see comment
Evaluate the positive and negative human impacts on ecosystems and design solutions to mitigate negative impacts.
*Combined with B+ 4: 3 & 4 were very similar and were consolidated.

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			<p>reducing the planet’s natural capital. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. These problems have the potential to cause a major wave of biological extinctions—as many species or populations of a given species, unable to survive in changed environments, die out—and the effects may be harmful to humans and other living things. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. ⁴ (p. 167)</p> <p>Crosscutting Concepts: Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change ⁴</p>
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Life Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.		Learning Progressions, Key Terms and Crosscutting Concepts
Ecosystems	HS.L2U2.19	<p>As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Matter and energy are conserved in each change. This is true of all biological systems, from individual cells to ecosystems. ⁴ (p. 148)</p> <p>Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web, and there is a limit to the number of organisms that an ecosystem can sustain. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil and are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved; some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. Competition among species is ultimately competition for the matter and energy needed for life. ⁴ (p. 154)</p> <p>Crosscutting Concepts: Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change⁴</p>
	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. Connections: 7.L2U2.10, 8.P4U1.3	
	HS+B.L2U2.3	
	Use mathematical representations to support claims for the cycling of matter and flow of energy through trophic levels in an ecosystem.	
	<p>HS+B.L2U2.6</p> <p>* Delete + standard: Too much breadth in standards, and carbon cycle is already covered in ES Model the cycling of carbon and nitrogen among the biotic and abiotic components of an ecosystem.</p>	

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Life Science Essential Standards		Learning Progressions, Key Terms and Crosscutting Concepts
HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.		
Cells and Organisms	HS.L1U1.20	Within cells there are many molecules of different kinds which interact in carrying out the functions of the cell. In multicellular organisms cells communicate with each other by passing substances to nearby cells to coordinate activity. A membrane around each cell plays an important part in regulating what can enter or leave a cell . Activity within different types of cells is regulated by enzymes . ² (p. 26)
	Generate questions and/or predictions based on observations and evidence to explain demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis . Connection: <u>6.L1U2.15</u>	
	HS+B.L1U2.4	Systems of specialized cells within organisms help them perform the essential functions of life, which involve chemical reactions that take place between different types of molecules, such as water, proteins, carbohydrates, lipids, and nucleic acids .
	Model and explain the interdependency and interactions between cellular organelles.	Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range . Outside that range (e.g., at a too high or too low external temperature, with too little food or water available), the organism cannot survive. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. ⁴ (p. 145)
	HS+B.L1U1.9 HS+B.L1U1.5	Crosscutting Concepts: Cause and effect; Systems and System Models; Energy and Matter; Stability and change; Structure and function ⁴
	Analyze and interpret data that demonstrates the relationship between cellular function and the diversity of protein functions. Analyze and interpret data which demonstrates how the properties of water impact cellular function.	
HS+B.L1U2.6	Use models to show how transport mechanisms function in cells. and examine the effect of surface area to volume ratio on the overall rate of diffusion of nutrients and wastes. *Combined with B+ 7b: 7b, & 10 are both related to transport and were consolidated.	

Commented [87]: *Combined essential 20 with essential #23.
#23 is deleted
Essential HS.L1U1.23 Generate questions and/or predictions based on observations and evidence to explain demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.

Essential #21 became a plus later in this section

Essential HS.L2U2.22 Use a model to develop a scientific explanation that illustrates how cellular respiration transforms breaks down macromolecules for use in metabolic processes. glucose into stored chemical energy. *Combination of Essential 21 & 22: 21 & 22 were very similar and were consolidated. (Then, the new standard was turned into a plus standard, and a plus was replaced as an Essential)

HS.L1U2.24 ← deleted
Obtain, evaluate, and communicate information to show that systems of specialized cells within organisms (plant and animal) help them perform the essential functions of life.

*The essential pieces are already covered in 23. Additional components add too much breadth.
Plus HS+B.L1U2.7b *Combined with B+ 10 (now 9),: 7b & 10 (now 9) are both related to transport and were consolidated. 7 (above) is now 6 due to deletion of + #6 Calculate and model the effects of surface area, volume, and cell shape on the overall rate of diffusion of nutrients and wastes.
Possibly delete + #9
HS+B.L1U2.6 Recommend removal of the latter portion of this standard because neither Big Ideas nor Framework support the specificity in this standard.

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	HS+B.L1U2.7	
	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms (plant and animal).	

Cells and Organisms	Life Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.		Learning Progressions, Key Terms and Crosscutting Concepts
	HS.L2U2.21		The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen . The sugar molecules thus formed contain carbon, hydrogen, and oxygen; their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. For example, aerobic (in the presence of oxygen) cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Anaerobic (without oxygen) cellular respiration follows a different and less efficient chemical pathway to provide energy in cells. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy loss to the surrounding environment. ⁴ (p. 148)
	Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.		
	Life Science Plus (+) Standards HS+ Standards are designed for students taking a high school Biology or honors biology course.	HS+B.L2U2.8	
Use a model to develop a scientific explanation that illustrates how photosynthesis transforms light energy into stored chemical energy and how cellular respiration breaks down macromolecules for use in metabolic processes .		In multicellular organisms individual cells grow and then divide via a process called mitosis , thereby allowing the organism to grow. Cellular	

Commented [88]: Used to be Plus HS+B.L2U2.8 * Reversed essential and plus standard because plus standard is more big picture and the essential standard was more specific.

Commented [89]: Used to be HS. L2U2.21 * Reversed essential and plus standard because plus standard is more big picture and the essential standard was more specific.

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			<p>division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. ⁴ (pp. 146-147)</p> <p>Crosscutting Concepts: Patterns; Scale, Proportion and Quantity; Stability and change; Structure and function ⁴</p> <p>Crosscutting Concepts: Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Structure and function ⁴</p>
	HS.L2U2.22		
	Construct an explanation for how cellular division (mitosis) is the process by which organisms grow and maintain complex, interconnected systems. Connection: 8.L3U1.9		
	<div> <div> Life Science Plus (+) Standards HS+ Standards are designed for students taking a high school Biology or honors biology course </div> <div> HS+B.L1U2.9 </div> </div> <p>Develop and use a model to communicate how a cell copies genetic information to make repl^{ica} new cells during asexual reproduction (mitosis).</p>		

Commented [90]: Used to be Plus HS+B.L1U2.13
* Reversed essential and plus standard because plus standard is more big picture and the essential standard was more specific.

Commented [91]: Used to be essential: HS.L3U2.26
Develop and use a model to communicate how a cell copies genetic information to make replica new cells during asexual reproduction (mitosis).
* Reversed essential and plus standard because plus standard is more big picture and the essential standard was more specific.

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Genetics	Life Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.		Learning Progressions, Key Terms and Crosscutting Concepts
	HS.L1U4.23		<p>Given a suitable medium, cells from a variety of organisms can be grown <i>in situ</i>, that is, outside the organism. These cell cultures are used by scientists to investigate cell functions, and have medical implications such as the production of vaccines, screening of drugs, and in vitro fertilization. Plant tissue culture is used widely in the plant sciences, forestry, and in horticulture. Most cells are programmed for a limited number of cell divisions. Diseases, which may be caused by invading microorganisms, environmental conditions or defective cell programming, generally result in disturbed cell function. Organisms die if their cells are incapable of further division. ² (p. 26)</p> <p>In sexual reproduction, a specialized type of cell division called meiosis occurs and results in the production of sex cells, such as gametes (sperm and eggs) or spores, which contain only one member from each chromosome pair in the parent cell. ⁴ (pp. 147)</p> <p>Crosscutting Concepts: Patterns; Scale, Proportion and Quantity; Stability and change; Structure and function ⁴</p>
	Evaluate and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.		
	HS.L3U2.24		
	Construct an explanation of how the process of sexual reproduction contributes to genetic variation. Connection: <u>8.L3U1.9</u>		
Life Science Plus (+) Standards HS+ Standards are designed for students taking a high school Biology or honors biology course.	HS+B.L3U2.10		<p>Use mathematics and statistical probability to explain the variation that occurs through meiosis and calculate the distribution of expressed traits in a population.</p>

Commented [92]: Used to be Essential HS.L1U4.27

Commented [93]: Used to be HS.L3U2.28

Commented [94]: Used to be HS+B.L3U2.15

*meiosis wasn't addressed anywhere else, which appeared to be a hole for students understanding the source of variation.

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Genetics	HS.L3U1.25		The information passed from parents to offspring is coded in the DNA molecules that form the chromosomes . In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation . Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations , which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. Environmental factors also affect expression of traits , and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depend on both genetic and environmental factors . ⁴ (p. 147) Crosscutting Concepts: Patterns; Cause and effect; Stability and change; Structure and function ⁴
	Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.		
	Life Science Plus (+) Standards HS+ Standards are designed for students taking a high school Biology or honors biology course.	HS+B.L3U1.11	
		Construct an explanation for how the structure of DNA and RNA determine the structure of proteins that perform essential life functions.	
		HS+B.L3U1.12	
	Analyze how mutations can lead to increased genetic variation in a population.		

Commented [95]: Used to be HS.L3U1.29

Commented [96]: Used to be HS+B.L3U1.16

Commented [97]: Used to be HS+B.L3U1.17

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Life Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.		Learning Progressions, Key Terms and Crosscutting Concepts
Genetics	HS.L3U3.26	<p>The overall sequence of genes of an organism is known as its genome. More is being learned all the time about genetic information by mapping the genomes of different kinds of organisms. When sequences of genes are known genetic material can be artificially changed to give organisms certain features. In gene therapy special techniques are used to deliver into human cells genes that are beginning to help in curing disease. ² (p. 28)</p> <p>Crosscutting Concepts: Patterns; Cause and effect; Stability and change; Structure and function ⁴</p>
	Construct an argument, based on evidence, regarding the ethical, social, economic, and/or political implications of a current genetic technology.	
	Connection: <u>8.L3U4.10</u>	
Life Science Plus (+) Standards HS+ Standards are designed for students taking a high school Biology or honors biology	HS+B.L3U4.13	
	Define problems and design solutions regarding the ethical, social, economic, and/or political implications of a current genetic technology.	

Commented [98]: Used to be HS.L3U3.30 or HS.L3U4.30

Commented [99]: Used to be HS+B.L3U41.18

Life Science Essential Standards HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.		Learning Progressions, Key Terms and Crosscutting Concepts
Evolution	Essential HS.L4U2.27	<p>Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. The traits that positively affect survival are more likely to be reproduced and thus are more common in the population. ⁴ (p. 164)</p>
	Obtain, evaluate, and communicate evidence that describes how changes in frequency of inherited traits in a population can lead to biological diversity.	
	HS+B.L4U1.14	

Commented [100]: Used to be: Essential HS.L4U2.31

Commented [101]: Used to be HS+B.L4U1.19

Working groups recommend deleting and combining with #20

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		<p>Construct an explanation based on evidence that the process of evolution may result from natural selection.</p> <p>*B+ 19 & 20 should be consolidated - 19 would be incorporated when teaching 20.</p>	<p>Natural selection is the result of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. Natural selection leads to adaptation—that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. Adaptation also means that the distribution of traits in a population can change when conditions change. Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or too drastic, the opportunity for the species' evolution is lost. ⁴ (pp. 165-166)</p>
		<p>HS+B.L4U2.14</p>	
		<p>Gather, evaluate, and communicate multiple lines of empirical evidence to explain the change in genetic composition of a population over successive generations.</p>	

Commented [102]: Used to be HS+B.L4U2.20

Life Science Plus (+) Standards
HS+ Standards are designed for students taking a high school Biology (B) course.
HS+B.L4U1.14

Construct an explanation based on evidence that the process of evolution may result from natural selection.
*B+ 19 & 20 should be consolidated - 19 would be incorporated when teaching 20.

HS+B.L4U2.15

Gather, evaluate, and communicate multiple lines of empirical evidence to explain the change in genetic composition of a population over successive generations.
*B+ 19 & 20 should be consolidated

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Distribution of High School Standards, (essential standards (HS) and course-specific plus (HS+))

	U1: Science's purpose is to find the cause or causes of phenomena in the natural world.	U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.	U3: The knowledge produced by science is used in engineering and technologies to create products.	U4: Applications of science often have both positive and negative ethical, social, economic, and political implications.
P1: All matter in the Universe is made of very small particles.	HS.P1U1.2 HS.P1U1.2 4 HS.P1U1.3 HS+C.P1U1.1 HS+C.P1U1.3 4 HS+C.P1U1.7 HS+C.P1U1.9	HS.P1U2.1 HS+C.P1U2.2 3 HS+C.P1U2.5 HS+C.P1U2.6	HS+C.P1U3.2	HS.P1U4.3 HS+C.P1U4.8 HS+C.P1U4.2
P2: Objects can affect other objects at a distance.	HS.P2U1.5 HS+Phy.P2U1.1		HS.P2U3.6 HS+Phy.P2U3.2	
P3: Changing the movement of an object requires a net force to be acting on it.	HS+Phy.P3U1.4 HS+Phy.P3U1.5	HS.P3U2.7 HS+Phy.P3U2.3	HS.P3U3.8 HS+Phy.P3U3.6	
P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	HS.P4U1.9 HS+Phy.P4U1.7 HS+Phy.P4U1.8 HS+Phy.P4U1.10 9 HS+Phy.P4U1.12		HS+Phy.P4U3.9 10 HS+Phy.P4U3.13	HS.P4U4.10 HS.P4U4.11 HS+Phy.P4U4.11
E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	HS.E1U1.11 HS+E.E1U1.1 HS+E.E1U1.2 HS+E.E1U1.4 HS+E.E1U1.6 HS+E.E1U1.8 HS+E.E1U1.11	HS.E1U2.12 HS.E1U2.13 HS+E.E1U2.3 HS+E.E1U2.5 HS+E.E1U2.7 HS+E.E1U2.9 HS+E.E1U2.10	HS+E.E1U3.12	HS.E1U4.14 HS+E.E1U4.13 HS+E.E1U4.14 HS+E.E1U4.15

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E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.	HS.E2U1.15 HS+E.E2U1.17 HS+E.E2U1.18 HS+E.E2U1.19 HS+E.E2U1.20 HS+E.E2U1.21	HS.E2U2.16 HS.E2U2.17 HS+E.E2U2.16	HS+E.E2U3.22	
L1: Organisms are organized on a cellular basis and have a finite life span.	HS.L1U1.20 HS.L1U1.23 HS+B.L1U1.9	HS.L1U2.24 HS+B.L1U2.7 HS+B.L1U2.10 HS+B.L1U2.11 HS+B.L1U2.13	HS+B.L1U3.14	HS.L1U4.27
L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	HS.L2U1.25 HS+B.L2U1.2	HS.L2U2.19 HS.L2U2.21 HS.L2U2.22 HS+B.L2U2.1 HS+B.L2U2.5 HS+B.L2U2.6 HS+B.L2U2.8 HS+B.L2U2.12	HS+B.L2U3.3	HS.L2U4.18
L3: Genetic information is passed down from one generation of organisms to another.	HS.L3U1.29 HS+B.L3U1.16 HS+B.L3U1.17 HS+B.L3U1.18	HS.L3U2.28 HS.L3U2.26 HS+B.L3U2.15		HS.L3U4.30
L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.	HS+B.L4U1.4 HS+B.L4U1.19	HS.L4U2.31 HS+B.L4U2.20		

Appendices

Appendix 1: Crosscutting Concepts

The seven crosscutting concepts bridge disciplinary boundaries and unite core ideas throughout the fields of science and engineering. Their purpose is to help students deepen their understanding of the core ideas in the standards and develop a coherent and scientifically

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based view of the world. Students should make explicit connections between their learning and the crosscutting concepts within each grade level.

These concepts also bridge boundaries between science and other disciplines. As educators focus on crosscutting concepts, they should look for ways to integrate them into other disciplines. For example, patterns are highly prevalent in language. Indeed, phonics, an evidence-based literacy instructional strategy, is specifically designed to assist students in recognizing patterns in language. By actively incorporating these types of opportunities, educators assist students in building connections across content areas to deepen and extend learning.

The crosscutting concepts **and their progressions** from *Chapter 4 Crosscutting concepts pages 83 - 102 in A Framework for K-12 Science Education*⁴ are summarized below.

Patterns: Observed patterns of forms and events guide organization and classification and prompt questions about relationships and the factors that influence them.

Patterns are often a first step in organizing and asking scientific and engineering questions. In science, classification is one example of recognizing patterns of similarity and diversity. In engineering, patterns of system failures may lead to design improvements. Assisting children with pattern recognition facilitates learning causing the brain to search for meaning in real-world phenomena.¹ Pattern recognition progresses from broad similarities and differences in young children to more detailed, scientific descriptors in upper elementary. Middle school students recognize patterns on both the micro- and macroscopic levels, and high school students understand that patterns vary in a system depending upon the scale at which the system is studied.

Cause and effect: Events have causes, sometimes simple, sometimes multifaceted. A major activity of both science and engineering is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Like patterns, a child's ability to recognize cause and effect relationships progresses as they age. In the early grades students build upon their understanding of patterns to investigate the causes of these patterns. They may wonder what caused one seed to grow faster than another one and design a test to gather evidence. By upper elementary, students should routinely be asking questions related to cause and effect. In middle school, students begin challenging others' explanations about causes through scientific argumentation. High school continues this trend while students expand their investigation into mechanisms that may have multiple mediating factors such as changes in ecosystems over time or mechanisms that work in some systems but not in others.

Scale, proportion, and quantity: In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

There are two major scales from which we study science: directly observable and those processes which required tools or scientific measurement to be quantified and studied. To understand scale, students must understand both measurement and orders of magnitude. Understanding of scale, proportion, and quantity progresses as children get older. Young children engage in relative measures such as hotter/colder, bigger/smaller, or older/younger without referring to a specific unit of measure. As students age, it is important that they recognize the need for a common unit of measure to make judgement of scale, proportion, and quantity. Elementary students start building this knowledge through length measurements and gradually progress to weight, time, temperature or other variables. Intersection with key mathematical concepts is vital to help students develop the ability to assign meaning to ratios and proportions when discussing scale, proportion, and quantity in science and engineering. By middle and high school, students apply this knowledge to algebraic thinking and are able to change variables, understand both linear and exponential growth, and engage in complex mathematical and statistical relationships.

Systems and system models: Because the world is too large and complex to comprehend all at once, students must define the system under study, specify its boundaries, and make explicit a model of that system provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Models of systems can also be useful in conveying information about that system to others. Many engineering designs start with system models as a way to predict outcomes and test theories prior to final development ensuring that interactions between system parts and subsystems are understood. As students age, their ability to analyze and predict outcomes strengthens. In the early grades, students should be asked to express systems thinking through drawings, diagrams, or oral explanations noting relationships between parts. Additionally, even at a young age, students can be asked to develop plans for their actions or sets of instructions to help them develop the concept that others should be able to understand and use them. As student's age, they should incorporate more facets of the system including those facets which are not visible such as energy flow. By high school, students can identify the assumptions and approximations that went into making the system model and discuss how these assumptions and approximations limit the precision and reliability of predictions.

Energy and matter: Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

The concept of conservation of energy within a closed system is complex and prone to misunderstanding. As a result, students in early elementary are only very generally exposed to the concept of energy. In the early grades, focus on the recognition of conservation of matter within a system and the flow of matter between systems builds the basis for understanding more complex energy concepts in later grades. In middle school and high school, students develop deeper understanding of this concept through chemical reactions and atomic structure. In high school, nuclear processes are introduced along with conservation laws related specifically to nuclear processes.

Structure and function: The way in which an object or living thing is shaped and its substructure determines many of its properties and functions.

Knowledge of structure and function is essential to successful design. As such, it is important that students begin investigation of structure and function at an early age. In early grades, this study takes the form of how shape and stability are related for different structures: braces make a bridge stronger, a deeper bowl holds more water. In upper elementary and middle school, students begin investigation of structures that are not visible to the naked eye: how the structure of water and salt molecules relate to solubility, the shape of the continents and plate tectonics. In high school students apply their knowledge of the relationship of structure to function when investigating the structure of the heart and the specific function it performs.

Stability and change: For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

When systems are stable, small disturbances fade away, and the system returns to the stable condition. In maintaining a stable system, whether it is a natural system or a human design, feedback loops are an essential element. Young children experiment with stability and change as they build with blocks or chart growth. As they experiment with these concepts, the educator should assist them in building associated language and vocabulary as well as learning to question why some things change and others stay the same. In middle school, understanding of stability and change extends beyond those phenomena which are easily visible to more subtle form of stability and change. By high school, students bring in their knowledge of historical events to explain stability and change over long periods of time, and they also recognize that multiple factors may feed into these concepts of stability and change.

Appendix 2: Science and Engineering Practices

The science and engineering practices, ~~formerly the scientific method~~, describe how scientists investigate and build models and theories of the natural world or how engineers design and build systems. They reflect science and engineering as they are practiced and experienced. As students conduct investigations, they engage in multiple practices as they gather information to solve problems, answer their questions, reason about how the data provide evidence to support their understanding, and then communicate their understanding of phenomena. Student investigations may be observational, experimental, use models or simulations, or use data from other sources. These eight practices identified in *Chapter 4 of A Framework for K-12 Science Education*² are critical components of scientific literacy. They are not instructional strategies.

Distinguishing Science & Engineering Practices

	Science	Engineering
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Ask Questions and Define Problems	Science often begins with a question about a phenomenon, such as “Why is the sky blue?” or “What causes cancer?” and seeks to develop theories that can provide explanatory answers to such questions. Scientists formulate empirically answerable questions about phenomena; they establish what is already known and determine what questions have yet to be satisfactorily answered.	Engineering begins with a problem, need, or desire that suggests a problem that needs to be solved. A problem such as reducing the nation’s dependence on fossil fuels may produce multiple engineering problems like designing efficient transportation systems or improved solar cells. Engineers ask questions to define the problem, determine criteria for a successful solution, and identify constraints.
Develop and Use Models	Science often involves constructing and using a variety of models and simulations to help develop explanations about natural phenomena. Models make it possible to go beyond what can be observed. Models enable predictions to be made to test hypothetical explanations.	Engineering uses models and simulations to analyze existing systems to see where flaws might occur or to test viable solutions to a new problem. Engineers use models of various sorts to test proposed systems and to recognize the strengths and limitations of their designs.
Plan and Carry Out Investigations	Scientific investigations may be conducted in the field or the laboratory. Scientists plan and carry out systematic investigations that require the identification of what is to be recorded and, if applicable, what are to be treated as the dependent and independent variables. Observations and data collected are used to test existing theories and explanations or to revise and develop new ones.	Engineers use investigations to gather data essential for specifying design criteria or parameters and to test their designs. Engineers must identify relevant variables, decide how they will be measured, and collect data for analysis. Their investigations help them to identify how effective, efficient, and durable their designs may be under a range of conditions.
Analyze and Interpret Data	Scientific investigations produce data that must be analyzed to derive meaning. Because data usually do not speak for themselves, scientists use a range of tools, including tabulation, graphical interpretation, visualization, and statistical analysis, to identify significant features and patterns in the data, sources of error, and the calculated degree of certainty. Technology makes collecting large data sets easier providing many secondary sources for analysis.	Engineers analyze data collected during the tests of their designs and investigations; this allows them to compare different solutions and determine how well each one meets specific design criteria; that is, which design best solves the problem within the given constraints. Engineers require a range of tools to identify the major patterns and interpret the results.

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Use Mathematics and Computational Thinking	In science, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks: constructing simulations, statistically analyzing data, and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable the behavior of physical systems to be predicted and tested. Statistical techniques are invaluable for assessing the significance of patterns or correlations.	In engineering, mathematical and computational representations of established relationships and principles are a fundamental part of design. For example, structural engineers create mathematically based analyses of designs to calculate whether they can stand up to the expected stresses of use and if they can be completed within acceptable budgets. Simulations of designs provide an effective test bed for the development
Construct Explanations and Design Solutions	In science, theories are constructed to provide explanatory accounts of phenomena. A theory becomes accepted when it has been shown to be superior to other explanations in the breadth of phenomena it accounts for and in its explanatory coherence. Scientific explanations are explicit applications of theory to a specific situation or phenomenon, perhaps with a theory-based model for the system under study. The goal for students is to construct logically coherent explanations of phenomena that incorporate their current understanding of science, or a model that represents it, and are consistent with the available evidence.	Engineering design is a systematic process for solving engineering problems and is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, feasibility, cost, safety, esthetics, and compliance with legal requirements. There is usually no single best solution but rather a range of solutions. The optimal solution often depends on the criteria used for making evaluations.
Engage in Argument from Evidence	In science, reasoning and argument are essential for identifying the strengths and weaknesses of a line of thinking and for finding the best explanation for a phenomenon. Scientists must defend their explanations, formulate evidence, based on a solid foundation of data, examine their own understanding in light of the evidence and comments offered by others, and collaborate with peers in searching for the best explanation for the phenomenon being investigated.	In engineering, reasoning and argument are essential for finding the best possible solution to a problem. Engineers collaborate with their peers throughout the design process, with a critical stage being the selection of the most promising solution among a field of competing ideas. Engineers use systematic methods to compare alternatives, formulate evidence, based on test data, make arguments from evidence to defend their conclusions, evaluate critically the ideas of others, and revise their designs to achieve the best solution to the problem at

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		hand.
Obtain, Evaluate, and Communicate Information	Science cannot advance if scientists are unable to communicate their findings clearly and persuasively or to learn about the findings of others. Scientists need to express their ideas, orally and in writing, using tables, diagrams, graphs, drawings, equations, or models and by engaging in discussions with peers. Scientists need to be able to derive meaning from texts (such as papers, the internet, symposia, and lectures) to evaluate the scientific validity of the information and to integrate that information with existing theories or explanations. Scientists routinely use technologies to extend the possibilities for collaboration and communication.	Engineers cannot produce new or improved technologies if the advantages of their designs are not communicated clearly and persuasively. Engineers need to express their ideas, orally and in writing, using tables, graphs, drawings, or models and by engaging in discussions with peers. Engineers need to be able to derive meaning from colleagues' texts, evaluate the information, and apply it usefully. Engineers routinely use technologies to extend the possibilities for collaboration and communication.

⁴Adapted from Box 3-2, National Research Council. pages 50-53

Appendix 3: Core Ideas

The core ideas encompass the content that occurs at each grade and provides the background knowledge for students to develop sense-making around phenomena. The core ideas center around understanding the causes of phenomena in physical, earth and space, and life science; the principles, theories, and models that support that understanding; engineering and technological applications; and societal implications. The Arizona Science Standards integrate learning progressions from *A Framework for K-12 Science Education*⁴ to build a coherent progression of learning for these core ideas from elementary school through high school. The following fourteen big ideas for knowing science and using science are adapted from *Working with Big Ideas of Science Education*² and represent student understanding of each core idea at the end of high school.

Core Ideas for Knowing Science	
P1: All matter in the Universe is made of very small particles.	Atoms are the building blocks of all normal matter, living and nonliving. The behavior and arrangement of the atoms explains the properties of different materials. In chemical reactions atoms are rearranged to form new substances. Each atom has a nucleus, containing neutrons and protons, surrounded by electrons. The opposite electric charges of protons and electrons attract each other, keeping atoms together and accounting for the formation of some compounds. Physicists and astronomers have begun to investigate other types of matter, dark matter, antimatter, and negative matter, which are also thought to be made up of very small particles. Those particles may or may not be atoms and tend to react differently to forces than normal matter.
P2: Objects can affect other objects at a distance.	All objects have an effect on other objects without being in contact with them. In some cases, the effect travels out from the source to the receiver in the form of radiation such as visible light. In other cases, action at a distance is explained in terms of the existence of a field of influence between objects, such as a magnetic, electric, or gravitational field. Gravity is a universal force of attraction between all objects, however large or small, keeping the planets in orbit around the Sun and causing terrestrial objects to fall towards the center of the Earth.
P3: Changing the movement of an object requires a net force to be acting on it.	A force acting on an object is not seen directly but is detected by its effect on the object's motion or shape. If an object is not moving, the forces acting on it are equal in size and opposite in direction, balancing each other. Since gravity affects all objects on Earth, there is always another force opposing gravity when an object is at rest. Unbalanced forces cause change in movement in the direction of the net force. When opposing forces acting on an object are not in the same line they cause the object to turn or twist. This effect is used in some simple machines.

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P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	The total amount of energy in the Universe is always the same but can be transferred from one energy store to another during an event. Many processes or events involve changes and require an energy source to make them happen. Energy can be transferred from one body or group of bodies to another in various ways. In these processes, some energy becomes less easy to use. Energy cannot be created or destroyed.
E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	Radiation from the Sun heats the Earth's surface and causes convection currents in the air and oceans creating climates. Below the surface, heat from the Earth's interior causes movement in the molten rock. This in turn leads to movement of the plates which form the Earth's crust, creating volcanoes and earthquakes. The solid surface is constantly changing through the formation and weathering of rock.
E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.	Our Sun and eight planets and other smaller objects orbiting it comprise the solar system. Day and night and the seasons are explained by the orientation and rotation of the Earth as it moves round the Sun. The solar system is part of a galaxy of stars, gas, and dust. It is one of many billions in the Universe, enormous distances apart. Many stars appear to have planets.
L1: Organisms are organized on a cellular basis and have a finite life span.	All organisms are constituted of one or more cells. Multicellular organisms have cells that are differentiated according to their function. All the basic functions of life are the result of what happens inside the cells which make up an organism. Growth is the result of multiple cell divisions.
L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	Food provides materials and energy for organisms to carry out the basic functions of life and to grow. Green plants and some bacteria are able to use energy from the Sun to generate complex food molecules. Animals obtain energy by breaking down complex food molecules and are ultimately dependent on green plants producers as their source of energy. In any ecosystem, there is competition among species for the energy resources and materials they need to live and reproduce.
L3: Genetic information is passed down from one generation of organisms to another.	Genetic information in a cell is held in the chemical DNA. Genes determine the development and structure of organisms. In asexual reproduction all the genes in the offspring come from one parent. In sexual reproduction half of the genes come from each parent.

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L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.	Over countless generations changes resulting from natural diversity within a species are believed to lead to the selection of those individuals best suited to survive under certain conditions. Species not able to respond sufficiently to changes in their environment become extinct.
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Core Ideas for Using Science	
U1: Science's purpose is to find the cause or causes of phenomena in the natural world.	Science is a search to explain and understand phenomena in the natural world. There is no single scientific method for doing this; the diversity of natural phenomena requires a diversity of methods and instruments to generate and test scientific explanations. Often an explanation is in terms of the factors that must be present for an event to take place as shown by evidence from observations and experiments. In other cases, supporting evidence is based on correlations revealed by patterns in systematic observation.
U2: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time.	A scientific theory or model representing relationships between variables of a natural phenomenon must fit the observations available at the time and lead to predictions that can be tested. Any theory or model is provisional and subject to revision in the light of new data even though it may have led to predictions in accord with data in the past.
U3: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.	The use of scientific ideas in engineering and technologies has made considerable changes in many aspects of human activity. Advances in technologies enable further scientific activity; in turn, this increases understanding of the natural world. In some areas of human activity technology is ahead of scientific ideas, but in others scientific ideas precede technology.
U4: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.	The use of scientific knowledge in technologies makes many innovations possible. Whether particular applications of science are desirable is a matter that cannot be addressed using scientific knowledge alone. Ethical and moral judgments may be needed, based on such considerations as personal beliefs, justice or equity, human safety, and impacts on people and the environment.

Appendix 5 4: Equity & Diversity in Science

All students can and should learn complex science. However, achieving equity in science education is an ongoing challenge. Students from underrepresented communities often face "opportunity gaps" in their educational experience. Inclusive approaches to science instruction can reposition youth as meaningful participants in science learning and recognize their science-related assets and those of their communities⁴.

The science and engineering practices have potential to be inclusive of students who have traditionally been marginalized in the science classroom and may not see science as being relevant to their lives or future. These practices support sense-making and language use as students engage in a classroom culture of discourse⁶. The science and engineering practices can support bridges between literacy and numeracy needs, which is particularly helpful for non-dominant groups when addressing multiple "opportunity gaps". By solving problems through engineering in local contexts (gardening, improving air quality, cleaning water pollution in the community), students gain knowledge of science content, view science as relevant to their lives and future, and engage in science in socially relevant and transformative ways². Science teachers need to acquire effective strategies to include all students regardless of age, racial, ethnic, cultural, linguistic, socioeconomic, and gender backgrounds³.

Effective teaching strategies³ for attending to equity and diversity for

- **Economically disadvantaged students** include (1) connecting science education to students' sense of "place" as physical, historical, and sociocultural dimensions in their community; (2) applying students' "funds of knowledge" and cultural practices; and (3) using **problem-based** and project-based science learning centered on authentic questions and activities that matter to students.
- **Underrepresented racial and ethnic groups** include (1) culturally relevant pedagogy, (2) community involvement and social activism, (3) multiple representation and multimodal experiences, and (4) school support systems including role models and mentors of similar racial or ethnic backgrounds.
- **Indigenous students** include (1) learning and knowing that is land- and place-based, (2) centers (not erases or undermines) their ways of knowing, and (3) builds connections between Indigenous and western Science Technology Engineering and Mathematics (STEM), and (4) home culture connections⁸.
- **Students with disabilities** include (1) multiple means of representation, (2) multiple means of action and expression, (3) multiple means of engagement, (4) **concrete experiences with realia**, and (5) **scaffolds in problem-based and project-based learning**.
- **English language learners** include (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, (5) home culture connections, (6) **concrete experiences with realia**, and (7) **scaffolds in problem-based and project-based learning**.
- **Alternative education setting for dropout prevention** include (1) structured after-school opportunities, (2) family outreach, (3) life skills training, (4) safe learning environment, and (5) individualized academic support.
- **Girls' achievement, confidence, and affinity with science** include (1) instructional strategies, (2) curricular decisions, and (3) classroom and school structure.
- **Gifted and talented students** include (1) different levels of challenge (including differentiation of content), (2) opportunities for self-direction, and (3) strategic grouping.

Appendix 5: Interdisciplinary Connections

The crosscutting concepts and along with the science and engineering practices provide opportunities for developing strong interdisciplinary connections across all content areas. Developing an Understanding of core ideas in science can be provide a context for helping students master key competencies from other content areas. while promoting It can also promote essential career readiness skills, including communication, creativity, collaboration, and critical thinking. The overlapping skills included in the science and engineering practices and the intellectual tools provided by the crosscutting concepts build meaningful and substantive connections to interdisciplinary knowledge and skills in all content areas. This affords all students equitable access to learning and ensures all students are prepared for college, career, and citizenship.

English Language Arts

The science and engineering practices incorporate reasoning skills used in language arts to help students improve mastery and understanding in reading, writing, speaking, and listening. The intersections between science and ELA teach students to analyze data, model concepts, and strategically use tools through productive talk and shared activity. Evidence-based reasoning is the foundation of good scientific practice. Reading, writing, speaking, and listening in science requires an appreciation of the norms and conventions of the discipline of science, including understanding the nature of evidence used, an attention to precision and detail, and the capacity to make and assess intricate arguments, verbally and orally present findings, synthesize complex information, and follow detailed procedures and accounts of events and concepts. To support these disciplinary literacy skills, teachers must foster a classroom culture where students think and reason together, connecting around the core ideas, science and engineering practices, and the crosscutting concepts.

Mathematics

Science is a quantitative discipline, so it is important for educators to ensure that students' science learning coheres well with their understanding of mathematics.⁵ Mathematics is fundamental to aspects of modeling and evidence-based conclusions. It is also essential for expressing relationships in the quantitative data. The Standards for Mathematical Practice (MP) naturally link to the science and engineering practices and multiple crosscutting concepts within the Arizona Science Standards. By incorporating the Arizona Mathematics Standards and practices with critical thinking in science instruction, educators provide students with opportunities to develop literacy in mathematics instruction. The goal of using mathematical skills and practices in science is to foster a deeper conceptual understanding of the science.

Computer Science

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Natural connections between science and computer science exist throughout the Standards, especially in the middle level and in high school. As students develop or refine complex models and simulations of natural and designed systems, they can use computer science to develop, test, and use mathematical or computational models to generate data. Students can apply computational thinking and coding to develop apps or streamline processes for collecting, analyzing, or interpreting data.

Technology

Technology is essential in teaching and learning science; it influences the science that is taught and enhances students' learning. Technologies in science run the range from tools for performing experiments or collecting data (thermometers, temperature probes, microscopes, centrifuges) to digital technologies for completing analysis or displaying data (calculators, computers). All of them are essential tools for teaching, learning, and doing science. Computers and other digital tools allow students to collect, record, organize, analyze, and communicate data as they engage in science learning. They can support student investigations in every area of science. When technology tools are available, students can focus on decision making, reflection, reasoning, and problem solving. Connections to engineering, technology, and applications of science are included at all grade levels and in all domains. These connections highlight the interdependence of science, engineering, and technology that drives the research, innovation, and development cycle where discoveries in science lead to new technologies developed using the engineering design process. Additionally, these connections call attention to the effects of scientific and technological advances on society and the environment.

Social Studies

Natural connections between the core ideas for using science and social studies exist throughout the Standards. Students need a foundation in social studies to understand how ethical, social, economic, and political issues of the past and present impact the development and communication of scientific theories, engineering and technological developments, and other applications of science and engineering. Students can use historical, geographic, and economic perspectives to understand that all cultures have ways of understanding phenomena in the natural world and have contributed and continue to contribute to the fields of science and engineering. Sustainability issues and citizen science provide contemporary contexts for integrating social studies with science. Citizen science is the public involvement in inquiry and discovery of new scientific knowledge. This engagement helps students build science knowledge and skills while improving social behavior, increasing student engagement, and strengthening community partnerships. Citizen science projects enlist K-12 students to collect or analyze data for real-world research studies, which helps students develop a deep knowledge of the geography, economics, and civic issues of specific regions.

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Health

Natural connections between Health and science exist throughout the Standards. The goals of Health being to maintain and improve students' health, prevent disease, and avoid or reduce health-related risk behaviors which can fit within the context of science standards.

Appendix 6: Connections to Other Academic Discipline

ELA and Math Grade Band Connections

Kindergarten - 2nd Grade

	Kindergarten	1st Grade	2nd Grade
<u>Arizona English Language Arts</u>	Use age-appropriate scientific texts and biographies to develop instruction that integrates surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards		
<u>Arizona Mathematics Standards</u>	Standards for Mathematical Practices <ul style="list-style-type: none"> -Make sense of problems and persevere in solving them -Use appropriate tools strategically -Look for and make use of structure -Look for and express regularity in repeated reasoning Counting and Cardinality <ul style="list-style-type: none"> -Develop competence with counting and cardinality -Develop understanding of addition and subtraction within 10 Measurement and Data <ul style="list-style-type: none"> -Describe and compare measurable attributes -Classify objects and count the number of objects in each category 	Standards for Mathematical Practice <ul style="list-style-type: none"> -Make sense of problems and persevere in solving them -Use appropriate tools strategically -Construct viable arguments and critique the reasoning of others -Attend to precision -Look for and make use of structure -Look for and express regularity in repeated reasoning Measurement and Data <ul style="list-style-type: none"> -Measure lengths indirectly and by iterating length units -Represent and interpret data Geometry <ul style="list-style-type: none"> -Reason with shapes and their attribute 	Standards for Mathematical Practice <ul style="list-style-type: none"> -Make sense of problems and persevere in solving them -Use appropriate tools strategically -Construct viable arguments and critique the reasoning of others. -Attend to precision -Look for and make use of structure -Look for and express regularity in repeated reasoning Operations and Algebraic Thinking <ul style="list-style-type: none"> -Represent and solve problems involving addition and subtraction Number and Operations in Base Ten <ul style="list-style-type: none"> -Use place value understanding and properties of operations to add and subtract Measurement and Data <ul style="list-style-type: none"> -Represent and interpret data

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			-Measure the length of an object using an appropriate tool including metrics.
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See also Appendix 4

3rd Grade - 5th Grade

	3rd Grade	4th Grade	5th Grade
<u>Arizona English Language Arts</u>	Use age-appropriate scientific texts and biographies to develop instruction that integrates surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards		
<u>Arizona Mathematics Standards</u>	Standards for Mathematical Practices <ul style="list-style-type: none"> -Make sense of problems and persevere in solving them -Reason abstractly and quantitatively -Use appropriate tools strategically -Construct viable arguments and critique the reasoning of others -Use appropriate tools strategically -Attend to precision -Look for and make use of structure Operations and Algebraic Thinking <ul style="list-style-type: none"> -Represent and solve problems involving addition and subtraction Number and Operations in Base Ten <ul style="list-style-type: none"> -Use place value understanding and properties of operations to perform multi-digit arithmetic Number and Operations - Fractions <ul style="list-style-type: none"> -Understand fractions as numbers Measurement and Data <ul style="list-style-type: none"> -Measure and estimate liquid volumes and 	Standards for Mathematical Practice <ul style="list-style-type: none"> -Make sense of problems and persevere in solving them -Use appropriate tools strategically -Construct viable arguments and critique the reasoning of others -Attend to precision -Look for and make use of structure -Look for and express regularity in repeated reasoning Operations and Algebraic Thinking <ul style="list-style-type: none"> -Use place value understanding and properties of operations to perform multi-digit arithmetic Number and Operations in Base Ten Number and Operations - Fractions <ul style="list-style-type: none"> -Understand decimal notation for fractions and compare decimal fractions Measurement and Data <ul style="list-style-type: none"> -Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit using metrics -Represent and interpret data 	Standards for Mathematical Practice <ul style="list-style-type: none"> -Make sense of problems and persevere in solving them reason abstractly and quantitatively -Construct viable arguments and critique the reasoning of other -Model with mathematics -Use appropriate tools strategically -Attend to precision -Look for and make use of structure -Look for and express regularity in repeated reasoning Operations and Algebraic Thinking <ul style="list-style-type: none"> -Write and interpret numerical expressions. -Analyze patterns and relationships Measurement and Data <ul style="list-style-type: none"> -Convert like measurement units within a given measurement system -Represent and interpret data -Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit using metrics

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	<p>masses of objects using metric units</p> <ul style="list-style-type: none"> -Solve problems involving measurement -Represent and interpret data 		<p>-Solve problems involving measurement using metrics</p> <ul style="list-style-type: none"> -Geometric measurement; understand concepts of volume and relate volume to multiplication and division.
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6th Grade - 8th Grade

	6th Grade	7th Grade	8th Grade
Arizona English Language Arts	<p>Use age-appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational Text, that integrates surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards</p>		

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<u>Arizona Mathematics Standards</u>	Standards for Mathematical Practices -Make sense of problems and persevere in solving them -Reason abstractly and quantitatively -Use appropriate tools strategically -Construct viable arguments and critique the reasoning of others -Use appropriate tools strategically -Attend to precision -Look for and make use of structure -Model with mathematics -Look for and express regularity in repeated reasoning Ratios and Proportional Relationships -Understand ratio concepts and use ratio reasoning to solve problems Expressions and Equations -Represent and analyze quantitative relationships between dependent and independent variable Geometry -Solve mathematical problems and problems in real-world context involving area, surface area and volume	Standards for Mathematical Practice -Make sense of problems and persevere in solving them -Reason abstractly and quantitatively -Use appropriate tools strategically -Construct viable arguments and critique the reasoning of others -Attend to precision -Look for and make use of structure -Look for and express regularity in repeated reasoning -Model with mathematics Statistics and Probability -Use random sampling to draw inferences about a population -Draw informal comparative inferences about two populations -Investigate chance processes and develop, use, and evaluate probability models	Standards for Mathematical Practice -Make sense of problems and persevere in solving them -Reason abstractly and quantitatively -Use appropriate tools strategically -Construct viable arguments and critique the reasoning of others. -Attend to precision -Look for and make use of structure -Look for and express regularity in repeated reasoning -Model with mathematics Expressions and Equations -Understand the connections between proportional relationships, lines, and linear equations Functions -Use functions to model relationships between quantities Statistics and Probability -Investigate patterns of association in bivariate data -Investigate chance processes and develop, use, and evaluate probability models
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Health Standards

Connection to the Arizona Health Standards for Grade Band Pre-K to 2

- **Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts**
 - **Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well being**
 - **Concept 3: Understanding personal health; PO 1 describe ways to prevent communicable diseases**
 - **Concept 3: Understanding personal health; PO 2 identify that foods are classified into food groups and that a variety of food is needed for personal health, growth, and development**

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- ~~Concept 3: Understanding personal health; PO 3 identify that physical activity is integral to good health~~
- ~~Strand 7: Ability to Practice Health-Enhancing Behaviors~~
- ~~Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors to maintain or improve personal health~~
- ~~Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks~~

Life Science Connections to the Arizona Health Standards for Grade Band Pre-K to 2

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- ~~Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being~~
- ~~Concept 3: Understanding personal health; PO 2 identify that foods are classified into food groups and that a variety of food is needed for personal health, growth, and development~~
- ~~Concept 3: Understanding personal health; PO 3 identify that physical activity is integral to good health~~

Strand 6: Use of Goal-Setting Skills to Enhance Health

- ~~Concept 2: Health-related goal setting; PO 1 identify a short-term personal health goals and take action toward achieving the goal~~

Strand 7: Ability to Practice Health-Enhancing Behaviors

- ~~Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors to maintain or improve personal health~~
- ~~Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks~~

See also Appendix 4

Third Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band 3 to 5

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- ~~Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being~~
- ~~Concept 3: Understanding personal health; PO 2 describe the key nutrients contained in the food groups and how these nutrients affect health and learning~~
- ~~Concept 3: Understanding personal health; PO 3 describe how physical activity impacts health~~

Strand 6: Use of Goal-Setting Skills to Enhance Health

- ~~Concept 2: Health-related goal setting; PO 1 set a personal health goal and track progress towards its achievement~~

Strand 7: Ability to Practice Health-Enhancing Behaviors

- ~~Concept 2: Healthy practices and behaviors; PO 1 demonstrate a variety of healthy practices and behaviors to maintain or improve personal health~~
- ~~Concept 2: Healthy practices and behaviors; PO 2 demonstrate a variety of behaviors that avoid or reduce health risks~~

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See also Appendix 4

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Fourth Grade Connections to Other Academic Disciplines

Life Science Connections to the Arizona Health Standards for Grade Band 3 to 5

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being

Strand 6: Use of Goal-Setting Skills to Enhance Health

- Concept 2: Health-related goal setting; PO 1 set a personal health goal and track progress towards its achievement

Strand 7: Ability to Practice Health-Enhancing Behaviors

- Concept 2: Healthy practices and behaviors; PO 1 demonstrate a variety of healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate a variety of behaviors that avoid or reduce health risks

Life Science Connections to the Arizona Health Standards for Grade Band 6 to 9

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 analyze the relationship between healthy behaviors and personal health
- Concept 2: Understanding personal health; PO 2 analyze how food provides energy and nutrients for growth and development, that nutrition requirements vary from person to person, and how food intake affects health

Strand 6: Use of Goal-Setting Skills to Enhance Health

- Concept 2: Health-related goal setting; PO 1 develop a goal to adopt, maintain, or improve a personal health practice

Strand 7: Ability to Practice Health-Enhancing Behaviors

- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors that will maintain or improve the health of self and others
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks to self and others

Life Science Connections to the Arizona Health Standards for Grade Band 6 to 9

Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts

- Concept 1: Understand relationship between health behaviors and health; PO 1 analyze the relationship between healthy behaviors and personal health
- Concept 2: Understanding personal health; PO 2 analyze how food provides energy and nutrients for growth and development, that nutrition requirements vary from person to person, and how food intake affects health

Strand 6: Use of Goal-Setting Skills to Enhance Health

- Concept 2: Health-related goal setting; PO 1 develop a goal to adopt, maintain, or improve a personal health practice

Strand 7: Ability to Practice Health-Enhancing Behaviors

- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors that will maintain or improve the health of self and others
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks to self and others

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