Arizona Science Standards Revision Working Group

Date and time of meeting:	June 28, 2018 | 8:30 am – 3:30 pm
Scope of work:	On June 28, 2018 a working group of diverse grade level content experts and community members reviewed the 6-8 grade level progression of standards. They made changes to the standards based off of Working with Big Ideas of Science Education and The Framework for K-12 Science Education, public comment, technical review and past working group suggestions. These committee members reviewed the draft of the 2018 Science Standards and addressed public comment/feedback that had been received as 12:00 p.m. (noon) on May 31st, 2018.
Work completed:	During the meeting the working group committee worked on grade level content (6-8) public of the draft standards. They came up with a progression that addressed concern but also kept in mind the overall progression of the standards.
Artifact (s):	Artifact 1: 2018 Draft of the Science Standards as of 6/28/28 The document (artifact) is the actual working document from the science working group committee. As the working groups discussed the feedback/comment they determined and comment on the artifact: • Content moved or suggest deletions are either ~~strikethrough~~ or highlighted in RED. This may indicate that this area needs to be deleted or has been moved to another section of the standards document. • Areas that are added to the draft standards are typed in red font.
Plans for next meeting:	The next working group meeting will continue to focus on the K-12 standards progression.

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 Sscientifically 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.

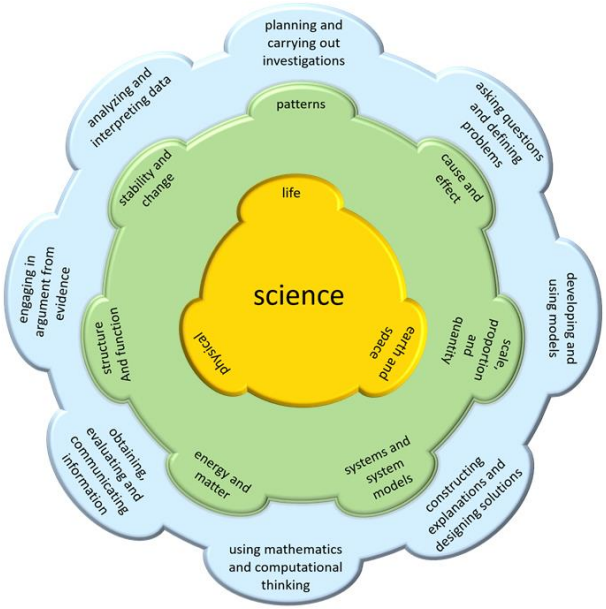
Commented [1]: moving to beginning

The standards are neither curriculum nor instructional practices.
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:

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



Science and Engineering Practices

The science and engineering practices[4] 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.

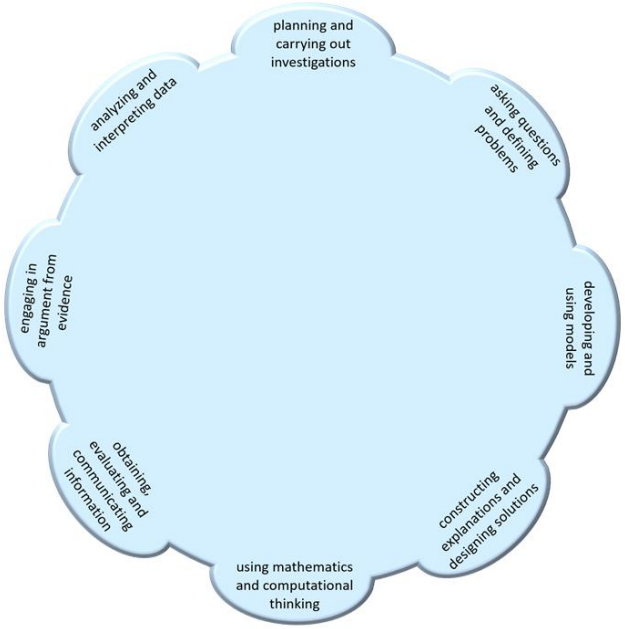


Figure 2: Science and engineering practices are used to investigate core ideas in science and develop scientific literacy

Crosscutting Concepts

Crosscutting concepts[4] 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

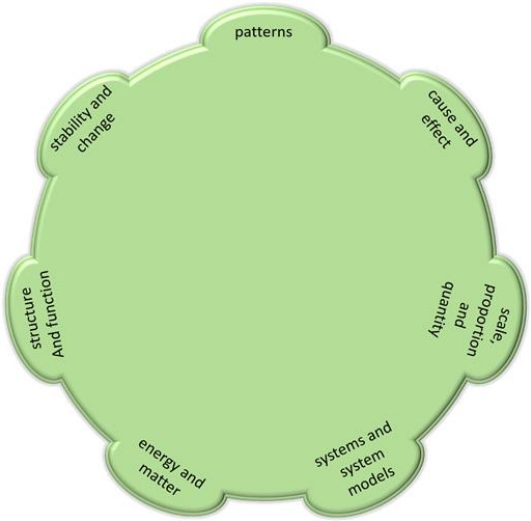


Figure 3: Crosscutting concepts provide a lens for understanding the core ideas

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.

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.

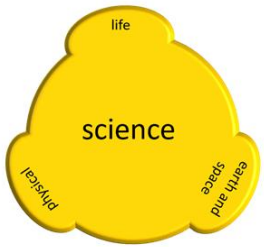


Figure 4: Core ideas for knowing science and using science develop scientific literacy through science content knowledge, understanding the nature of science, applications of science and engineering, and social implications

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

Design of the Arizona Science Standards

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.

Commented [2]: moving to beginning

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:

- 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.

The standards are neither curriculum nor instructional practices.

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.

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.

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

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 4 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 5 for strategies to support equity and diversity in science.

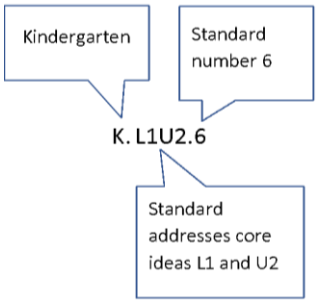
Safety Expectations

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)

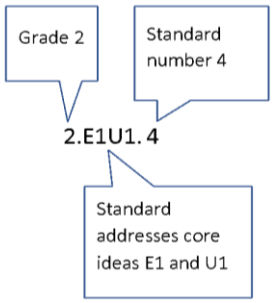
1) Identify hazards. Hazards may be physical, chemical, health, or environmental.
2) Evaluate the type of risk associated with each hazard.
3) Instruct students on all procedures and necessary safety precautions in such a way as to eliminate or reduce the risk associated with each hazard.
4) Prepare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



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.

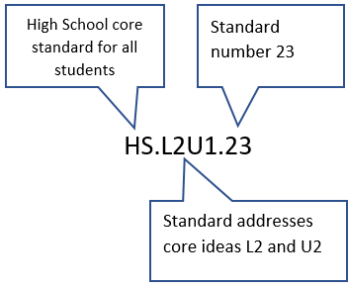
Coding of the High School Science Standards

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.

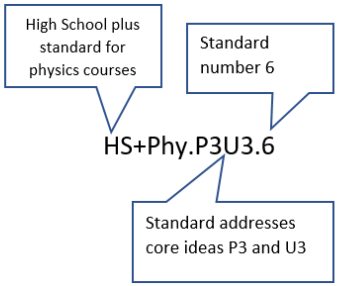
- All high school essential standards (HS) should be learned by every high school student regardless of the 3-credit course sequence they take. The full set of essential high school (HS) standards is designed to be taught over a 3-year period.
- The high school plus (HS+) standards are designed to enhance 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.



HS.L2U1.23. Construct an explanation for how organisms regulate internal functions.



HS+Phy.P3U3.6. Design, evaluate, and refine a device that minimizes or maximizes the force on a macroscopic object during a collision.

Grades K-2 Science Standards

The K-2 Science Standards are designed to provide opportunities for students to develop understanding of all fourteen core ideas (see Appendix 3) across the K-2 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, students engage in multiple science and engineering practices 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). They 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 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 and crosscutting concepts help students 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 thinking of how energy and matter relate to how water helps change 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.

Commented [3]: On the HS standard, the call out box does not agree with the standard - U1 in standard, but U2 in callout box.

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 how the senses 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.

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**.	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] Technologies have been created by people to provide the things they need or can use, such as food, tools, clothes, somewhere to live and ways of communicating. All around us are examples of how materials have been changed so that they can be used for certain purposes.[2] Crosscutting Concepts: **patterns; structure and function**, energy and matter, cause and effect, systems and system models.[4]
K.P2U3.2	
Design and evaluate a tool that helps people extend their 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
K.E1U1.3	
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] Crosscutting Concepts: **patterns; structure and function**, energy and matter, cause and effect, stability and change, systems and system models[4]
K.E1U1.4	
Observe, describe, ask questions, and predict seasonal weather patterns; understand and how those patterns impact plants and animals (including humans).	

Life Sciences: Students develop an understanding that the world is comprised of living and non-living nonliving 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
K.L1U1.5	
Obtain, evaluate, and communicate information about the systems of the human body which carry out life processes. **Obtain, evaluate, and communicate** information how organisms use different body parts for survival.	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] Crosscutting Concepts: **patterns; structure and function**, cause and effect, stability and change, systems and system models[4]
K.L2U2.6	

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**, stability and change[4]
K.L4U2.7	
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.	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] Crosscutting Concepts: **patterns; structure and function**, stability and change[4] [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?]

Kindergarten Connections to Other Academic Disciplines

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

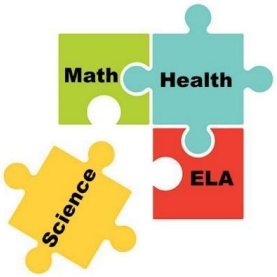
- Strand 1: Comprehension of Health Promotion and Disease Prevention Concepts
  - Concept 1: Understand relationship between health behaviors and health; PO 1 identify that healthy behaviors affect personal health and overall well-being
  - Concept 3: Understanding personal health; PO 1 describe ways 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.

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 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 K.P2U2.1	Some materials allow **light** to pass through them (**transparent**), others allow only some light through (**translucent**), and others block all the light (**opaque**) 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. Light and sound are **wavelike** phenomena. **Sound** can make **matter vibrate**, and vibrating matter can make sound. Light and sound are wavelike phenomena. **Sound** can make **matter vibrate**, and vibrating matter can make sound.[4] Crosscutting Concepts: **cause and effect, stability and change,** patterns, structure and function, energy and matter, systems and system models[4]
1.P2U2.2	
Use models to provide evidence that vibrating matter creates sound and sound can make matter vibrate. Concepts taught in K.P2U2.1	
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 (balanced forces)**. The movement of objects is changed if the forces acting on them are not in **balance (unbalanced forces)**.[4]

	Crosscutting Concepts: **cause and effect, stability and change,** patterns, structure and function, energy and matter, scale, proportion and quantity, systems and system models[4]
1.P4U3.4	
Design and evaluate solutions 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] Crosscutting Concepts: **cause and effect, stability and change,** patterns, structure and function, energy and matter, scale, proportion and quantity, systems and system models[4]

Earth and Space Sciences: Students develop an understanding that organisms depend on Earth 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. **Investigate** the properties of earth materials and how humans use resources in everyday life.	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**. 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. Crosscutting Concepts: **cause and effect, stability and change,** patterns, structure and function, scale, proportion and quantity.[4]

Life Sciences: Students develop an understanding that the Earth has supported, and continues to support, a large variety of organisms which 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.	**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.[2] Crosscutting Concepts: **cause and effect, stability and change,** patterns, structure and function.[4]
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.	All living things need food as their source of **energy** as well as air, water and certain temperature conditions. Plants can use **sunlight** to make the food they need. 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.[2] Animals depend on their surroundings (**habitats**) to get what they need, including food, water, shelter, and a favorable temperature.[4] Crosscutting Concepts: **cause and effect, stability and change,** patterns, structure and function.[4]
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 K.L1U1.5, K.L4U2.7	
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. Crosscutting Concepts: **cause and effect, stability and change,** patterns, structure and function.[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] Crosscutting Concepts: **cause and effect, stability and change,** patterns, structure and function.[4]
1.L4U4.11	
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.	

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

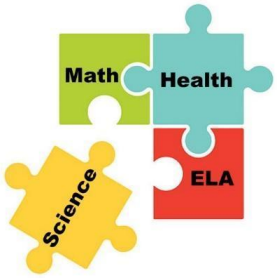
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks

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

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

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 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 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 energy and matter and systems and system models.

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] Crosscutting Concepts: **energy and matter**, **systems and system models**, patterns, cause and effect, stability and change[4]
2.P1U2.2	
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] Crosscutting Concepts: **energy and matter**, **systems and system models**, patterns, cause and effect, stability and change, structure and function.[4]

Earth and Space Sciences: Students develop an understanding of the distribution and role of water and wind in weather, shaping land, where organisms live, and changing environments. They learn that humans and other organisms can change environments. Students also develop an understanding of changing patterns in the sky, including the position of Sun, Moon, and stars, and the 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] 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.[2] Crosscutting Concepts: **energy and matter**, **systems and system models**, patterns, cause and effect, stability and change, structure and function.[4]
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).	
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 K.E1U1.3, K.E1U1.4	**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] Crosscutting Concepts: **energy and matter**, **systems and system models**, patterns, cause and effect, 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: **energy and matter**, **systems and system models**, patterns, cause and effect, stability and change[4]
2.E2U1.8	
Analyze and interpret data to explain the Earth'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. **Observe** and **explain** the Sun's position at different times during a twenty four hour period and changes in the apparent shape of	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] Crosscutting Concepts: **energy and matter**, **systems and system models**, patterns, cause and effect, stability and change[4]

the Moon from one night to another.	

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] (Boundary: At this grade level, no attempt is made to give a precise or complete definition of energy.)[4] [Note: This progression from Big Ideas blends into he 7-11 age band. Thoughts?]
2.L2U1.10	
Construct a model representing how life on Earth depends on energy from the Sun and energy from other organisms. Review of and continuation of content taught in K.P2U2.1, K.L1U1.5	Crosscutting Concepts: **energy and matter**, **systems and system models**, patterns, cause and effect, form and function, stability and change[4]

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

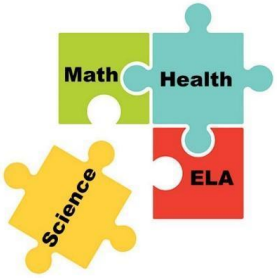
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks

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

Distribution of K-2 Standards

	U1: Science's purpose is to find the cause or	**U2**: Scientific explanations, theories,	**U3**: The knowledge produced by science is	**U4**: Applications of science often have

	causes of phenomena in the natural world.	and models are those that best fit the evidence available at a particular time.	used in engineering and technologies to create products.	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.	2.E2U1.8			
L1: Organisms are organized on a cellular basis and have a finite life span.	K.L1U1.5 1.L1U1.6			
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.L2U2.6 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.		K.L4U2.7 1.L4U2.10		1.L4U4.11

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, students engage in multiple science and engineering practices 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). They 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 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 and crosscutting concepts help students develop transferable skills and understandings from one grade to the next and between content areas.

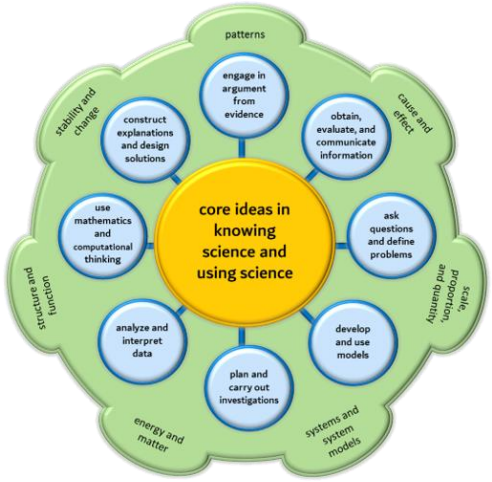


Figure 1: Three Dimensions of Science Instruction

- In third grade, students use cause and effect relationships to understand how the Sun provides the primary source of energy for supporting life on Earth.
- In third grade, students develop understanding of cause and effect relationships involving energy and matter as they investigate properties of light and sound waves.
- In fourth grade, students apply systems thinking as they understand that Earth systems are impacted by different forms of energy.
- In fourth grade, students apply systems thinking as they investigate how energy the availability of resources affects Earth systems (geosphere and biosphere)
- 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.

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.

Third Grade: Focus on 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 cause and effect and energy and matter.

Physical Sciences: Students develop an understanding of the sources, properties, characteristics, and types of waves and how waves can transfer energy.

Physical Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
3.P2U1.1	
Ask questions and investigate the relationship between light, lenses, and parts of the human eye. **Ask questions and investigate** the relationship between light, objects, and the human eye. Concepts taught in 1.P2U1.1 and characteristics such as speed and shadows	**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] Crosscutting Concepts: **cause and effect, energy and matter**, patterns; structure and function, stability and change[4]
3.P2U2.2	
Collect data and construct arguments based on evidence to explain how sound waves affect objects at varying distances. and parts of the human ear.	
3.P4U1.3	
Construct an explanation of how light and sound waves transfer energy.	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] Some energy resources are renewable, such as those produced by wind, waves, sunlight and tides. [2] Crosscutting Concepts: **cause and effect, energy and matter**, patterns; structure and function, stability and change[4]

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

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
3.E1U1.4	
Construct an explanation describing how the Sun is the primary source of energy impacting Earth systems. for the Earth.	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 physical changes in Earth's materials and living organisms.[4] [Note: This is from Framework's 6-8 grade band. Can anyone find this topic in the 3-5 grade band or 7-11 age in Big Ideas???] In all these changes, energy is transferred from one object, which is an energy source or resource, to another. Some energy resources are renewable, such as those produced by wind, waves, **sunlight** and tides, others are non-renewable such as from burning fossil fuels with oxygen (Big Ideas, p. 23). Crosscutting Concepts: **cause and effect, energy and matter**, patterns; structure and function, stability and change[4]

Life Sciences: Students develop an understanding 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	
Obtain, evaluate, and communicate that the human body has different systems which carry out life processes. Review of content taught in 2.L2U1.10; 3.P2U1.1; 3.P2U2.2	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] Crosscutting Concepts: **cause and effect, energy and matter**, patterns; structure and function, stability and change[4]
3.L1U2.5	
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.	
3.L2U2.6	
Plan and carry out investigations to demonstrate ways plants and animals react to stimuli.	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] Crosscutting Concepts: **cause and effect, energy and matter**, patterns; structure and function, stability and change[4]
3.L2U1.7	
Use food chains as **system models** to describe the exchange of energy between the Sun, plants, and animals. Concepts taught in 2.L2U1.10	**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). Organisms can survive only in environments in which their particular needs are met. (Boundary: At this grade level, no attempt is made to give a precise or complete definition of energy.)[4] Crosscutting Concepts: **cause and effect, energy and matter**, patterns; structure and function, stability and change[4]
3.L2U3.8	
Design, test, and refine a solution to reduce damaging effects of sunlight on plants or animals.	

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 heath 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

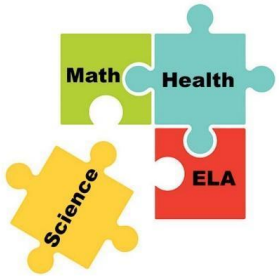
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate a variety of healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate a variety of behaviors that avoid or reduce health risks

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 preform multi-digit arithmetic
- Number and Operations – Fractions
  - Understand fractions as numbers
- Measurement and Data
  - Solve problems involving measurement
  - Represent and interpret data



See also App`endix 4

Fourth Grade: Systems and System Models; 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 and stability and change.

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	
Develop and use a model to demonstrate how a system transfers energy from one object to another even when the objects are not touching.	There are various ways of causing an event or bringing about change in objects or materials. Objects can be made to change their movement by pushing or pulling. **Heating** can cause change, as in cooking, melting solids or changing water to vapor. **Electricity** can make light bulbs glow. Wind can rotate the blades of wind **turbines**. [2] [5-7] In all these changes, **energy** is transferred from one object, which is an **energy source** or **resource**, to another. Fuels such as **oil**, **gas**, **coal** and **wood** are energy resources. Some energy resources are **renewable**, such as those produced by **wind, waves, sunlight and tides**, others are **non-renewable** such as from burning **fossil fuels** with oxygen. [2] [7-11] [Is there a better way to describe from our resource documents this section?]
4.P4U2.2	
Develop and use a model that demonstrates how energy is moved from place to place through electric and magnetic currents. **Develop and use a model** that explains how energy is moved from place to place through electric currents. Concepts taught in 1.P3U1.3	
4.P2.U1.3	

Develop and use a model to demonstrate magnetic forces.	Crosscutting Concepts: **system and system models**, **stability and change**, cause and effect, energy and matter, patterns; structure and function [4]
4.P4U4.4	
Construct an explanation and engage in argument from evidence on the use and impact of renewable and nonrenewable resources to provide energy.	

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	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. 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 we.re formed. **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] [Note: term seismic waves not mentioned until 9-12 grade Framework; Thoughts? I feel this section is messy - help]
Use models to explain seismic waves and their effect on the Earth.	
4.E1U1.6	
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.	
4.E1U2.7X take out	
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.	
4.E1U2.7	
Develop and/or revise a model using various rock types and fossils to show evidence that Earth has changed over time. **Develop and/or revise a model** using various rock types, fossil location, and landforms to show evidence that Earth's surface has changed over time. Connections to 4.E1U2.6	

4.E1U2.8	Crosscutting Concepts: **system and system models**, **stability and change**, cause and effect, energy and matter, patterns, structure and function[4]
Collect, analyze, and interpret data to explain weather and climate patterns. Concepts taught in 2.E1U3.6	
4.E1U4.9	
Construct and support an evidence-based argument about the availability of water and its impact on life. Concepts taught in 2.E1U2.5	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 appearance of the land. Nearly all of Earth's available water is in the ocean. Most **fresh water** is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. [4] Crosscutting Concepts: **system and system models**, **stability and change**, cause and effect, patterns, structure and function[4]
4.E1U3.10	
Identify the causes and effects of natural disasters, **define the problem(s),** and **design solution(s)** to minimize those effects on humans. **Define problem(s) and design solution(s)** to minimize the effects of natural hazards.	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. Crosscutting Concepts: **system and system models**, **stability and change**, cause and effect, patterns, structure and function[4]

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.	**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] Crosscutting Concepts: **system and system models**, **stability and change**,

	cause and effect, patterns, structure and function[4]
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.	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] Crosscutting Concepts: **system and system models**, **stability and change**, cause and effect, patterns, structure and function[4]

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

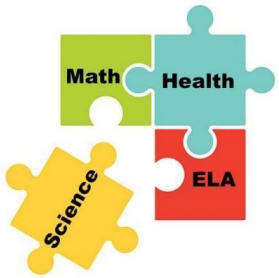
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate a variety of healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate a variety of behaviors that avoid or reduce health risks

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 preform multi-dig
- 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

Fifth Grade: Scale, Proportion, and Quantity; Patterns

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 , 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 a basic 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 scale, proportion and quantity and patterns.

Physical Sciences: Students develop an understanding that changes can occur to matter/objects on Earth or in space, but both energy and matter 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.	When some **substances** are combined they form a new substance (or substances) with properties that are different from the original ones. 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] Crosscutting Concepts: **scale, proportion, and quantity; patterns;** system and system models; stability and change; cause and effect; structure and function[4]
5.P1U1.2	
Plan and carry out investigations to demonstrate that some substances combine to form new substances with different properties and others can be mixed without taking on new properties.	
5.P2U1.3	
Construct an explanation using evidence to demonstrate that objects can affect other objects even when they are not touching.	**Gravity** is the universal attraction between all objects, however large or small, although it is only apparent when one of the objects is very

Concepts taught in 4.P4U2.2	large. This **gravitational attraction** keeps the planets in **orbit** round 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] 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 Crosscutting Concepts: **scale, proportion, and quantity; patterns;** system and system models; stability and change; cause and effect; structure and function[4]
5.P3U1.4	
Obtain, analyze, and communicate evidence of the effects that balanced and unbalanced forces have on the motion of objects.	**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] [Note: from Big Ideas grades 5-7] Crosscutting Concepts: **scale, proportion, and quantity; patterns;** system and system models; stability and change; cause and effect; structure and function[4]
5.P3U3.5	
Apply scientific ideas to def**ine problems** and **design solutions** pertaining to force and motion. Application of key concepts outlined in 5.P3U1.4	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]
5.P4U1.6	
Analyze and interpret data to determine whether energy is present and can be transferred whenever there are moving objects. **Analyze and interpret data** to determine how and where energy is transferred when objects move.	Crosscutting Concepts: **scale, proportion, and quantity; patterns;** system and system models; stability and change; cause and effect; structure and function[4]

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	
Develop and use models based on evidence to construct explanations about the movement of the Earth and Moon within our Solar System.	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. Crosscutting Concepts: **scale, proportion, and quantity; patterns;** system and system models; stability and change; cause and effect[4]
5.E2U2.8	
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).	**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] The gravitational force of Earth acting on an object near the Earth's surface pulls that object towards the planet's center. 4 Crosscutting Concepts: **scale, proportion, and quantity; patterns;** system and system models; stability and change; cause and effect; structure and function[4]

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. 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] 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. Other features, such as skills and behavior, are not passed on in the same way and have to be learned. (2) Crosscutting Concepts: **scale, proportion, and quantity; patterns;** system and system models; stability and change; cause and effect; structure and function[4]
5.L3U2.10	
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 4.L4U2.11	
5.L4U4.11	
Obtain, evaluate, and communicate evidence about how natural and human caused changes to habitats or climate can impact populations.	Sometimes the differences in **characteristics** between individuals of the same **species** provide advantages in surviving, finding **mates**, and **reproducing**. 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. Crosscutting Concepts: **scale, proportion, and quantity; patterns;** system and system models; stability and change; cause and effect; structure and function[4]

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

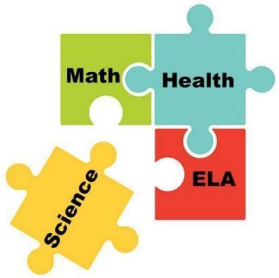
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate a variety of healthy practices and behaviors to maintain or improve personal health
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate a variety of behaviors that avoid or reduce health risks

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

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 5.P2U1.3	3.P2U2.2 4.P2U2.1		
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.P4U2.2		4.P4U4.3
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.E1U1.5	4.E1U2.4 4.E1U2.6 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

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 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, students engage in multiple science and engineering practices 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). They 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 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 and crosscutting concepts help students 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.
- In seventh grade, students will ~~explore~~ investigate the relationship between ~~how~~ forces and the ~~cause~~ changes in motion, how energy ~~is~~ transfer~~red in~~ impacts ~~g~~geologic and atmospheric processes, and the structure and function of cells~~, and environmental processes.~~
- STOP In eighth grade, students will describe how the constant interaction of stability and change and the process of cause and effect influence the natural world.

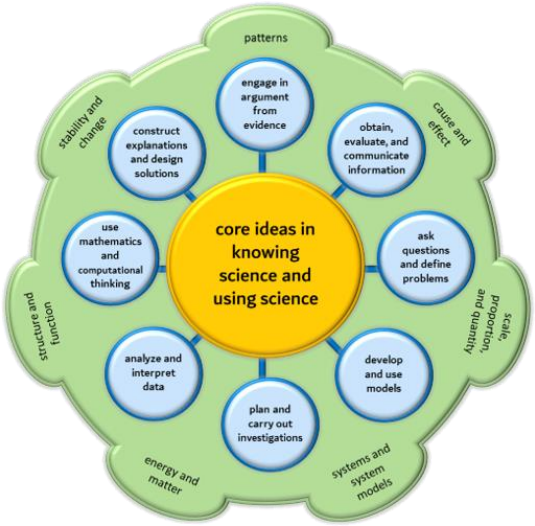


Figure 1: Three Dimensions of Science Instruction

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.

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

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 energy and matter; scale, proportion, and quantity; systems and system models; and patterns.

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).	**Gases** and **liquids** are made of molecules or inert **atoms** that are moving about relative to each other. In a liquid, the molecules are constantly in contact with each other; in a gas, they are widely spaced except when they happen to collide. In a **solid**, atoms are closely spaced and vibrate in position but do not change relative locations. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). The changes of state that occur with variations in **temperature** or **pressure** can be described and predicted using these models of matter. (Boundary: Predictions here are qualitative, not quantitative.) The term "**heat**" as used in everyday language refers both to **thermal energy** (the motion of atoms or molecules within a substance) and energy transfers by **convection**, **conduction**, and **radiation** (particularly infrared and light) .Temperature is a measure of the average **kinetic energy** of particles of **matter**. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. [4]
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.	

	Crosscutting Concepts: **Patterns**; Cause and effect; **Scale, Proportion and Quantity**; **Systems and System Models**; **Energy and Matter**; Stability and change; Structure and function [4]
~~**6.P3U2.4**~~	
~~**Plan and carry out an investigation** that can support an evidence-based explanation of how objects on Earth are affected by gravitational forces.~~ ~~Concepts taught in 5.P2U1.3, 5.P3U1.4, 5.P3U3.5, 5.E2U2.8~~ ~~Grade level connection to 6.E1U1.7, 6E1U2.11~~ *Moved to 7th grade	~~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 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 hollowed out to displace a large weight of water.~~ [2] ~~Crosscutting Concepts: **Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; Patterns;** stability and change; cause and effect; structure and function~~ [4]
6.P2U2.4	
Develop and use a model to predict how forces act on objects at a distance. 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.	**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. 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. 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] Crosscutting Concepts: **Patterns**; **Cause and effect; Scale, Proportion and Quantity**; **Systems and System Models**[4]
6.P4U3.5	

Analyze how humans use technology to store (potential) and/or use (kinetic) energy. Chemical to electrical energy No change in standard. Moved numbering is all.	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] Crosscutting Concepts: **Energy and Matter** [4]

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.

Earth and Space Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
6.E1U1.6	
Investigate and construct an explanation demonstrating ~~how~~ that radiation from the Sun provides energy and is absorbed to warm the Earth's surface and atmosphere. Extension of those taught in 4.P4U2.1, 4.E1U1.5	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] Crosscutting Concepts: **Patterns**; **Cause and effect; Scale, Proportion and Quantity**; **Systems and System Models**; [4]
6.E2U1.87	
Use ratios and proportions to **analyze and interpret data** related to scale, properties, and relationships among objects in our Solar System. Gravity on moon vs Earth, planetary distances, Complementary Standard: **6.P2U2.4**	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 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
6.E2U2.98	
Develop and use models to explain how constellations and other night sky patterns appear to move due to Earth's rotation and	

revolution. Complementary Standard: 6.P2U2.4	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] 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] Crosscutting Concepts: **Patterns**; **Cause and effect; Scale, Proportion and Quantity**; **Systems and System Models**; [4]
~~6.E2U3.10~~	
~~**Construct an explanation** from evidence that correlates patterns in the night sky to human navigation and agricultural practices. (remove)~~ ~~Per technical reviewer:~~ ~~Can be curriculum addition to standard 6.E2U2.9~~ Possibly move to 5th grade	
6.E2U2.~~11~~ ~~9~~	
Develop and use models to construct an explanation of how eclipses, moon phases, and tides occur within the Sun-Earth-Moon system. Concepts taught in 4.E1U2.4 Complementary Standard: ~~6.P3U2.4~~ 6.P2U2.4 **Pg. 176 of Framework** **Connects to P2**	
6.E2U1.~~12~~ ~~10~~	
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.	

Life Sciences: Students develop an understanding ~~of purposes~~ the function of internal cell structures and their roles in life processes.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
~~6.L1U2.13~~ ~~6.L2U4.11~~	
~~**Carry out an investigation** 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.~~ *Moved to 7th Grade	**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

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. *Moved from 7th Grade	organisms). The decomposers 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] **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. Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]
~~**6.L1U1.12** 6.L2U2.12~~ ~~**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 **Develop and use models** to demonstrate the interdependence of organisms and their environment including biotic and abiotic factors. Concepts taught in 2.L2U2.10	
~~**6.L1U2.15** 13~~ 6.L2U2.13 ~~**Construct an explanation** to demonstrate the relationship between major cell structures and cell functions (plant and animal).~~	**Move all this red text below to 7th grade to match with**

~~Grade level connection to 6.L1U1.14~~ **6.L1U2.1513 moved to 7th grade.** **Construct a model** that shows the cycling of matter and flow of energy in ecosystems. Concepts taught in 6.E1U1.6 *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.	cells! 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. [2] (Add info about major cell structures) Crosscutting Concepts: **Energy and Matter; Scale, Proportion and Quantity; Systems and System Models;** Patterns; stability and change; cause and effect; **structure and function**[4]
~~**6.L2U1.1614**~~	
~~**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.~~	~~**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, 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]

	~~Crosscutting Concepts:~~ **~~Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; Patterns;~~** ~~stability and change; cause and effect; structure and function[4]~~

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 heath

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

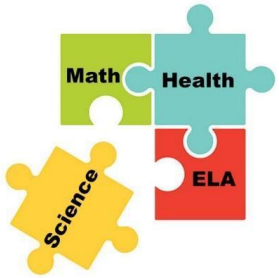
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors that will maintain or improve the health of self and others
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks to self and others

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

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 **forces** and motion in a wide variety of systems, model how heat energy drives cycles in weather and climate, and explain 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 though patterns, cause and effect, and structure and function.

Physical Sciences: Students will explore how forces and motion take place within and between a wide variety of 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	
7.P#U1.1 (not P2) **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.[4] Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]
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.P2U2.2** **Develop and use a model** to predict how forces act on objects at a distance. Concepts taught in 6.E2U2.11 -6/28 committee recommends having this standard in both 6th and 7th	
6.P4U3.5 **Analyze** how humans use technology to store (potential) and/or use (kinetic) energy. (Moved from 6th grade) **See notes in 6th grade section	Objects can have **stored energy** (that is, the ability to make things change) either because of their chemical composition (as in fuels and batteries), their **movement**, their **temperature**, their **position** in a **gravitational or**

-6/28 committee groups recommends keeping this standard in 7th **7.P4U3.3**	**other field**, or because of **compression** or **distortion** of an **elastic material**. 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. [2] Crosscutting Concepts: **Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; Patterns;** stability and change; cause and effect; structure and function[4]
~~**8.P4U1.3**~~ **Construct an explanation** on how energy can be transferred from one energy (store- delete) form to another. (Moved from 8th grade) **See notes in 8th grade section. -6/28 committee recommends keeping this standard in 8th **7.P4U3.4**	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 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.
8.P4U1.4 **Evaluate** how energy affects wave characteristics and interactions **using mathematical models**. Concepts taught in 7.E1U2.4 (Moved from 8th grade) **See notes in 8th grade section. -6/28 committee recommends keeping this standard in 8th	
7.P3U2.~~3~~ 5	
Use non-algebraic **mathematics and computational thinking** to explain Newton's laws of motion.<-- Moved to 8th	(Add info about Newton's 1st and 2nd laws) For any pair of interacting objects, the **force** exerted by the first object on the second object is equal in strength to the

Concepts taught in 6.P1U1.1, 6.P4U3.5 To address public concern, move to 8th grade 6/28 committee group recommends keeping this standard in 7th	force that the second object exerts on the first but in the opposite direction **(Newton's third law)**. 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**. 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] Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]

Earth and Space Sciences: Students develop an understanding of the results of energy flowing and matter cycling within and among the Earth's system. 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
~~7.E1U2.4~~	
6.L2.U2.# **Construct a model** that shows the cycling of matter and flow of energy in the atmosphere, hydrosphere, and geosphere. Move to 6th Concepts taught in 6.E1U1.6	All **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 physical changes** in Earth's materials and living organisms. Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]
7.E1U2.5 6	
~~**Analyze and interpret data** on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.~~ Concepts taught in 4.E1U2.6, 4.E1U2.7, 4.L4U2.11 **Construct a model to explain how** the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	**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] Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]
~~8.E1U1.6~~ 7.E1U2.7 **Develop and use a model** of Earth's geological column Earth's rock strata	Note: suggested adding the use of fossils in biostratigraphy and geologic cross sections to communicate the Law of Superposition. (Reviewer

(geological column) to **communicate** relative ages of rock layers and fossils. Concepts taught in **7.E1U2.7** (Moved from 8th grade.) **See notes for 8th grade section.	suggested)
7.E1U3.6 8	
Analyze and interpret data ~~Construct an explanation~~ for how the technology scientists use to predict weather and to explore Earth has evolved over time. Moved to 8th grade. ← Moved to 8th As per public's concerns. of how the technology scientists use to predict weather and to explore Earth has evolved over time.	**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] **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 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**. Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]

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.

Life Science Standards	Learning Progressions, Key Terms, and Crosscutting Concepts
~~7.L1U1.7~~ 7.L1U2.9	
~~Explain how organisms maintain internal stability and evaluate the effect of the external factors on organisms' internal stability.~~ **Obtain, evaluate, and communicate information** to provide evidence that all liging things are made of cells, cells come from existing cells, and cells are the basic structural and functional unit of all living things.	Both single celled and multicellular organisms have **mechanisms** to **maintain temperature** and **acidity** within certain **limits** that enable the organism to survive. [2] Designing a solution to a problem generally involves making a drawing or model. Physical, mathematical or computer models enable the effect of changes in materials or design to be tested and the solution improved. There are usually many factors to be considered in optimizing a solution, such as cost, availability of materials and impact on users and on the environment, which may constrain choices. [2] Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]
~~7.L1U3.8~~ 7.L1U2.10	
~~Obtain and evaluate information about devices developed to help humans maintain homeostasis.~~ ~~Delete~~ **Construct an explanation** to demonstrate the relationship between major cell structures and cell functions (plant and animal).	
~~7.L2U2.9~~ ~~7.~~ I Don't Know!.11	
~~6.L2U2.#~~ ~~Develop and use models to demonstrate the interdependence of organisms and their environment including biotic and abiotic factors. Move to 6th Concepts taught in 2.L2U1.10~~ **Develop and use a model** to explain how cells, tissues, and organ systems main 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 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**
~~7.L2U2.10~~ 7.L1U1.12	
~~Construct an explanation of how organisms use energy sources in ecosystems. Concepts taught in 3.L2U1.8~~	

~~-Delete~~ **Explain** how organisms maintain internal stability and evaluate the effect of the external factors on organisms' internal stability.	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]
~~7.L2U4.11~~ 7.L2U1.13 ~~6.L2U4.#~~ ~~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. Move to 6th~~ **Construct an explanation** for how some plant cells convert light energy into food energy. Connects to 6.E1U1.6	Note: Add info from pg. 152 of the Framework regarding interdependent relationships (symbiosis, etc). Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]

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 heath

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

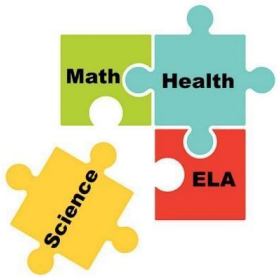
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors that will maintain or improve the health of self and others
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks to self and others

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

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

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 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, stability and change, and energy and matter.

Physical Sciences: Students 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	
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. Concepts introduced in 6.P1U1.1, and 6.P1U2.3	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] Crosscutting Concepts: **Energy and Matter**; Scale, Proportion and Quantity; Systems and System Models; Patterns**; stability and change**; **cause and effect;** structure and function[4]
8.P1U3.2	
Obtain and evaluate information regarding how scientists use technology to identify substances based on unique physical and chemical properties.	
~~**7.P3.U2.3**~~ ~~**(Use** non-algebraic **mathematics and computational thinking) Delete in**~~	(Add info about Newton's 1st and 2nd laws) For any pair of interacting objects, the **force** exerted by the first

~~parenthesis~~ ~~to explain Newton's laws of motion. **See note on 7th grade section.~~ **8.P3.U2.3** **Use non-algebraic mathematics and computational thinking to explain Newton's laws of motion.**	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 **(Newton's third law**). 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**. 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] Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]
8.P4U1.3 ~~4~~	
Construct an explanation on how energy can be transferred from one energy store to another. 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.	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
8.P4U1.4 ~~5~~	
Evaluate how energy affects wave characteristics and interactions **using mathematical models**. Move to 7th grade Concepts taught in 7.E1U2.4 -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.	
8.P4U3.5 ~~6~~	

Develop a solution to increase efficiency when transferring energy from one source to another.	weather. The transfer of energy in making things happen almost always results in 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.

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

Earth and Space Standards	Key concepts include but are not limited to:

8.E1U1.6	
Develop and use a model of Earth's geological column to **communicate** relative ages of rock layers and fossils. Concepts taught in 7.E1U2.5 **8.E1U1.7** **Analyze and interpret data** about the Earth's geological column to **communicate** relative ages of rock layers and fossils. Per public comments.	
8.E1U3.7 8	
Obtain, evaluate, and communicate information about technologies that use data and historical patterns to predict natural hazards **and other geological events.**	
8.E1U4.8 9	
Construct and support an argument about how human consumption of limited resources impacts the geosphere.	
8.E1U3.10 **Construct an explanation** for how (the technology) Delete scientists (use to) Delete predict weather and (to) Delete explore Earth (with technology that) Inserted has evolved over time. (Should say) **Construct an explanation for how scientists predict weather and explore Earth with technology that has evolved over time.**	**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] **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 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**. Crosscutting Concepts: Energy and Matter; Scale, Proportion and Quantity; Systems and System Models; **Patterns**; stability and change; **cause and effect; structure and function**[4]

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.~~9~~ 11	
Explain how the transfer of genetic information from each parent produces variation in offspring. ~~Explain the transfer of genetic information from each parent to produce variations in offspring that result from the subset of chromosomes inherited or (more rarely) from mutations. (Suggested edit)~~ **Explain the transfer of genetic information from each parent to produce variations in offspring that are inherited or from mutations.**	Concepts taught in 5.L3U1.9 and stress on the impact of gene transmission vs the mechanism, cell division, chromosomes, genes, meiosis, mitosis, growth, reproduction (sexual, asexual), acquired vs inherited traits, Mendelian genetics, deoxyribonucleic acid (DNA), DNA structure (Add information about chromosomes inherited and mutations from pg 159 of the Framework)
8.L3U4.~~10~~ 12	
~~Communicate~~ ~~how advancements in technology have furthered the field of genetic research and **use evidence to support an argument** about whether or not genetic research has improved human lives.~~ **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.**	Genetic engineering, selective breeding, genomics
8.L4U2.~~11~~ 13	
Develop and use a model to explain how natural selection may lead to increases	Probability, statistics, modeling

and decreases of specific traits in populations over time.	Hardy Weinberg equilibrium calculations are not introduced until high school (remove per technical review)
8.L4U2.~~12~~ 14	
Gather and communicate evidence on the processes by which a species may change over time in response to environmental conditions.	concepts taught in 5.L3U2.10 and extinction, speciation, population change, adaptation, mutation, process of natural selection, limited resources, genetic drift, mate selection, X-linked

Eighth 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 heath

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

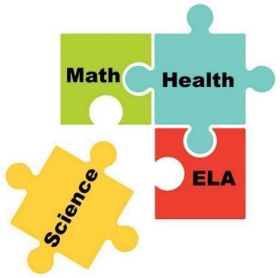
- Concept 2: Healthy practices and behaviors; PO 1 demonstrate healthy practices and behaviors that will maintain or improve the health of self and others
- Concept 2: Healthy practices and behaviors; PO 2 demonstrate behaviors that avoid or reduce health risks to self and others

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 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



See also Appendix 4

Distribution of the Grades 6-8 Standards

7.11 NEEDS A PROPER CODING	**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.P###U1.1 ←- this letter P needs to be changed to a different number**	6.P2U2.4 7.P2U2.2		
P3: Changing the movement of an object requires a net force to be acting on it.		~~6.P3U2.4~~ ~~7.P3U2.3~~ 7.P3U2.5		
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.	8.P4U1.3 8.P4U1.4		6.P4U3.5 7.P4U3.3 7.P4U3.4 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.E1U2.4~~ 7.E1U2.6 ~~7.E1U2.5~~ 7.E1U2.7	~~7.E1U3.6~~ 7.E1U3.8 8.E1U3.7	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.E2U1.8~~ ~~6.E2U1.12~~ 6.E2U1.10	~~6.E2U2.9~~ 6.E2U2.8 ~~6.E2U2.11~~ 6.E2U2.9	~~6.E2U3.10~~	
L1: Organisms are organized on a cellular basis and have a finite life span.	~~6.L1U1.14~~ 7.L1U1.12 ~~7.L1U1.7~~	~~6.L1U2.13~~ 7.L1U2.9 ~~6.L1U2.15~~ 7.L1U2.10	7.L1U3.8	
L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	~~6.L2U1.16~~ 7.L2U1.13	6.L2U2.12 6.L2U2.13 ~~7.L2U2.9~~ ~~7.L2U2.10~~		6.L2U4.11 ~~7.L2U4.11~~
L3: Genetic information is passed down from one generation of organisms to another.	8.L3U1.9			8.L3U4.10
L4: The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms.		8.L4U2.11 8.L4U2.12		

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.

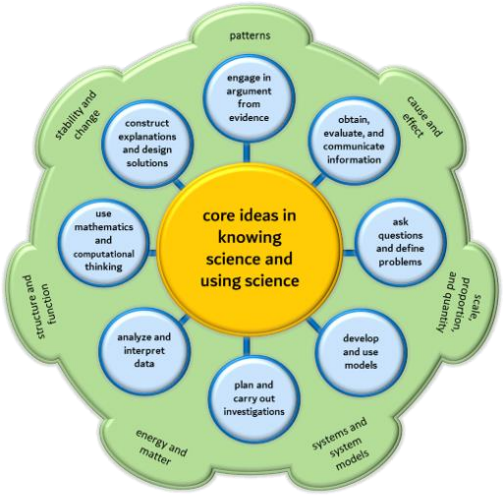


Figure 1: Three Dimensions of Science Instruction

Throughout grades K through 8, students are engaged in multiple science and engineering practices 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.

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.

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.

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.

Physical Science Standards

Chemistry

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.

Essential HS.P1U2.1

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.

Connections: 6.P1U2.3, HS.E2U1.15, HS.L2U1.25

Learning Progressions, Key Terms and Crosscutting Concepts

Atoms themselves have an internal structure, consisting of a heavy **nucleus**, made of **protons** and **neutrons**, surrounded by light **electrons**. The electrons and protons have **electric charge** – that of an electron being called negative and that of a proton called positive. Atoms are neutral, charges balancing exactly. Electrons move rapidly in **matter**, forming **electric currents** and causing **magnetic forces**. Their net effect is a force of attraction holding atoms and molecules together in compounds. When some electrons are removed or added, the atoms are left with a positive or negative charge and are called **ions**. In some atoms the nucleus is unstable and may emit a **particle**, a process called **radioactivity**. This process involves the release of radiation and an amount of energy far greater than any reaction between atoms. The behavior of matter at the scale of nuclei, atoms and molecules is different from that observed at the scale of ordinary experience.[2]

Crosscutting Concepts: Crosscutting Concepts: **system and system models; stability and change;** cause and effect; **energy and matter**; patterns; **structure and function**[4]

Physical Science Plus (+) Standards
HS+ Standards are designed for students taking a high school general chemistry (C) or honors chemistry course.

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.P1U3.2 ***Change to*** **Plus HS+C.P1U4.2**

Engage in argument, from evidence, 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 Engage in argument, from evidence, regarding the ethical, social, economic, and/or political benefits and liabilities of fission, fusion, and radioactive decay.

Connection: 8.E1U1.6, HS.E1U2.13

Plus HS+C.P1U2.3

Use a historical model of the atom to evaluate qualitatively the evidence supporting claims about how atoms absorb and emit energy in the form of electromagnetic radiation.

Plus HS+C.P1U1.4

Use mathematical representation to determine stoichiometric relationships between reactants and products in chemical reactions.

Chemistry	**Essential HS.P1U1.2** ***Describe patterns in the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.*** Connections: 5.P1U1.2, 8.P1U1.2, HS.E2U1.15, HS.L2U1.25		**Learning Progressions, Key Terms and Crosscutting Concepts** 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, with consequent changes in total **binding energy** (i.e., the sum of all bond energies in the set of 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. Crosscutting Concepts: Crosscutting Concepts: **system and system models; stability and change;** cause and effect; **energy and matter**; patterns; **structure and function**[4]
	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school chemistry (C) or honors chemistry course.	**HS+C.P1U2.5** Develop and use models to predict and explain forces within and between molecules.	
		HS+C.P1U2.6 Develop and use models to explain the differences between chemical compounds using patterns as a method for identification.	
Chemistry	**Essential HS.P1U4.3** ***Engage in argument from evidence about how the use of chemistry has positive and negative ethical, social, economic, and/or political implications.***		**Learning Progressions, Key Terms and Crosscutting Concepts** Although **energy** cannot be destroyed, it can be converted to less useful forms—for example, to **thermal energy** in the surrounding environment. **Machines** are judged as efficient or inefficient based on the amount of energy input needed to perform a particular useful task. Inefficient machines are those that produce more waste heat while performing a task and thus require more energy input. It is therefore important to design for high efficiency so as to reduce costs, waste materials, and many environmental impacts.[4] The behavior and arrangement of the atoms explains the
	Physical	**HS+C.P1U1.7**	

	Science Plus (+) Standards HS+ Standards are designed for students taking a high school chemistry (C) or honors chemistry	Plan and conduct investigations to test predictions of the outcomes of various chemical reactions, based on patterns of physical and chemical properties. Connection: HS.P1U2.1	properties of different materials. In **chemical reactions** atoms are rearranged to form new substances. The opposite electric charges of protons and electrons attract each other, keeping atoms together and accounting for the formation of some **compounds**.[2] The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.[4] Crosscutting Concepts: Crosscutting Concepts: **system and system models; stability and change;** cause and effect; **energy and matter**; patterns; **structure and function**[4]
		HS+C.P1U4.8 Construct an explanation, design a solution, or refine the design of a chemical system in equilibrium to maximize production.	
Chemistry	**Essential HS.P1U1.4** *Plan and carry out investigations to explore the cause and effect relationship between reaction rate factors.* Connections: 8.P1U2.1, HS.E2U1.15		**Learning Progressions, Key Terms and Crosscutting Concepts**
	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school chemistry (C) or honors chemistry	**HS+C.P1U1.9** Plan and conduct investigations to gather evidence of the relationships between kinetic molecular theory and gas laws.	Systems often change in predictable ways; understanding the **forces** that drive the transformations and cycles within a system, as well as the forces imposed on the system from the outside, helps predict its behavior under a variety of conditions. When a system has a great number of component pieces, one may not be able to predict much about its precise future. For such systems (e.g., with very many colliding molecules), one can often predict average but not detailed properties and behaviors (e.g., average temperature, motion, and **rates of chemical change,** but not the trajectories or other changes of particular molecules).[4] Crosscutting Concepts: Crosscutting Concepts: **system and system models; stability and change;** cause and effect; **energy and matter**; patterns; **structure and function**[4] This standard doesn't fit with Essential Standard HS.P1U1.4
ysic	**Physical Science Essential Standards** HS Essential Standards are intended for ALL students to have learned by the		

s	end of 3 credits of high school science courses and are on the state assessment.	
	Essential HS.P2U1.5	**Learning Progressions, Key Terms and Crosscutting Concepts**
	Try to put a clean break here from chem to physics on a new page *Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic).* Connections: 4.P4U2.2, 5.P3U1.4, 7.P2U1.1, 7.P2U2.2, HS.E2U2.16	
	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics **Plus HS+Phy.P2U1.1** Plan and conduct investigations to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	
ysic s	**Essential HS.P2U3.6**	**Learning Progressions, Key Terms and Crosscutting Concepts**
	Investigate and communicate how fields (electric, gravitational, magnetic) are utilized and how they influence the structure and function of different technologies. Connections: 8.P4U1.3, HS.E2U2.16	
	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics **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.	
ysic	**Essential HS.P3U2.7**	**Learning Progressions, Key Terms and Crosscutting Concepts**

s	***Develop a mathematical model, using Newton's laws, to predict the change in motion of an object or system in <u>one dimension</u>.*** Connections: <u>6.P3U2.4, 7.P3U2.3</u>, <u>HS.E2U2.16</u>		
	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics	**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 ***two dimensions*** (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		**Learning Progressions, Key Terms and Crosscutting Concepts**
	Analyze mathematically how Newton's laws are used in engineering and technologies to create products to serve human ends.		
ysic	***HS.P4U1.9***		**Learning Progressions, Key Terms and Crosscutting Concepts**
s	*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.* *Connections: <u>7.E1U2.4</u>, <u>7.L2U2.10, 8.P4U1.3</u>*		
	Physical Science Plus	**HS+Phy.P3U3.6**	Does this + standard fit better with essential #8?

	(+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics	Design, evaluate, and refine a device that minimizes or maximizes the force on a macroscopic object during a collision.	
		HS+Phy.P4U1.7	
		Explore the graphical and mathematical relationships among the frequency, wavelength, and speed of waves traveling in various media.	This one doesn't seem to fit with an essential????
		HS+Phy.P4U1.8	
		Explore the graphical and mathematical relationships between power, current, voltage, and resistance. Connection: 4.P4U2.2	This one doesn't seem to fit with an essential???? This plus standard appears to fit better with Essential Standard HS.P4U4.10
		HS+Phy.P4U1.9	
		Analyze and interpret data to quantitatively describe changes in energy within a system and/or energy flows in and out of a system.	
ysic s	***HS.P4U4.10***		
	Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.		
	Physical Science Plus (+) Standards HS+ Standards are designed for students taking a high school physics (P) or honors physics	**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. Progression should explicitly state the word light as well as electromagnetic radiation	
		HS+Phy.P4U4.11	
		Engage in argument, from evidence, regarding the ethical, social, economic, and/or political benefits and liabilities of fission, fusion, and radioactive decay.	
		HS+Phy.P4U1.12	
		Plan and conduct investigations to determine the power and efficiency in the change of energy storage modes within various systems.	
		HS+Phy.P4U3.13	
		Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	

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, magnetics, 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.

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.

Discipline Area	**Earth and Space Science Essential Standards** HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.	**Key Concepts include but should not be limited to:**	**Earth and Space Science Plus (+) Standards** HS+ Standards are designed for students taking a high school earth and space sciences (E) course.	**Key Concepts may include those listed in the essential standards and:**

rth S c i e n c e	**HS.E1U1.11** Analyze and interpret data to determine how energy from the Sun affects weather patterns and climate. Connections: 7.E1U2.6, 8.P4U1.3, HS.P4U1.9	Ultraviolet radiation, ozone, atmospheric layers, clouds, impact of solar activity (solar flares, sunspots), climate models, Earth's angle, differential heating of land and water	**HS+E.E1U1.1** Construct an evidence-based explanation for how the Sun's energy transfers between Earth's systems.	Build upon and apply concepts from HS.E1U1.11
			HS+E.E1U1.2 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	
			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.	

Discipline Area	**Earth and Space Science Essential Standards** HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.	**Key Concepts include but should not be limited to:**	**Earth and Space Science Plus (+) Standards** HS+ Standards are designed for students taking a high school earth and space sciences (E) course.	**Key Concepts may include those listed in the essential standards and:**
Earth Science	**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	Parts that make up the four spheres, sphere interactions, interconnectedness of spheres Biogeochemical cycles: carbon, oxygen, nitrogen	**HS+E.E1U1.4** Analyze geoscience data to make the claim that dynamic interactions with Earth's surface can create feedbacks that cause changes to other Earth systems. **HS+E.E1U2.5** Develop and use a model based on the characteristics of Earth's interior to describe the cycling of matter. **HS+E.E1U1.6** Plan and conduct investigations 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.	Build upon and apply concepts from HS.E1U2.12

Discipline Area	**Earth and Space Science Essential Standards** HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.	**Key Concepts include but should not be limited to:**	**Earth and Space Science Plus (+) Standards** HS+ Standards are designed for students taking a high school earth and space sciences (E) course.	**Key Concepts may include those listed in the essential standards and:**
rth Science	**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	Systems (tectonic, hydrologic, glacial, groundwater, shoreline, (a)eolian, global air circulation); Energy (heat, chemical, radiant, nuclear, elastic, electrical); heat transfer; rock cycle, plutonic activity; time (geologic, relative, radiometric)	**HS+E.E1U1.8** Evaluate evidence of the theory of plate tectonics to explain the differences in age, structure, and composition of Earth's crust. **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. **HS+E.E1U2.10** Develop and use a model to illustrate how Earth's internal and surface processes operate over time to form, modify, and recycle continental and	Build on and apply concepts from HS.E1U2.13

			ocean floor features. **HS+E.E1U1.11** Construct an argument, based on evidence, about the impact of changes in Earth's systems on the biosphere.	
rth S c i e r c e	**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. Connections: 5.L4U4.11, 8.E1U3.7, HS.L2U4.18, HS.L2U2.24, HS.L2U4.25 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	Natural hazards include but are not limited to those which occur from a variety of systems and sources such as atmospheric, hydrologic, oceanographic, volcanologic, seismic, neotectonic Volcanic regions, warning systems	**HS+E.E1U3.12** Evaluate competing design solutions for developing, managing, and utilizing mineral resources. **HS+E.E1U4.13** 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. **HS+E.E1U4.14** Evaluate a solution to a complex problem, based on prioritized criteria and tradeoffs, that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	Build on and apply concepts from HS.E1U4.14

			HS+E.E1U4.15 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.	
ace S c i e n c e	**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	Star life cycle, Nebular theory, energy production, astronomical time periods, H-R diagram	**HS+E.E2U2.16** Develop and use a model to relate the role of nuclear fusion in the Sun's core to the life cycles of stars. **HS+E.E2U1.17** Communicate scientific ideas about the way stars, throughout their stellar stages, produce elements and energy.	Build on and apply concepts from HS.E2U4.15
ace S c i e n c e	**HS.E2U2.16** 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: 6.P3U2.4, HS.P2U1.5, HS.P2U3.6, HS.P2U2.7	Comets, asteroids, Law of Orbits, Law of Areas, Law of Periods, gravitational forces, algebraic computation, ratios	**HS+E.E2U1.18** Analyze how gravitational forces are influenced by mass, density, and radius. **HS+E.E2U1.19** Construct an explanation of how gravitational forces impact the evolution of planetary structure, surfaces, atmospheres, moons, and rings.	Build on and apply concepts from HS.E1U2.16 Refer also to HS+Phy.P3U2.3

ace Science	**HS.E2U2.17** Analyze, interpret, and critique theories related to the scale and expansion of the universe.	Scientific theories vs scientific laws, scientific investigation, phase change, theories and scientific evidence surrounding the origin of universe, Big Bang, Theory, galaxies, constellations, stars	**HS+E.E2U1.20** Analyze how the nebular theory explains solar system formation with distinct regions characterized by different types of planetary and other bodies.	Build on and apply concepts from HS.E2U2.17
			HS+E.E2U1.21 Obtain, evaluate, and communicate information about patterns of size and scale of the solar system, our galaxy, and the Universe.	
			HS+E.E2U3.22 Evaluate the impact of technology on human understanding of the formation, scale, and composition of the Universe.	

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.

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.

Discipline Area	**Life Science Essential Standards** HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.	**Key Concepts include but should not be limited to:**	**Life Science Plus (+) Standards** HS+ Standards are designed for students taking a high school Biology (B) course.	**Key Concepts may include those listed in the essential standards and:**
Ecosystems	**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	Biodiversity, habitat, pollution, harvesting of natural resources, air/water quality, diseases Biomagnification, Keystone species	**HS+B.L2U2.1** Graph and model the relationship between limiting factors and carrying capacity in ecosystems.	Limiting factors, carrying capacity
			HS+B.L2U1.2 Predict how changes to an environment impact biodiversity and carrying capacity.	Refer to standard
			HS+B.L2U3.3 Evaluate the positive and negative human impacts on ecosystems and design solutions to mitigate negative impacts.	Refer to standard
			HS+B.L4U1.4 Evaluate evidence supporting claims that changes in environmental conditions or human interventions may change species diversity in an ecosystem.	Geographic isolation, founder effect, reduction in gene flow, reproductive isolation

Ecosystems	**HS.L2U2.19** 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	Trophic level transfer efficiency, biomagnification	**HS+B.L2U2.5** Use mathematical representations to support claims for the cycling of matter and flow of energy through trophic levels in an ecosystem.	Biomass, transfer of energy, conservation of matter, 10% rule
			HS+B.L2U2.6 Model the cycling of carbon and nitrogen among the biotic and abiotic components of an ecosystem.	Conservation of carbon and nitrogen
Cells & Organisms	**HS.L1U1.20** Generate questions and/or predictions based on observations and evidence to explain cellular organization, structure, and function. Connection: 6.L1U2.15	Prokaryotes, eukaryotes, organelle structure and function, subcellular structure as it relates to life of cell	**HS+B.L1U2.7** Calculate and model the effects of surface area, volume, and cell shape on the overall rate of diffusion of nutrients and wastes.	Passive transport, hypertonic, hypotonic, isotonic

Discipline	**Life Science Essential Standards** HS Essential Standards are intended for ALL students to learn across 3 credits of high school science courses.	**Key Concepts include but should not be limited to:**	**Life Science Plus (+) Standards** HS+ Standards are designed for students taking a high school Biology (B) course.	**Key Concepts may include those listed in the essential standards and:**

Area				
Cells & Organisms	**HS.L2U2.21** Use a model to develop a scientific explanation that illustrates how photosynthesis transforms light energy into stored chemical energy. Connection: 6.L2U1.16	Chloroplasts, chlorophyll, light dependent/independent reactions	**HS+B.L2U2.8** Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.	Calvin cycle, Krebs cycle (citric acid cycle) electron transport chain, fermentation
Cells & Organisms	**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. Connections: HS.P1U2.1, HS.P1U2.2	Mitochondria, ADP/ATP, glycolysis, aerobic/anaerobic respiration,		

Cells & Organisms	**HS.L1U1.23** Construct an explanation for how organisms regulate internal functions. Connections: 7.L1U1.7, 7.L1U1.8	Negative feedback, positive feedback, homeostasis	**HS+B.L1U1.9** Analyze and interpret data which demonstrates how the properties of water impact cellular function.	Osmosis, surface tension, cohesion, adhesion, polar
			HS+B.L1U2.10 Use models to show how transport mechanisms function in cells.	Active transport, cell membrane structure, molecular structure, phagocytosis, pinocytosis, endocytosis, exocytosis
Cells & Organisms	**HS.L1U2.24** 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. Connection: 6.L1U1.14	Relate cell structure to cell purpose, organ systems	**HS+B.L1U2.11** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms (plant and animal).	Nutrient uptake, water delivery, organism movement in response to stimuli, functions at the organ system level
Cells & Or	**HS.L2U1.25** Construct an explanation demonstrating how organisms combine carbon and other atoms from the environment to form macromolecules.	Carbon, hydrogen, oxygen, nitrogen, carbohydrates, nucleic acids, lipids, proteins	**HS+B.L2U2.12** Use evidence to construct and revise an explanation regarding how bonds are broken and formed resulting in a net transfer of energy within an organism (plants and animals). L2U2.22	Specific focus on energy from food sources and oxygen L2U2.22 Application of knowledge from core and plus standards HS.L2U2.22, HS.L2U1.25, HS+B.L2U2.8

ganisms	Connections: HS.P1U2.1, HS.P1U1.2			
Cells & Organisms	**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). Connection: 8.L3U1.9	Cell cycle, replication, chromosomes, binary fission	**HS+B.L1U2.13** Construct an explanation for how cellular division (mitosis) is the process by which organisms grow and maintain complex, interconnected systems.	Differentiation)Multicellular organism, fertilized egg, daughter cells, tissues, organs
Cells & Organisms	**HS.L1U4.27** Evaluate and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.	Case studies as applicable for your community and context	**HS+B.L1U3.14** Obtain, evaluate, and communicate information related to cell abnormality that contributes to the development of new technologies.	Possible concepts to explore may include blood disorders, pacemakers, any medical inventions designed to correct

Genetics	**HS.L3U2.28** Construct an explanation of how the process of sexual reproduction contributes to genetic variation. Connection: 8.L3U1.9	Meiosis, DNA structure, RNA structure, nucleic acids, chromosomes, genes, alleles, crossing over, genotype, phenotype, monohybrid cross (Punnett square), codominant traits, X-linked traits polygenic traits	**HS+B.L3U2.15** Use mathematics and statistical probability to explain the variation and distribution of expressed traits in a population.	Hardy Weinberg, probability, dihybrid crosses (Punnett squares)
Genetics	**HS.L3U1.29** Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.	Replication, somatic, insertion, deletion, inversion, duplication, point, codon	**HS+B.L3U1.16** Construct an explanation for how the structure of DNA and RNA determine the structure of proteins that perform essential life functions.	Central dogma, protein structure (primary, secondary, tertiary)
			HS+B.L3U1.17 Analyze how mutations can lead to increased genetic variation in a population.	Advantageous/detrimental/ neutral alleles
Genetics	**HS.L3U4.30** Construct an argument, based on evidence, regarding the ethical, social, economic, and/or political implications of a current genetic technology. Connection: 8.L3U4.10	Genetically modified foods, genetic engineering, human genome project	**HS+B.L3U1.18** Define problems and design solutions regarding the ethical, social, economic, and/or political implications of a current genetic technology.	Refer to standard
Evo	**HS.L4U2.31** Obtain, evaluate, and communicate	Adaptations, genetic variation, gene flow, fitness, competition for	**HS+B.L4U1.19** Construct an explanation based on	Vestigial structures, homologous structures, fossil record

l u t i o n	evidence that describes how inherited traits in a population can lead to biological diversity.	resources and mates, artificial selection, coevolution	evidence that the process of evolution may result from natural selection.	
			HS+B.L4U2.20 Gather, evaluate, and communicate multiple lines of empirical evidence to explain the change in genetic composition of a population over successive generations.	Classification, cladogram, dichotomous keys, natural selection, hybridization, mutation, inbreeding, genetic drift, phylogeny

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.P1U1.4 HS+C.P1U1.1 HS+C.P1U1.4 HS+C.P1U1.7 HS+C.P1U1.9	HS.P1U2.1 HS+C.P1U2.3 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.P4U1.9 HS+Phy.P4U1.12		HS+Phy.P4U3.10 HS+Phy.P4U3.13	HS.P4U4.10 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
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.E2U2.16 HS.E2U2.17 HS+E.E2U2.16	HS+E.E2U3.22	

	HS+E.E2U1.19 HS+E.E2U1.20 HS+E.E2U1.21			
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 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 *A Framework for K-12 Science Education*[1] 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 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 *A Framework for K-12 Science Education*[4] are critical components of scientific literacy. They are not instructional strategies.

Distinguishing Science & Engineering Practices

	Science	Engineering
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	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

	and determine what questions have yet to be satisfactorily answered.	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.

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 hand.
Obtain, Evaluate,	Science cannot advance if scientists are unable to	Engineers cannot produce new or improved technologies

and Communicate Information	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.	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.

[4]Adapted 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.
P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to	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

another during an event.	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 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.
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.

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 4: Interdisciplinary Connections

The crosscutting concepts and 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 a context for helping students master key competencies from other content areas while promoting 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. 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
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.

Commented [4]: add metrics?

Commented [5]: No it is math standards and per 6/13 would put in grade band

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.

Appendix 5: 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 communities[4].

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 discourse[6]. 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 ways[7]. Science teachers need to acquire effective strategies to include all students regardless of age, racial, ethnic, cultural, linguistic, socioeconomic, and gender backgrounds[3].

Effective teaching strategies[3] 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 connections[8].
- **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 6: Connections to Other Academic Disciplines

Kindergarten - 2nd Grade

	Kindergarten	1st Grade	2nd Grade
Arizona English Language Arts	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		
Arizona Mathematics Standards	**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	**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	**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 -Measure the length of an object using an appropriate tool including metrics.

See also Appendix 4

3rd Grade - 5th Grade

	3rd Grade	4th Grade	5th Grade
Arizona English Language Arts	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		
Arizona Mathematics Standards	**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 **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** -Measure and estimate liquid volumes and masses of objects using metric units -Solve problems involving measurement -Represent and interpret data	**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** -Use place value understanding and properties of operations to perform multi-digit arithmetic **Number and Operations in Base Ten** **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 using metrics -Represent and interpret data	**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 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** -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 using metrics -Solve problems involving measurement using metrics -Geometric measurement; understand concepts of volume and relate volume to multiplication and division.

6th Grade - 8th Grade

	6th Grade	7th Grade	8th Grade
Arizona English Language Arts	Use age-appropriate scientific texts and biographies to develop instruction surrounding the Reading Standards for Informational 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		
Arizona Mathematics Standards	**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

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
  - 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 heath 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
  - See also Appendix 4

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

fe 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 heath

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 8

Commented [6]: add in metrics

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 heath

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

References

[1]Barkman, R.C. (2000, November). *Patterns, the Brain, and Learning*. Retrieved February 16, 2018, from http/www.ascd.org/publications/classroom-leadership/nov2000/Patterns,-the-Brain,-and-Learning.aspx.

[2]Harlen, W. (2015) *Working with Big Ideas of Science Education*. Global Network of Science Academies (IAP) Science Education Programme: Trieste, Italy.

[3] Lee, O., & Buxton, C. A. (2010). *Diversity and equity in science education: Theory, research, and practice.* New York: Teachers College Press.

[4] National Research Council (NRC). (2012). *A Framework for K-12 Science Education: Practices, crosscutting concepts, and core ideas.* Washington, DC: The National Academies Press.

[5] NGSS Lead States. (2013) *Next Generation Science Standards: For States, By State*s. Appendix D Case Studies. Washington, DC: The National Academies Press.

[6] Quinn H., Lee O., Valdés G. (2012). Language demands and opportunities in relation to next generation science standards for English language learners: What teachers need to know. Paper presented at the Understanding Language Conference, Stanford, CA. Retrieved November 15, 2017 from http://ell.stanford.edu/sites/default/files/pdf/academic-papers/03-Quinn%20Lee%20Valdes%20Language%20and%20Opportunities%20in%20Science%20FINAL.pdf

[7] Rodriguez, A. J., & Berryman, C. (2002). Using sociotransformative constructivism to teach for understanding in diverse classrooms: A beginning teacher's journey. *American Educational Research Journal, 39*, 1017-1045.

[8] Spang, M. & Bang, C. A. (2014) *Practice Brief #11: Implementing Meaningful STEM Education with Indigenous Students & Families*. Retrieved November 15, 2017 from http://stemteachingtools.org/brief/11.

National Science Teachers Association. (2015, October). *National Science Teachers Association.* Retrieved June 13, 2018, from NSTA Position Statement: Safety and School Science Instruction: http://www.nsta.org/about/positions/safety.aspx
(citation for safety expectations)