The MPS Quick-Reference Guide to the

AzSS

K-12

mesa PUBLIC SCHOOLS

CHAPTER 3: STANDARDS AND CORE IDEA ELEMENTS AS IDENTIFIED BY MPS

Grade K

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard K.P2U1.1 Investigate how senses can detect light, sound, and vibrations even when they come from far away; use the collected evidence to develop and support an explanation.	• People use their senses to learn about the world around them. • Their eyes detect light, their ears detect sound, and they can feel vibrations by touch. • 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.
Az Science Standard K.P2U2.2 Design and evaluate a tool that helps people extend their senses.	• People also use a variety of devices to communicate (send and receive information) over long distances. • Objects that are seen either give out or reflect light that human eyes can detect. • Sounds are heard when the vibrations in the air enter our ears. • Designs can be conveyed through sketches, drawings, or physical models. • There is always more than one possible solution to a problem, so it is useful to compare designs, test them, and discuss their strengths and weaknesses.
Az Science Standard K.E1U1.3 Observe, record, and ask questions about temperature, precipitation, and other weather data to identify patterns or changes in local weather. **Az Science Standard K.E1U1.4** Observe, describe, ask questions, and predict seasonal weather patterns; and how those patterns impact plants and animals (including humans).	• 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.

Az Science Standard K.E2U1.5 Observe and ask questions about patterns of the motion of the Sun, Moon, and stars in the sky. Note: There is a strong connection between the use of tools like the telescope and the extension of the senses learned in Unit 1 Sequence 2: K.P2U2.2.	• Patterns of the motion of the Sun, Moon, and stars in the sky can be observed, described, and predicted. • At night one can see the light coming from many stars with the naked eye, but telescopes make it possible to see many more and to observe them and the Moon and planets in greater detail.
Az Science Standard K.L1U1.6 Obtain, evaluate, and communicate information about how organisms use different body parts for survival. **Az Science Standard K.L1U1.7** Observe, ask questions, and explain how specialized structures found on a variety of plants and animals (including humans) help them sense and respond to their environment.	• All organisms have external parts. • Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. • 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 senses with behaviors that help them survive (e.g., find food, run from a predator) • Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive, grow, and produce more plants.
Science Standard K.L2U1.8 Observe, ask questions, and explain the difference between the characteristics of living and non-living things.	• There is a wide variety of living things (organisms), including plants and animals. • Living things are distinguished from non-living things by their ability to move, reproduce, and react to certain stimuli.

Grade 1

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard 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. Note: Stress that light can be multiple sources, i.e., Sun, flashlight, lightbulb, candle	• some materials allow light to pass through them, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them (i.e., on the other side from the light source), where the light cannot reach. • Mirrors and prisms can be used to redirect a light beam. • Light and sound are wavelike phenomena
Az Science Standard 1.P2U1.2 Use models to provide evidence that vibrating matter creates sound and sound can make matter vibrate. Note: Experience and define vibration. Experience and define matter	• Light and sound are wavelike phenomena. • Sound can make matter vibrate, and vibrating matter can make sound.
Az Science Standard 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. Note: Students will need to understand the term "force".	• 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.
Az Science Standard 1.P4U2.4 Design and evaluate ways to increase or reduce heat from friction between two objects.	• When two objects rub against each other, this interaction is called friction. • Friction between two surfaces can warm both of them (i.e., rubbing hands together). • There are ways to reduce the friction between two objects. • Designs can be conveyed through sketches, drawings, or physical models.
Az Science Standard 1.E1U1.5 Obtain, evaluate, and communicate information about the properties of Earth materials and investigate how people use natural resources.	• 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. • People 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 tools.
Az Science Standard 1.L1U1.6 Observe, describe, and predict life cycles of animals and plants. Note: Identify the parts of the life cycle. Model and explain how to make a prediction.	• Plants and animals have predictable characteristics at different stages of development. • Plants and animals grow and change. • Adult plants and animals can have young.

Az Science Standard 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. **Az Science Standard 1.L2U1.8** Construct an explanation describing how organisms obtain resources from the environment including materials that are used again by other organisms.	• Animals depend on their surroundings to get what they need, including food, water, shelter, and a favorable temperature. Animals depend on plants or other animals for food. • Designs can be conveyed through sketches, drawings, or physical models. • Because there is always more than one possible solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weaknesses. • They use their senses to find food and water, and they use their body parts to gather, catch, eat, and chew the food. Plants depend on air, water, minerals (in the soil), and light to grow. • Animals can move around, but plants cannot, and they often depend on animals for pollination or to move their seeds around. • Animals need food that they can break down, which comes either directly by eating plants (herbivores) or by
Az Science Standard 1.L3U1.9 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.	• Organisms have characteristics that can be similar or different. • Plants and animals, including humans, resemble their parents in many features because information is passed from one generation to the next. • Living things produce offspring of the same kind, but offspring are not identical with each other or with their parents. • Young animals are very much, but not exactly, like their parents and also resemble other animals of the same kind. • Plants also are very much, but not exactly, like their parents and resemble other plants of the same kind.
Az Science Standard 1.L4U1.10 Develop a model to describe how animals and plants are classified into groups and subgroups according to their similarities.	• Animals and plants are classified into groups and subgroups according to their similarities.
Az Science Standard 1.L4U3.11 Ask questions and explain how factors can cause species to go extinct.	• There are many different kinds of plants and animals in the world today and many kinds that once lived but are now extinct. These are evident from their fossils. • Some kinds of plants and animals that once lived on Earth (e.g., dinosaurs) are no longer found anywhere, although others now living (e.g., lizards) resemble them in some ways.

Grade 2

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard 2.P1U1.1 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 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. • Different kinds of matter exist (i.e., wood, metal, water).
Az Science Standard 2.P1U1.2 Plan and carry out investigations to gather evidence to support an explanation on how heating or cooling can cause a phase change in matter.	• Different materials are recognizable by their properties, some of which are used to classify them as being in the solid, liquid or gas state. • Different kinds of matter exist (e.g., wood, metal, water), and many of them can be either solid or liquid, depending on temperature
Az Science Standard 2.P4U1.3 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.
Az Science Standard 2.E1U1.4 Observe 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. It carries soil and rocks from one place to another and determines the variety of life forms that can live in a particular location. • Resulting landforms together with the materials on land determine the variety of life forms that can live in a particular location.
Az Science Standard 2.E1U1.5 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 is found in the ocean, rivers, lakes, and ponds. • Water exists as solid ice and in liquid form.
Az Science Standard 2.E1U2.6 Analyze patterns in weather conditions of various regions of the world and design, test, and refine solutions to protect people from severe weather conditions.	• 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. • Designs can be conveyed through sketches, drawings, or physical models. • Because there is always more than one possible solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weaknesses.
Az Science Standard 2.E1U3.7 Construct an argument (explanation) from evidence regarding positive and negative changes in water and land systems that impact people 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 (i.e., the shape of land, the flow of water). • People 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 extracted from Earth to make cooking pans. • Things that people do to live comfortably can affect the world around them, but they can make choices that reduce their impacts on the land, water, air, and other living things—for example, by reducing trash through reuse and recycling.
Az Science Standard 2.E2U1.8 Observe and explain the Sun's position at different times during a twenty-four-hour period and changes in the apparent shape of the Moon from one night to another.	• 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.
Az Science Standard 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.
Az Science Standard 2.L2U1.10 Develop a model representing how life on Earth depends on energy from the Sun and energy from other organisms.	• 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.

Grade 3

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard 3.P2U1.1 Ask questions and investigate the relationship between light, objects, and the human eye.	• Sources give out light, which travels from them in various directions and is detected when it reaches and enters our eyes. • Light is seen because it affects the objects it reaches, including our eyes. • Objects that are seen either give out or reflect light that human eyes can detect. • The color humans see depends on the color of the available light sources as well as the properties of the surface. • Because lenses bend light beams, they can be used, singly or in combination, to provide magnified images of objects too small or too far away to be seen with the naked eye.
Az Science Standard 3.P2U1.2 Plan and carry out an investigation to explore how sound waves affect objects at varying distances. Note: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.	• Sounds are heard when the vibrations in the air enter our ears. • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). • Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other.
Az Science Standard 3.P4U1.3 Develop and use models to describe how light and sound waves transfer energy. Note: At this grade level, no attempt is made to give a precise or complete definition of 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. (Note: At this grade level, no attempt is made to give a precise or complete definition of energy.) • Energy is present whenever there are moving objects, sound, light, or heat. • When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. • Light also transfers energy from place to place. For example, energy radiated from the Sun is transferred to Earth by light. • When this light is absorbed, it warms Earth's land, air, and water and facilitates plant growth.
Az Science Standard: 3.E1U1.4 Construct an explanation describing how the Sun is the primary source of energy impacting Earth systems.	• All Earth processes are the result of energy flowing and matter cycling within and among the Earth's systems. • This energy originates from the Sun and from Earth's interior. • 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.
Az Science Standard 3.L1U1.5 Develop and use models to explain that plants and animals (including humans) have internal and external structures that serve various functions that aid in growth, survival, behavior, and reproduction.	• Animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. • Animals (humans) have both internal and external structures that serve various functions in growth, survival, and behavior.
Az Science Standard 3.L2U1.6 Plan and carry out investigations to demonstrate ways plants and animals react to stimuli. Note: This Learning Sequence will focus on plants. Focus is on understanding the macroscale systems and their function, not microscopic processes.	• 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.
Az Science Standard 3.L2U1.7 Develop and use system models to describe the flow of energy from the Sun to and among living organisms. **Az Science Standard 3.L2U1.8** Construct an argument from evidence that organisms are interdependent.	• The food of almost any kind of animal can be traced back to plants. • Organisms are related in food webs in which some animals eat plants. • Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." • A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. • Organisms obtain gases, water, and minerals from the environment and release waste matter (gas, liquid, or solid) back into the environment. (Simple photosynthesis)

Grade 4

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard 4.P4U1.1 Develop and use a model to demonstrate how a system transfers energy from one object to another even when the objects are not touching.	• The faster a given object is moving, the more energy it possesses. • Energy can be moved place to place by moving objects, or through sound, light, or electric currents. Note: At this grade level, no attempt is made to give a precise or complete definition of energy.
Az Science Standard 4.P4U1.2 Develop and use a model that explains how energy is moved from place to place through electric currents.	• Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. • The currents may have been produced to begin with by transforming the energy of motion into electrical energy (e.g., moving water drives a spinning turbine which generates electric currents).
Az Science Standard 4.P2U1.3 Develop and use a model to demonstrate magnetic forces	• Objects in contact exert forces on each other (elastic pushes and pulls). • Magnetic forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. • The sizes of the forces in each situation depends on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.
Az Science Standard 4.P4U3.4 Engage in an argument from evidence on the use and impact of renewable and nonrenewable resources to generate electricity	• Electric power generation is based on fossil fuels (i.e., coal, oil, and natural gas), nuclear fission, or renewable resources (e.g., solar, wind, tidal, geothermal, and hydro power). • Transportation today chiefly depends on fossil fuels, but the use of electric and alternative fuel (e.g., hydrogen, biofuel) vehicles is increasing. • All forms of electricity generation and transportation fuels have associated economic, social, and environmental costs and benefits, both short and long term. • Technological advances and regulatory decisions can change the balance of those costs and benefits. • All materials, energy, and fuels that people use are derived from natural sources, and their use affects the environment in multiple ways. • Some resources are renewable over time, and others are not.
Az Science Standard 4.E1U1.5 Use models to explain seismic waves and their effect on the Earth. Note: At this level, students are to understand that earthquakes are evidence of change and can shape Earth. Wave	• Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. • Earthquakes cause seismic waves, which are waves of motion in Earth's crust.

properties are not covered in detail. "Seismic" is not defined.	
Az Science Standard 4.E1U1.6 Plan and carry out an investigation to explore and explain the interactions between Earth's major systems and the impact on Earth's surface materials and processes	• 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.
Az Science Standard 4.E1U1.7 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. Note: At this level, fossils will be examined in different rock layers/types to understand changes in Earth's landscape over time. Rock types are not covered in detail.	• Rainfall helps shape the land and affects the types of living things found in a region. • Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. • Human activities affect Earth's systems and their interactions at its surface. • 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. • The presence and location of certain fossil types indicate the order in which rock layers were formed. • The downhill movement of water as it flows to the ocean shapes the appearance of the land.
Az Science Standard 4.E1U1.8 Collect, analyze, and interpret data to explain weather and climate patterns.	• Weather is the minute-by-minute to day-by-day variation of the atmosphere's condition on a local scale. • Climate describes the ranges of an area's typical weather conditions and the extent to which those conditions vary over years to centuries. • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).
Az Science Standard 4.E1U3.9 Construct and support an evidence-based argument about the availability of water and its impact on life.	• 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. • Nearly all of Earth's available water is in the ocean. • Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.
Az Science Standard 4.E1U2.10 Define problem(s) and design solution(s) to minimize the effects of natural hazards. Note: Examples of design solutions to weather related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.	• People cannot eliminate natural hazards but can take steps to reduce their impacts. • Possible solutions to a problem are limited by available materials and resources (constraints). • The success of a designed solution is determined by considering the desired features of a solution (criteria).

Az Science Standard 4.L4U1.11 Analyze and interpret environmental data to demonstrate that species either adapt and survive or go extinct over time. Note: Provide a basic definition of "species" for student context.	• When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. • 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. • Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful.

Grade 5

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard 5.P1U1.1 Analyze and interpret data to explain that matter of any type can be subdivided into particles too small to see and, in a closed system, if properties change or chemical reactions occur, the amount of matter stays the same.	• Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. For example, a model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects (e.g., leaves in wind, dust suspended in air); and the appearance of visible scale water droplets in condensation, fog, and, by extension, also in clouds or the contrails of a jet. • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. • 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.
Az Science Standard 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.	• When two or more different substances are mixed, a new substance with different properties may be formed; such occurrences depend on the substances and the temperature. • No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Note: Mass and weight are not distinguished at this grade level.) • Other substances simply mix without changing permanently and can often be separated again.
Az Science Standard 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 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. This downward attraction is called the weight of an object. • 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.
Az Science Standard 5.P3U1.4 Obtain, analyze, and communicate evidence of the effects that balanced and unbalanced forces have on the motion of objects.	• Each force acts on one particular object and has both a strength and a direction. • An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. • Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Note: Qualitative and

	conceptual, but not quantitative addition of forces are used at this level.) • The patterns of an object's motion in various situations can be observed and measured; when past motion exhibits a regular pattern, future motion can be predicted from it. • 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 and pull at a distance.
Az Science Standard 5.P3U2.5 Define problems and design solutions pertaining to force and motion.	• 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.
Az Science Standard 5.P4U1.6 Analyze and interpret data to determine how and where energy is transferred when objects move.	• The faster a given object is moving, the more energy it possesses. • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. • Energy is present whenever there are moving objects, sound, light, or heat. • Light also transfers energy from place to place. • Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. • The currents may have been produced to begin with by transforming the energy of motion into electrical energy (e.g., moving water driving a spinning turbine which generates electric currents).
Az Science Standard 5.E2U1.7 Develop, revise, 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. • The orbits of Earth around the Sun and of the Moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns.
Az Science Standard 5.E2U1.8 Obtain, analyze, and communicate evidence to support an explanation that	• 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.

the gravitational force of Earth on objects is directed toward the planet's center.	• On the Earth it results in everything being pulled down towards the center of the Earth. This downward attraction is called the weight of an object. • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.
Az Science Standard 5.L3U1.9 Obtain, evaluate, and communicate information about patterns between the offspring of plants, and the offspring of animals (including humans); construct an explanation of how genetic information is passed from one generation to the next.	• Many characteristics of organisms are inherited from their parents. • Offspring acquire a mix of traits from their biological parents. • Different organisms vary in how they look and function because they have different inherited information. • In each kind of organism there is variation in the traits themselves, and different kinds of organisms may have different versions of the trait. • Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. • Many characteristics involve both inheritance and environment.
Az Science Standard 5.L3U1.10 Construct an explanation based on evidence that the changes in an environment can affect the development of the traits in a population of organisms.	• The environment 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. • When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.
Az Science Standard 5.L4U3.11 Obtain, evaluate, and communicate evidence about how natural and human-caused changes to habitats or climate can impact populations.	• 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. • Scientists have identified and classified many plants and animals. • Populations of organisms live in a variety of habitats and change in those habitats affects the organisms living there. • Humans, like all other organisms, obtain living and non-living resources from their environments.
Az Science Standard 5.L4U3.12 Construct an argument based on evidence that inherited characteristics can be affected by behavior and/or environmental conditions.	• Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. • 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.

Grade 6

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard 6.P1U1.1 Analyze and interpret data to show that changes in the states of matter are caused by different rates of movement of atoms in solids liquids, and gases (Kinetic Theory). **Az Science Standard 6.P1U1.2** Plan and carry out an investigation to demonstrate that variations in temperature and/or pressure affect changes in state of matter.	• The differences between substances in the solid, liquid or gas state can be explained in terms of the speed and range of the movement of particles and the separation and strength of the attraction between neighboring particles. • The properties of different materials can be explained in terms of the behavior of atoms and groups of atoms of which they are made. • All the particles of a particular substance are the same and different from those of other substances. • The particles are not static but move in random directions. • The speed at which they move is experienced as the temperature of the material.
Az Science Standard 6.P1U1.3 Develop and use models to represent that matter is made up of smaller particles called atoms.	• If a substance could be divided into smaller and smaller pieces it would be found to be made of very, very small particles, smaller than can be seen even with a microscope. These particles are not in a substance; they are the substance. • All materials, anywhere in the universe, living and non-living, are made of a very large number of basic 'building blocks' called atoms, of which there are about 100 different kinds.
Az Science Standard 6.P2U1.4 Develop and use a model to predict how forces act on objects at a distance.	• Gravity is the universal attraction between all objects, however large or small, although it is only apparent when one of the objects is very large. • This gravitational attraction keeps the planets in orbit around the Sun, the Moon round the Earth and their moons round other planets. • The 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.
Az Science Standard 6.P4U2.5 Analyze how people use technology to store (potential) and/or use (kinetic) energy.	• 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. • Motion energy is properly called kinetic energy. • A system of objects may also contain stored (potential) energy, depending on their relative positions.
Az Science Standard 6.E1U1.6 Investigate and construct an explanation demonstrating that radiation from the Sun provides energy and is absorbed to warm the Earth's surface and atmosphere.	• 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.
Az Science Standard 6.E2U1.7 Use ratios and proportions to analyze and interpret data related to scale, properties, and relationships among objects in our solar system.	• The Earth is one of eight (so far known) planets in our solar system which, along with many other smaller bodies, orbit the Sun, in roughly circular paths, at different distances from the Sun and taking different times to complete an orbit. • The distances between these bodies are huge – Neptune is 4.5 billion km from the Sun, 30 times further than Earth. • As seen from Earth, planets move in relation to the positions of the stars which appear fixed relative to each other.
Az Science Standard 6.E2U1.8 Develop and use models to explain how constellations and other night sky patterns appear to move due to Earth's rotation and revolution.	• 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 around the Sun.
Az Science Standard 6.E2U1.9 Develop and use models to construct an explanation of how eclipses, Moon phases, and tides occur within the Sun-Earth-Moon system	• 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.
Az Science Standard 6.E2U1.10 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.	• 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. • 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.
Az Science Standard 6.L2U3.11 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. **Az Science Standard 6.L2U3.12** Engage in argument from evidence to support a claim about the factors that cause species to change and how people can impact those factors. **Az Science Standard 6.L2U1.13** Develop and use models to demonstrate the interdependence of organisms and their environment including biotic and abiotic factors.	• 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 grow, so the molecules in the organisms are constantly re-used. • In any given ecosystem, there is competition among species for the energy resources and the materials they need to live. • 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. 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. • Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms.

Az Science Standard 6.L2U1.14 Construct a model that shows the cycling of matter and flow of energy in ecosystems	• 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. • The persistence of an ecosystem depends on the continued availability in the environment of these energy resources and materials. • A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life.

Grade 7

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard 7.P2U1.1 Collect and analyze data demonstrating how electromagnetic forces can be attractive or repulsive and can vary in strength. **Az Science Standard 7.P2U1.2** Develop and use a model to predict how forces act on objects at a distance.	• Electric and magnetic 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. • Forces that act at a distance can be explained by force fields that extend through space and can be mapped by their effect on a test object • Gravitational forces are always attractive.
Az Science Standard 7.P3U1.3 Plan and carry out an investigation that can support an evidence-based explanation of how objects on Earth are affected by gravitational force.	• 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. • Forces that act at a distance [gravitational] can be explained by force fields that extend through space and can be mapped by their effect on a test object (e.g., a ball). • On Earth, it [gravity] results in everything being pulled down towards the center of the Earth. This downward attraction is called 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, people observe the resulting motion of the object, not of the Earth.
Az Science Standard 7.P3U1.4 Use non-algebraic mathematics and computational thinking to explain Newton's laws of motion.	• For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first but in the opposite direction. • The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. • The greater the mass of the object, the greater the force needed to achieve the same change in motion. • For any given object, a larger force causes a larger change in motion. Forces on an object can also change its shape or orientation.
Az Science Standard 7.E1U1.5 Construct a model that shows the cycling of matter and flow of energy in the atmosphere, hydrosphere, and geosphere.	• 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. • Radioactive decay of material inside the Earth since it was formed is its internal source of energy.

Az Science Standard 7.E1U1.6 Construct a model to explain how the distribution of fossils and rocks, continental shapes, and seafloor structures provide evidence of 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.
Az Science Standard 7.E1U2.7 Analyze and interpret data to construct an explanation for how advances in technology have improved weather prediction.	• Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. • 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. • 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. • 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.
Az Science Standard 7.L1U1.8 Obtain, evaluate, and communicate information to provide evidence that all living things are made of cells, cells come from existing cells, and cells are the basic structural and functional unit of all living things. **Az Science Standard 7.L1U1.9** Construct an explanation to demonstrate the relationship between major cell structures and cell functions (plant and animal). Note: in this grade level, the major cell structures will be identified as the nucleus, chloroplasts, mitochondria, cell membrane and cell wall.	• 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 are often aggregated into tissues, tissues into organs, and organs into organ systems.
Az Science Standard 7.L1U1.10 Develop and use a model to explain how cells, tissues, and organ systems maintain life (animals). **Az Science Standard 7.L1U1.11** Construct an explanation for how organisms maintain internal stability and evaluate the effect of the external factors on organisms' internal stability.	• Cells divide to replace aging cells and to make more cells in growth and in reproduction. • Cells are often aggregated into tissues, tissues into organs, and organs into organ systems. • Organisms range in composition from a single cell (unicellular microorganisms) to multicellular organisms, in which different groups of large number of cells work together to form systems of tissues and organs (e.g. circulatory, respiratory, nervous, musculoskeletal, digestive), that are specialized for particular functions.

	• 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. • In the human body, systems carry out such key functions as respiration, digestion, elimination of waste and temperature control. • Both single cell and multi-cellular organisms have mechanisms to maintain temperature and acidity within certain limits that enable the organism to survive. • Organisms respond to stimuli from their environment and actively maintain their internal environment through homeostasis.
Az Science Standard 7.L2U1.12 Construct an explanation for how some plant cells convert light energy into food energy.	• In most cases, the energy needed for life is ultimately derived from the Sun through photosynthesis (although in some ecologically important cases, energy is derived from reactions involving inorganic chemicals in the absence of sunlight e.g. chemosynthesis). • Plants, algae (including phytoplankton), and other energy-fixing microorganisms use sunlight, water and carbon dioxide to facilitate photosynthesis, which stores energy (sugar), forms plant matter, releases oxygen, and maintains plants' activities. • These sugars can be used immediately or stored for growth or later use. • Food is the energy source they need in order to carry out these and other functions [cellular, homeostasis].

Grade 8

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard 8.P1U1.1 Develop and use a model to demonstrate 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. **Az Science Standard 8.P1U1.2** Obtain and evaluate information regarding how scientists identify substances based on unique physical and chemical properties.	• 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. • Substances react chemically in characteristic ways. • In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. • The total number of each type of atom is conserved, and thus the mass does not change.
Az Science Standard 8.P4U1.3 Construct an explanation on how energy can be transferred from one energy store to another.	• 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. • 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.
Az Science Standard 8.P4U1. 4 Develop and use mathematical models to explain wave characteristics and interactions.	• A sound wave needs a medium through which it is transmitted. • A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.
Az Science Standard 8.P4U2. 5 Develop a solution to increase efficiency when transferring energy from one source to another.	• 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 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.
Az Science Standard 8.E1U1.6 Analyze and interpret data about the Earth's geological column to communicate relative ages of rock layers and fossils. Note: Plate tectonics covered in depth in previous grade level. A basic understanding that the Earth moves is needed to understand rock layers.	• 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 movement are responsible for most continental and ocean floor features and for the distribution of most rocks and minerals within Earth's crust. • 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.
Az Science Standard 8.E1U3.7 Obtain, evaluate, and communicate information about data and historical patterns to predict natural hazards and other geological events.	• By tracking the upward movement of magma, for example, volcanic eruptions can often be predicted with enough advance warning to allow neighboring regions to be evacuated. • Earthquakes, in contrast, occur suddenly; the specific time, day, or year cannot be predicted. • However, the history of earthquakes in a region and the mapping of fault lines can help forecast the likelihood of future events. • Finally, satellite monitoring of weather patterns, along with measurements from land, sea, and air, usually can identify developing severe weather and lead to its reliable forecast.
Az Science Standard 8.E1U3.8 Construct and support an argument about how human consumption of limited resources impacts the biosphere.	• Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing extinction of many other species. • But changes to Earth's environment can have different impacts (negative and positive) for different living things. • Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Az Science Standard 8.L3U1.9 Construct an explanation of how genetic variations occur in offspring through the inheritance of traits or through mutations. Note: Emphasis is on using data to support explanations for the way variation occurs. At this grade level, do not include the phases of meiosis or the biochemical mechanism of specific steps in the process.	• Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. • Each distinct gene chiefly controls the production of a specific protein, which in turn affects the traits of the individual. • Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. • Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited or (more rarely) from mutations. (Note: The stress here is on the impact of gene transmission in reproduction, not the mechanism.) • Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent, randomly. These versions may be identical or may differ from each other. • Though rare, mutations may result in changes to the structure and function.
Az Science Standard 8.L3U3.10 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.	• Note: there is no research in A Framework for K-12 Science Education or Working with Big Ideas in Science Education supporting this standard
Az Science Standard 8.L4U1.11 Develop and use a model to explain how natural selection may lead to increases and decreases of specific traits in populations over time. **Az Science Standard 8.L4U1.12** Gather and communicate evidence of how the process of natural selection provides an explanation of how new species can evolve. Note: Focus how natural selection and other factors leads to speciation and therefore an increase in biodiversity.	• Genetic variations among individuals in a population give some individuals an advantage in surviving and reproducing in their environment. This is known as natural selection. • It [natural selection] leads to the predominance of certain traits in a population and the suppression of others. • Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. • Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. • In artificial selection, people have the capacity to influence certain characteristics of organisms by selective breeding. • One can choose desired parental traits determined by genes, which are then passed on to offspring. • In separated populations with different conditions, the changes can be large enough that the populations, provided they remain separated (a process called reproductive isolation), evolve to become separate species.

	• Biodiversity is the wide range of existing life forms that have adapted to the variety of conditions on Earth, from terrestrial to marine ecosystems. • Biodiversity includes genetic variation within a species, in addition to species variation in different habitats and ecosystem types (e.g., forests, grasslands, wetlands). • Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.

P1 High School Essential Standards

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard Essential HS.P1U1.1 Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed in the Periodic Table and describe how these models are revised with new evidence. **Az Science Standard Essential HS.P1U1.2** Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.	• Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. • The repeating patterns of this table reflect patterns of outer electron states.
Az Science Standard Essential HS.P1U1.3 Ask questions, plan, and carry out investigations to explore the cause and effect relationship between reaction rate factors	• Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, that are matched by changes in kinetic energy. • In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. • The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.
Az Science Standard Essential HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications	• Scientific understanding can help to identify implications of certain applications but decisions about whether certain actions should be taken will require ethical and moral judgements which are not provided by knowledge of science. • There is an important difference between the understanding that science provides about, for example, the need to preserve biodiversity, the factors leading to climate change and the adverse effects of harmful substances and lifestyles, and the actions that may or may not be taken in relation to these issues. • Opinions may vary about what action to take but arguments based on scientific evidence should not be a matter of opinion.

P2 High School Essential Standards

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard Essential HS.P2U1.5 Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic).	• Newton's law of universal gravitation provides the mathematical models to describe and predict the effects of gravitational distant objects. • Forces at a distance are explained by fields permeating space that can transfer energy through space.

P3 High School Essential Standards

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard Essential HS.P3U1.6 Collect, analyze, and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws.	• Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. • In any system, total momentum is always conserved. • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
Az Science Standard Essential HS.P3U2.7 Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends.	• The application of science in making new materials is an example of how scientific knowledge has led advances in technology and provided engineers with a wider choice in designing constructions. • At the same time technological advances have helped scientific developments by improving instruments for observation and measuring, automating processes that might otherwise be too dangerous or time consuming to undertake, and particularly through the provision of computers. • Thus, technology aids scientific advances which in turn can be used in designing and making things for people to use

P4 High School Essential Standards

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard Essential HS.P4U1.8 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.	• Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. • The availability of energy limits what can occur in any system. • Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. • That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. • "Chemical energy" generally is used to mean the energy that can be released or stored in chemical processes.
Az Science Standard Essential HS.P4U3.9 Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.	• Across the world, the demand for energy increases as human populations grow and because modern lifestyles require more energy, particularly in the convenient form of electrical energy. • Therefore other ways of generating electricity have to be sought, whilst reducing demand and improving the efficiency of the processes in which we use it.
Az Science Standard Essential HS.P4U1.10 Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.	• The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. • Resonance is a phenomenon in which waves add up in phase in a structure, growing in amplitude due to energy input near the natural vibration frequency. Structures have particular frequencies at which they resonate. This phenomenon (e.g., waves in a stretched string, vibrating air in a pipe) is used in speech and in the design of all musical instruments. • All electromagnetic radiation travels through a vacuum at the same speed, called the speed of light. Its speed in any other given medium depends on its wavelength and the properties of that medium.

	• When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). • Photovoltaic materials emit electrons when they absorb light of a high-enough frequency. • Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them

E1 High School Essential Standards

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard Essential HS.E1U1.11 Analyze and interpret data to determine how energy from the Sun affects weather patterns and climate. Note: In this course, climate change will be discussed through geological evidence and historical data. Human impact on climate is discussed in HS.E1U3.14 in Biology SC49	• Weather, which varies from day to day and seasonally throughout the year, is the condition of the atmosphere at a given place and time. • Climate is longer term and location sensitive; it is the range of a region's weather over 1 year or many years, and, because it depends on latitude and geography, it varies from place to place. • The foundation for Earth's global climate system is the electromagnetic radiation from the Sun as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems and this energy's reradiation into space. • When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). • Climate change can occur when certain parts of Earth's systems are altered. • Geological evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere; longer term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis; or even more gradual atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years.
Az Science Standard Essential HS.E1U1.12 Develop and use models of the Earth that explains the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere).	• Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. • These properties include water's exceptional capacity to absorb, store, and release large amounts of energy; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of rocks. • A model of Earth has a hot but solid inner core, a liquid outer core, a solid mantle, and crust. • The top part of the mantle, along with the crust, forms structures known as tectonic plates.
Az Science Standard Essential HS.E1U1.13 Evaluate explanations and theories about the role of energy and matter in geologic changes over time.	• Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and the gravitational movement of denser materials toward the interior. • The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual coevolution of Earth's surface and the life that exists on it.

	• Beneath the Earth's solid crust is a hot layer called the mantle. The mantle is solid when under pressure but melts (and is called magma) when the pressure is reduced. • In some places there are cracks (or thin regions) in the crust which can allow magma to come to the surface, for example in volcanic eruptions. • The Earth's crust consists of a number of solid plates which move relative to each other, carried along by movements of the mantle. • Where plates collide, mountain ranges are formed and there is a fault line along the plate boundary where earthquakes are likely to occur and there may also be volcanic activity. • Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time. • Continental rocks, which can be older than 4 billion years, are generally much older than rocks on the ocean floor, which are less than 200 million years old. • Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches.
Essential HS.E1U3.14 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.	• Historically, humans have populated regions that are climatically, hydrologically, and geologically advantageous for freshwater availability, food production via agriculture, commerce, and other aspects of civilization. • Resource availability affects geopolitical relationships and can limit development. • Much energy production today comes from nonrenewable sources, such as coal and oil. • However, advances in related science and technology are reducing the cost of energy from renewable resources, such as sunlight. • As a result, future energy supplies are likely to come from a much wider range of sources.

E2 High School Essential Standards

STANDARD	CORE IDEA ELEMENTS ***Elements:*** *Components of A Framework for K-12 Science Education and Working with Big Ideas of Science Education progression that were used to write the standard. These elements give background information on the origin of the standard*
Az Science Standard Essential HS.E2U1.15 Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star.	• The source of energy that the Sun and all stars radiate comes from nuclear reactions in their central cores. • Nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases the energy seen as starlight.
Az Science Standard Essential HS.E2U1.16 Construct an explanation of how gravitational forces impact the evolution of planetary motion, structure, surfaces, atmospheres, moons, and rings. *Note: application of laws rather than memorization should be emphasized.*	• The solar system consists of the Sun and a collection of objects of varying sizes and conditions—including planets and their moons—that are held in orbit around the Sun by its gravitational pull on them. • Earth and the Moon, Sun, and planets have predictable patterns of movement. • These patterns, which are explainable by gravitational forces and conservation laws, in turn explain many large-scale phenomena observed on Earth. • Planetary motions around the Sun can be predicted using Kepler's three laws, which can be explained based on Newton's theory of gravity. • Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.
Az Science Standard Essential HS.E2U1.17 Construct an explanation of the origin, expansion, and scale of the universe based on astronomical evidence.	• There are billions of galaxies in the universe, almost unimaginably vast distances apart and perceived as moving rapidly away from each other. • This apparent movement of galaxies may indicate that the universe is expanding from an event called a 'big bang', about 13.7 billion years ago. • Nearly all observable matter in the universe is hydrogen or helium, which formed in the first minutes after the Big Bang. • Elements other than these remnants of the Big Bang continue to form within the cores of stars. • Nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases the energy seen as starlight.