AERO

Next Generation Science Standards

Progressions by Performance Expectations

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***"To develop a thorough understanding of scientific explanations of the world, students need sustained opportunities to work with and develop the underlying ideas and to appreciate those ideas' interconnections over a period of years rather than weeks or month."* (NRC, 2012, p. 26).**

The idea of building an understanding overtime is referred to as a **learning progression**. The development of understanding over time is a foundation for all three dimensions of the NGSS, **disciplinary core ideas**, **science and engineering practices**, and **crosscutting concepts**.

A learning progression represents both the logical progression of a science concept and how students' ideas progress to the more complete understanding of the concept (Furtak & Heredia, 2014). There are two anchor points in a learning progression, the initial ideas about a topic students have when they enter school and the level of understanding about the topic desired upon completion of school (NRC, 2007). The learning progression is then created from those two points to illustrate how conceptual understanding of the scientific phenomena develops over time. The progression is not about just adding more content pieces to an idea. The focus of the progression is students developing a more coherent, complete, accurate, and complex understanding.

Standards based on learning progressions offer an opportunity to support the improvement in science teaching and learning. It is important to note that the Framework and the subsequent NGSS, focuses on a few core set of science idea (disciplinary core ideas) throughout the K-12 education. This is important for the successful implementation of learning progressions theory and the goal of creating scientifically literate students because students need focused, sustained, and coherent learning opportunities to develop a conceptual understanding of a scientific phenomenon or concept. We cannot facilitate this if the set of science ideas that are required each year is large and wide spread. "It is highly unlikely that brief periods of uncoordinated instruction are going to achieve the goal of helping students generate a scientifically informed epistemology, a deep and well-structured knowledge base, and a firm understanding of the purposes and methods of science" (NRC, 2007). The focus on the learning progression of select science concepts will improve the understanding of science students are able to develop throughout their K12 education.

Learning progressions are used to plan coherent units of instruction as they are focus on connected concepts related to a big science phenomena or idea. The learning progressions in the NGSS provide us with a road map of how a science concept builds K-12. This helps with planning as the learning progressions illustrate the development of student understanding. Thus, if students are struggling to develop an understanding of a concept we can trace the concept back in the standards to identify parts of the concept that students may need further learning opportunities to understand.

The following document provides a look at the progression of the K-8 **performance expectations**. It is important to note that performance expectations specify a set of learning outcomes—that is, they illustrate the competencies students should develop as a result of classroom instruction. The performance expectations are specifications for assessments with implications for curriculum and instruction, but **they are not instructional units**.

Performance expectations embody the three dimensions of NGSS, the science and engineering practices, the disciplinary core ideas, and the crosscutting concepts. It is important to examine the three columns beneath the performance expectation. These boxes are statements from *A Framework for K–12 Science Education* (NRC 2012) and provide detailed *content* for the three elements in the performance expectation.

Furtak, E. & Heredia, C. (2014). Exploring the influence of learning progressions in two teacher communities. *Journal of Research in Science Teaching*, 51(8), 982-1020.
National Research Council (2007). *Taking science to school: Learning and teaching science in grades K-8*. Washington, D.C. National Research Council
National Research Council (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: National Academies Pres

	PreK	K	1	2	3	4	5	MS	HS
Matter and Its Interactions	PreK-PS1-1 Ask questions and use observations to test the claim that different kinds of matter exist as either solid or liquid.			2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.			5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.	MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.	HS-PS1-1, Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms
				2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.			5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.	MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

	PreK	K	1	2	3	4	5	MS	HS
Matter and Its Interactions				2-PS1-3 Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object			5-PS1-3 Make observations and measurements to identify materials based on their properties.	MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.	HS-PS1-3, Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
	.			2-PS1-4 Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot			5-PS1-4 Conduct an investigation to determine whether the mixing of two or more substances results in new substances.	MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	HS-PS1-4 Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
								MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved	HS-PS1-5 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs

	PreK	K	1	2	3	4	5	MS	HS
Matter and Its Interactions								MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.	HS-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
									HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
									HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

	PreK	K	1	2	3	4	5	MS	HS
Forces and Motion	PreK-PS2-1 Use tools and materials to design and build a device that causes an object to move faster with a push or a pull.	K-PS2-1 Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.			3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.		5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down.	MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*	HS-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration
		K-PS2-2 Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.			3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.			MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.	HS-PS2-2 Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

	PreK	K	1	2	3	4	5	MS	HS
Forces and Motion					3-PS2-3 Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other			MS-PS2-3 Ask questions about data to determine the factors that affect the strength of electric and magnetic forces	HS-PS2-3 Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
					3-PS2-4 Define a simple design problem that can be solved by applying scientific ideas about magnets.*			MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects	HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
								MS-PS2-5 Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.	HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

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Forces and Motion									HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
Energy		K-PS3-1 Make observations to determine the effect of sunlight on Earth's surface.				4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object	5-PS3-1 Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.	MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.	HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
		K-PS3-2 Use tools and materials provided to design and build a structure that will reduce the warming effect of sunlight on Earth's surface.				4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.		MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.	HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

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Energy						4-PS3-3 Ask questions and predict outcomes about the changes in energy that occur when objects collide.		MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.	HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
						4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.		MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
								MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object	HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

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Waves and Their Applications	PreK-PS4-1 Plan and conduct investigations to provide evidence that sound is produced by vibrating materials		1-PS4-1 Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.			4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.		MS-PS4-1, Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.	HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
		1-PS4-2 Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.			4-PS4-2 Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen		MS-PS4-2, Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.		HS-PS4-2 Evaluate questions about the advantages of using a digital transmission and storage of information

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Waves and Their Applications			1-PS4-3 Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.			4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information		MS-PS4-3 Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals	HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
			1-PS4-4 Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.						HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
									HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

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From Molecules to Organisms: Structures and Processes	PreK-LS1-1 Observe familiar plants and animals (including humans) and describe what they need to survive.	K-LS1-1 Use observations to describe patterns of what plants and animals (including humans) need to survive.	1-LS1-1 Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.*		3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	5-LS1-1 Support an argument that plants get the materials they need for growth chiefly from air and water.	MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.	HS-LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells
	PreK-LS1-2 Plan and conduct an investigation to determine how familiar plants and/or animals use their external parts to help them survive in the environment.		1-LS1-2 Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.			4-LS1-2 Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.		MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms

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From Molecules to Organisms: Structures and Processes								MS-LS1-3 Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
								MS-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively	HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
								MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms	HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy

	PreK	K	1	2	3	4	5	MS	HS
From Molecules to Organisms: Structures and Processes								MS-LS1-6 Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	HS-LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules
								MS-LS1-7 Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.	HS-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
								MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	

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Ecosystems: Interactions, Energy, and Dynamics				2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight and water to grow.	3-LS2-1 Construct an argument that some animals form groups that help members survive.		5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	MS-LS2-1, Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
				2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*				MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems	HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
								MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

	PreK	K	1	2	3	4	5	MS	HS
Ecosystems: Interactions, Energy, and Dynamics								MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
								MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*	HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere
									HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

	PreK	K	1	2	3	4	5	MS	HS
Ecosystems: Interactions, Energy, and Dynamics									HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*
									HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce

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Heredity: Inheritance and Variation of Traits	PreK- LS3-1 Develop a model to describe that some young plants and animals are similar to, but not exactly like, their parents.			2-LS3-1 Make observations of plants and animals to compare the diversity of life in different habitats				MS-LS3-1 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.	HS-LS3-1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
								MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.	HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
									HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

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Biological Evolution: Unity and Diversity					3-LS4-1 Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.			MS-LS4-1, Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past	HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
					3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.			MS-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.	HS-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

	PreK	K	1	2	3	4	5	MS	HS
Biological Evolution: Unity and Diversity					3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.			MS-LS4-3 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy	HS-LS4-3 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
					3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.			MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.	HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
								MS-LS4-5 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms	HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

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Biological Evolution: Unity and Diversity								MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.	HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

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Earth's Place in the Universe	PreK ESS1-1 Observe and describe the apparent motions of the Sun, moon, and stars to recognize predictable patterns		1-ESS1-1 Use observations of the sun, moon, and stars to describe patterns that can be predicted	2-ESS1-1 Use information from several sources to provide evidence that Earth events can occur quickly or slowly.		2-ESS1-1 Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.	5-ESS1-1 Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.	MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.	HS-ESS1-1 Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.
			1-ESS1-2 Make observations at different times of year to relate the amount of daylight to the time of year				5-ESS1-2 Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky	MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.	HS-ESS1-2 Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
								MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.	HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.

	PreK	K	1	2	3	4	5	MS	HS
Earth's Place in the Universe								MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.	HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
									HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
									HS-ESS1-6 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

	PreK	K	1	2	3	4	5	MS	HS
Earth's Systems	PreK- ESS2-1 Ask questions, make observations, and collect and record data using simple instruments to recognize patterns about how local weather conditions change daily and seasonally.	K-ESS2-1 Use and share observations of local weather conditions to describe patterns over time.		2-ESS2-1 Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.	3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.	4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.	5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact	MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.	HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features
		K-ESS2-2 Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.		2-ESS2-2 Develop a model to represent the shapes and kinds of land and bodies of water in an area.	3-ESS2-2 Obtain and combine information to describe climates in different regions of the world.	4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.	5-ESS2-2 Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.	MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.	HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

	PreK	K	1	2	3	4	5	MS	HS
Earth's Systems				2-ESS2-3 Obtain information to identify where water is found on Earth and that it can be solid or liquid.				MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	HS-ESS2-3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
								MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.	HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
								MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

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Earth's Systems								MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.	HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
									HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth

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Earth and Human Activity	PreK- ESS2-3 Plan and conduct an investigation to determine the effect of sunlight on Earth's surface.	K-ESS3-1 Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.			3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.*	4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.	HS-ESS3-1 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
		K-ESS3-2 Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.				4-ESS3-2 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.		MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.	HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

	PreK	K	1	2	3	4	5	MS	HS
Earth and Human Activity		K-ESS3-3 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.						MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment	HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
								MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per- capita consumption of natural resources impact Earth's systems.	HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

	PreK	K	1	2	3	4	5	MS	HS
Earth and Human Activity								MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems
									HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

	K-2	3-5	MS	HS
Engineering Design	K-2 ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
	K-2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem	3-5-ETS1- 2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
	K-2-ETS1-3 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts
			MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practices		
Asking Questions and Defining Problems	A basic practice of the scientist is the ability to formulate empirically answerable questions about phenomena to establish what is already known, and to determine what questions have yet to be satisfactorily answered.	Engineering begins with a problem that needs to be solved, such as "How can we reduce the nation's dependence on fossil fuels?" or "What can be done to reduce a particular disease?" or "How can we improve the fuel efficiency of automobiles?"
Developing and Using Models	Science often involves the construction of models and simulations to help develop explanations about natural phenomena.	Engineering makes use of models and simulations to analyze systems to identify flaws that might occur or to test possible solutions to a new problem.
Planning and Carrying Out Investigations	A major practice of scientists is planning and carrying out systematic scientific investigations that require identifying variables and clarifying what counts as data.	Engineering investigations are conducted to gain data essential for specifying criteria or parameters and to test proposed designs.
Analyzing and Interpreting Data	Scientific investigations produce data that must be analyzed to derive meaning. Scientists use a range of tools to identify significant features and patterns in data.	Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria.
Using Mathematics, Information, and Computer Technology and Computational Thinking	In science, mathematics and computation are fundamental tools for representing physical variables and their relationships.	In engineering, mathematical and computational representations of established relationships and principles are an integral part of the design process.
Constructing Explanations and Designing Solutions	The goal of science is the construction of theories that provide explanatory accounts of the material world.	The goal of engineering design is a systematic approach to solving engineering problems that is based on scientific knowledge and models of the material world.
Engaging in Argument From Evidence	In science, reasoning and argument are essential for clarifying strengths and weaknesses of a line of evidence and for identifying the best explanation for a natural phenomenon.	In engineering, reasoning and argument are essential for finding the best solution to a problem. Engineers collaborate with their peers throughout the design process.
Obtaining, Evaluating, and Communicating Information	Science cannot advance if scientists are unable to communicate their findings clearly and persuasively or learn from the findings of others.	Engineering cannot produce new or improved technologies if the advantages of their designs are not communicated clearly and persuasively.
This chart is from The NSTA Reader's Guide to A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas **Author: Harold Pratt**		