Disciplinary Core Idea Progressions

The tables below illustrate the progression of the Disciplinary Core Ideas K-12 found within the *Framework for K-12 Science Education.* This progression is for reference only and in no way endorses separation of the disciplinary core ideas from the other dimensions. Though the South Dakota Standards are presented as detailed integrations of the three dimensions, this document was built by the South Dakota Science Standards Workgroup to display the coherence and progression of the core ideas across K-12. This document can provide great support for schools and districts to ensure vertical progression occurs within the larger system. This document can also assist teachers seeking to identify where the major ideas appear within their respective grade-bands.

Physical Science Progression

DCI	K-2	3-5	6-8	9-12
PS1.A *Structure of matter*	Classifying different materials by their observable properties. Determining which of those properties are best suited for a specific purpose. Designing devices that require the assembly or disassembly of smaller objects. Understanding the effects of heating and cooling on the properties of matter.	Developing models that portray matter as particles too small to be seen, yet can be identified macroscopically based on their properties. Collecting evidence that matter is always conserved.	Developing models that describe atomic and molecular composition. Analyzing the physical and chemical properties of matter, describing its natural sources, phase transitions, and impact on society.	Using the periodic table as a model to predict the relative chemical and physical properties and reactivity of elements based on the patterns of electrons in the outermost energy level of atoms. Planning and carrying out investigations that compare atomic and molecular structure and its impact on the strength of electrical forces between particles. Building models that illustrate the storage of energy in chemical bonds, and its effect on equilibrium.

PS1.B *Chemical reactions*	Using evidence to determine if a change caused by heating or cooling can be reversed.	Providing quantitative evidence of the conservation of matter during both physical and chemical changes. Conducting investigations to prove whether changes observed during the mixing of substances are physical or chemical.	Analyzing matter before and after an interaction to determine if a reaction has taken place, and the relevance of such a change within the context of the world in which we live. Understanding that while they might change state, matter and energy are conserved during a chemical reaction.	Explaining the outcome of a chemical reaction based on knowledge of atomic structure, periodic trends, and knowledge of patterns of chemical properties. Building models that illustrate the transfer of energy between particles and their surroundings during a chemical reaction. Explaining the effects of changing temperature or concentration on the rate or equilibrium state of a chemical reaction. Accounting for the conservation of matter during a chemical reaction.
PS1.C *Nuclear processes*	N/A	N/A	N/A	Modeling and illustrating the changes in the nuclear composition and energetics of the atom during the processes of fission, fusion, and radioactive decay. Developing a model to describe nuclear fusion in the sun's core and its release of energy that

				reaches Earth in the form of radiation.
PS2.A *Forces and motion*	Comparing and contrasting the effect of pushes and pulls in various directions and magnitudes on the motion of an object. Designing a solution to influence speed and direction change for various objects.	Using observation and measurement to determine the affect of balanced and unbalanced forces on an objects motion, and to determine its future motion.	A change in an objects motion (acceleration) depends on a change in the net force acting on an object and the mass of that object. Applying this, along with Newton's Third Law, can be used to solve a problem involving the collision of two objects.	Analyzing data supporting Newton's second law of motion and Coulomb's Law, and their effects on an objects net force, mass, and acceleration. Supporting the conservation of momentum within a system through mathematical representations. Using this information to design a device that minimizes net force on an object during a collision. Understanding how molecular structure plays a role in each of these concepts.
PS2.B *Types of interactions*	Determining the relationship between pushes/pulls and speed/direction.	Using scientific ideas to ask questions and conduct investigations about cause and effect relationships pertaining to gravitational, electric and magnetic interactions.	Analyzing and questioning data, arguments, and observations to determine the factors affecting electromagnetic and gravitational interactions.	Understanding how to manipulate net force on an object during a collision. Engineering devices that minimize this net force. Mathematically predicting gravitational and electrostatic forces between macroscopic and molecular objects, and evidentially supporting

				those predictions.
PS2.C *Stability and instability in physical systems*	Determining if a design solution works as intended to change the speed or direction of an object.	N/A	N/A	Mathematically supporting the conservation of momentum in a system with no net force.
PS3.A *Definitions of energy*	N/A	Defining the relationship between energy and motion, sound, light, heat, electricity, and collisions.	Describing the impact of thermal energy on the physical and chemical properties of matter. Evaluating the roles and interaction of kinetic and potential energy.	Defining the relationship between molecular and macroscopic energy, and utilizing this information to design devices capable of converting energy between various forms.
PS3.B *Conservation of energy and energy transfer*	Determining the effects of sunlight on the Earth's surface. Building a structure that can minimize temperature changes resulting from this interaction.	Describing energy transfer in various forms (motion, sound, light, heat, electricity, and collisions).	Understanding insulation, conduction, and their role in the transfer of energy. Engaging in argument regarding the transfer of energy to or from an object.	Utilizing technology to model energy transfer, and supporting this through experiential evidence consistent with the 2nd Law of Thermodynamics.
PS3.C *Relationship between energy and forces*	N/A	Understanding the impact of energy transfer on various forces, and forces on energy transfer.	Describing the relationship of kinetic and potential energy.	Modeling the interaction of electric and magnetic fields to illustrate the resulting force and energy interactions.
PS3.D *Energy in chemical processes and everyday life*	Determining the effects of sunlight on the Earth's surface.	Designing a device capable of converting energy from one form to another. Use models to describe energy conversion from sunlight to various functions in	N/A	Providing evidence of thermal energy transfer according to the 2nd Law of Thermodynamics. Relating energy transfer to the transmission and

		living species.		capture of information and energy.
PS4.A *Wave properties*	Investigating the relationship between vibrating materials and sound, vision and light, and how knowledge of these concepts can be used to develop communication devices.	Developing a model to describe wave and light patterns.	Using mathematical formulas to describe the wave model, and how waves are reflected, absorbed, or transmitted through various media.	Mathematically supporting claims describing wave properties in various media. Evaluating the advantages of digital transmission and storage of information.
PS4.B *Electromagnetic radiation*	Determining the effect light has on different objects, and using this information to develop a device for visual communication.	Developing a model to describe radiation (wave) and light patterns.	Using mathematical formulas to describe electromagnetic radiation, and how it is reflected, absorbed, or transmitted through various media.	Describing wave-particle duality as it pertains to electromagnetic radiation. Evaluating evidence of the effects of radiation on matter.
PS4.C *Information technologies and instrumentation*	Utilizing sound and light to develop communication devices.	Developing and optimizing multiple pattern solutions to information transfer.	Comparing and contrasting digitized and analog signaling.	Evaluating the process and advantages of digital transmission, capture, and storage of information.

Life Science Progression

DCI	K-2	3-5	6-8	9-12
LS1.A *Structure and function*	Using plant and animal anatomical function to design a solution to a human problem of growth and development.	Making an argument about how the structure and function of plant and animal anatomy can support growth, behavior, and reproduction.	Investigating the idea that organisms are made of one or more cells, and that cells or parts of cells may have different functions within a larger system. Supporting the argument that the body is comprised of subsystems, which are in turn composed of groups of cells.	Constructing an explanation, using evidence, for how DNA structure has downstream effects on the structure and function of an organism. Investigating how feedback mechanisms maintain homeostasis in an organism.
LS1.B *Growth and development of organisms*	Describing patterns of survival for plants and animals, and their assistance in the survival of offspring.	Developing models to describe both common and unique life cycle processes in different organisms.	Using empirical evidence and reasoning to explain characteristics and behaviors of organisms, and how they might influence reproduction. Explaining how environmental and genetic factors might influence the growth of organisms.	Developing a model to explain the hierarchy of interacting systems and functions within multicellular organisms. Illustrating the role of mitosis and differentiation in producing and maintaining complex organisms.
LS1.C *Organization for matter and energy flow in organisms*	Explaining the life cycle of different organisms within an ecosystem.	Using evidence to describe how plants get the materials they need to survive from air and water. Developing a	Constructing a scientific explanation for the role of photosynthesis in the cycling of matter and flow of energy into and out of	Illustrating how photosynthesis transforms light energy into stored chemical energy. Constructing and revising

		model to show how matter and energy can be transferred through different participants within an ecosystem.	organisms. Modeling how food can be digested and processed through chemical reactions, forming new molecules to support matter and energy transfer in an organism.	an explanation for how elements from non-living sources can combine to form organic molecules, and how cellular respiration plays a crucial role in the energy transfer that accompanies this process.
LS1.D *Information processing*	N/A	Modeling and describing the processing of the five senses to the brain to support survival, growth, behavior, and reproduction.	N/A	Explain the role of information processing within the context of anatomical structure and function.
LS2.A *Interdependent relationships in ecosystems*	Determining if plants need sunlight and water to grow. Explaining the role of animals in the dispersion of seeds and pollination in plants.	Making arguments about how some animals form groups to help members survive.	Describing the effects of resource availability on organisms and groups of organisms within an ecosystem. Recognizing patterns of interactions among organisms across multiple ecosystems.	Supporting and revising explanations about factors affecting populations in ecosystems.
LS2.B *Cycles of matter and energy transfer in ecosystems*	N/A	Developing a model to show how matter and energy can be transferred through different participants within an ecosystem.	Modeling the cycling of matter and energy among living and nonliving parts of an ecosystem. Constructing a scientific explanation for the role of photosynthesis in the cycling of matter and flow	Constructing an explanation for the cycling of matter and flow of energy under aerobic and anaerobic conditions, and among organisms in an ecosystem. Quantitatively illustrate the role of

			of energy into and out of organisms.	photosynthesis and cellular respiration in the cycling of carbon.
LS2.C *Ecosystem dynamics, functioning, and resilience*	N/A	Using evidence and reasoning to describe how certain characteristics of the same species and different species within an ecosystem may provide advantages in survival, mating, and reproduction.	Explaining why changes to physical or biological components of an ecosystem affect its population. Evaluating competing design solutions for maintaining ecosystem services.	Computationally modeling how factors can affect the carrying capacity of ecosystems at different scales. Evaluating claims and evidence that ecosystems maintain relative homeostasis, but can be altered as the result of changing conditions.
LS2.D *Social interactions and group behavior*	N/A	Making arguments about how some animals form groups to help members survive.	Explaining patterns of interactions among organisms across multiple ecosystems.	Examining evidence of group behavior and its influence on survival and reproduction.
LS3.A *Inheritance of traits*	Explaining, using evidence, how plants and animals are both similar and dissimilar to their parents.	Using data to provide evidence of inherited traits in plants and animals.	Using a model to describe why asexual organisms share identical genetic information with their parents and sexual organisms do not.	Asking questions to clarify the role of DNA and chromosomes in coding for the inheritance of traits. Using statistical data to explain how organisms with an advantageous and inheritable trait tend to increase in proportion to organisms lacking this trait.
LS3.B	Explaining, using evidence,	Using data to provide	Using a model to describe	Making and defending

Variation of traits	how plants and animals are both similar and dissimilar to their parents.	evidence of variable traits in plants and animals. Understanding that traits can be influenced by both inheritance and environment.	how genetic mutations have downstream effects in the function of organisms.	claims regarding how genetic variations can result from a number of factors.
LS4.A *Evidence of common ancestry and diversity*	Making observations about plant and animal similarities and diversity in different habitats.	Analyzing data to describe organisms and environments that existed long ago.	Examining the fossil record as documentation of diversity and commonality over the history of life on Earth, and how those similarities and differences can infer evolutionary relationships.	Examining the passing of traits from parents to offspring, and across populations over time. Communicating this information through multiple lines of empirical evidence.
LS4.B *Natural selection*	N/A	Using evidence and reasoning to describe how certain characteristics of the same species may provide advantages in survival, mating, and reproduction.	Using evidence to explain how genetic variations of traits can increase some individuals' probability of survival and reproduction in a specific environment. Explaining how natural non-natural influences can alter this process.	Providing evidence of evolution and the factors that drive this process. Using statistical data to explain how organisms with an advantageous and inheritable trait tend to increase in proportion to organisms lacking this trait.
LS4.C *Adaptation*	N/A	Explaining the impact that habitat, genetic inheritance, and ability to adapt can have on an organism's chances of survival. Understanding that plants and animals	Supporting the claim that natural selection can lead to increases or decreases in specific traits over time. Explaining the impact that habitat, genetic inheritance, and ability to	Using statistical evidence and probability to explain the variation, distribution, and expression of traits over time in a population. Providing evidence of the factors that drive this

		might change as a result of changes in the environment.	adapt can have on an organism's chances of survival, growth, and reproduction.	process, and how natural selection and changing environments lead to the adaptation, emergence, and extinction of populations.
LS4.D *Biodiversity and humans*	Describing similarities and differences in different organisms of the same species and different species.	Explaining why different members of the same species might have similar or different characteristics.	Describing how human influence and technologies can influence the inheritance of specific traits over time. Developing competing design solutions for maintaining biodiversity in a given population.	Designing, evaluating, and optimizing solutions for minimizing the impact of human activity on the environment and biodiversity. Mathematically representing natural and non-natural (human) factors that affect biodiversity within an ecosystem.

Earth and Space Science Progression

DCI	K-2	3-5	6-8	9-12
ESS1.A *The universe and its stars*	Predicting patterns found in the sun, moon, and stars.	Supporting the argument that distance from the Earth plays a role in the brightness of the sun and other stars.	Modeling the Earth-sun-moon system to describe the repetition of patterns in each.	Using astronomical evidence to construct an explanation of the Big Bang Theory. Explaining through scientific ideas how stars can produce elements.
ESS1.B *Earth and the solar system*	Relating the movement of Earth in comparison to the patterns of the sun, moon, and stars, as well as the amount of daylight during different seasons.	Using graphical data to reveal changing patterns in the length of shadows, day and night, and the appearance of the night sky over time.	Explaining how gravity plays a role in the motions of galaxies and our solar system.	Explaining how energy, resulting from fusion reactions in the sun's core, can travel to Earth in the form of radiation. Using mathematical and computational representations to predict interplanetary motion.
ESS1.C *The history of planet Earth*	Garnering the ability to describe changes on Earth that occur quickly or slowly.	Utilizing patterns in rock formations and fossils to describe changes in the Earth over time.	Using data to scale measurements and properties within the context of our solar system.	Determining the age of crustal rocks by examining past and current movements of the Earth's crust in the context of plate tectonics. Applying scientific reasoning and planetary evidence to account for Earth's early history.

ESS2.A *Earth materials and systems*	Providing multiple solutions to slowing or preventing land changes that result from the movement of wind or water.	Making observations and collecting data as evidence of weathering or erosion. Describing the interaction of the geosphere, biosphere, hydrosphere, and/or atmosphere.	Modeling the Earth's materials cycle and the energy that drives those processes.	Analyzing geoscience data to explain changing feedback and responsive processes in the Earth's systems. Describing the role of system changes on regional climates.
ESS2.B *Plate tectonics and large-scale system interactions*	Modeling different shapes and kinds of land and water in a given area.	Analyzing and interpreting data from Earth maps to describe physical patterns and features on the Earth's surface.	Explaining changes in the Earth's surface over time based on evidence of geoscience processes. Using the distribution of fossils, rocks, continents, and the sea floor to provide evidence of plate motion.	Using plate tectonics as evidence to explain the ages of crustal rocks.
ESS2.C *The roles of water in Earth's surface processes*	Identifying where water is found on Earth and that it can take on various physical states.	Using data to describe water distribution on the Earth's surface, as well as its role in erosion and weathering.	Modeling the water cycle based on evidence of energy transfer from the sun and gravity.	Investigating the role of water on the Earth's materials and surface processes.
ESS2.D *Weather and climate*	Sharing observations of local weather conditions over an extended period of time, including how to predict and respond to severe weather.	Using data to describe weather patterns during specific seasons, and in specific climates throughout the world.	Collecting and interpreting evidence of air movement and its impact on weather conditions. Using a model of the heating and rotation of the Earth to describe atmospheric and oceanic currents, as well as regional climates.	Explaining climate changes using evidence of energy transfer into and out of the Earth's systems.
ESS2.E	Engaging in argument	Using fossils as evidence	N/A	Describing the cycling of

Biogeology	about the ability of plants and animals to change the environment to meet their needs.	to support changes in the Earth's landscape over time.		matter by thermal convection.
ESS3.A *Natural resources*	Understanding the relationship between living organisms and the natural resources around them.	Using data and observations to describe how energy and fuel are derived from Earth's natural resources.	Using evidence to describe the uneven distribution of natural resources that result from geoscience processes.	Evaluating competing positions for the development and consumption of energy and natural resources based on a cost-benefit ratio and its impact on sustainability, human populations, and biodiversity. Explaining the impact that scarce availability of natural resources can have on human activity.
ESS3.B *Natural hazards*	Discussing severe weather patterns.	Providing a design solution that protects against severe weather-related hazards.	Analyzing and interpreting data on natural hazards to forecast catastrophic events and to develop technologies that diminish their effects.	Explaining the impact that occurrences of natural hazards can have on human activity.
ESS3.C *Human impacts on Earth systems*	Using evidence to discuss the impact of humans on a changing environment and ecosystem. Discussing potential solutions to minimizing this impact.	Generating and comparing multiple solutions to minimize the impact of the Earth's natural processes on humans. Combining information about how communities	Applying scientific principles to design methods of monitoring and minimizing human impact on the environment. Constructing arguments	Optimizing technological solutions that reduce the impact of human activity on Earth systems. Using computational models to illustrate how our relationship with Earth

		use science to protect the Earth's resources and environment.	supported by evidence for how the human population has impacted the consumption of natural resources and impacted Earth's systems	systems is changing due to human activity.
ESS3.D *Global climate change*	N/A	N/A	Asking questions and providing clarifying statements about the factors that have caused changes in global temperatures and climates over the past century.	Explaining the impact that climate change can have on human activity. Analyzing data of global climate models in order to forecast future climate changes.

Engineering Design Progression

This table was included to complement the addition of the optional Engineering Design Standards. Please see APPENDIX C for the list of the grade-banded standards.

DCI	K-2	3-5	6-8	9-12
ETS1.A *Defining and delimiting an engineering problem*	Approaching change as a problem that is solvable through engineering: asking questions, gathering information, and determining solutions.	Understanding that solutions to a problem are limited by the availability of materials and resources. These limitations can be minimized through the optimization of design.	Consideration of scientific principles and relevant knowledge towards a proposed solution to a problem.	Utilizing design criteria, constraints, and technological models to address function, durability, risk, and design specifications.
ETS1.B *Developing possible solutions*	Developing sketches, drawings, or models to express a design strategy.	Researching a problem through available resources, such as the internet, library, or observation, and brainstorming *prior* to generating a design strategy.	Testing a design solution, or combining multiple solutions for optimization. Communicating solutions to others.	Breaking down problems into simpler components in order to develop potential solutions, taking into account a variety of constraints (cost, safety, reliability, aesthetics, societal impacts, etc).
ETS1.C *Optimizing the design solution*	Comparing designs, while discussing strengths and weaknesses of each.	Comparing designs, looking for the best possible solution within a given set of constraints.	Systematically comparing designs, within the context of constraints and criteria, through tests, control experiments, and optimization.	Determining the best possible design for a solution under a given set of prioritized constraints. Utilizing a design matrix to aide the process of optimization.