Wisconsin Standards for Science - Draft for Public Review July 12, 2017 - August 12, 2017

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Vision

Our communities and our state need scientifically literate citizens who can make informed decisions, help manage our abundant resources, and move our economy forward. In a world of continual innovation and discovery, students across Wisconsin must have the ability to apply scientific thinking, skills, and understanding to real-world phenomena and problems. Therefore, student learning must include experiences requiring that type of work.

The National Research Council issued A Framework for K-12 Science Education (2012), laying out an expectation for high school graduates that provides succinct vision for science education in Wisconsin: "[By] the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology." All Wisconsin students need these skills to be able to address problems we are facing and new challenges that will arise.

Reflecting on this statewide vision, educators should work with their colleagues and communities to create their own visions for science education based on their unique contexts.

Introduction

These Wisconsin Standards for Science were built from the *National Research Council's Framework for K-12 Science Education* and the *Next Generation Science Standards*. Starting from those documents, a committee of educators, scientists, and engineers from across Wisconsin came together to decide what content, practices, and big ideas were critical for Wisconsin students' development into scientifically literate citizens who are ready for college and career success. One significant contribution of this group was adding specific Wisconsin contexts to these science concepts in order to support making science relevant and engaging across our communities.

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Explanatory Materials - How to Read the Standards

The new Wisconsin standards across all disciplines are formatted from a common template to support educators in reading and interpreting them. The discipline is clearly stated at the top of the template. In the case of the science standards, there are three sections: science content standards, science and engineering practice standards, and crosscutting concept standards. The three sections are color coded. Content standards are in orange. Science and engineering practice standards are in blue. Crosscutting concept standards are in green. The intention is for these three dimensions to be used together, in an integrated fashion, to guide learning and assessment.

Structure, Development, and Language of the Science Content Standards
The science content standards are further divided into standards in life science (LS), physical science (PS), earth and space science (ESS), and engineering, technology and science applications (ETS). The figure below shows a sample standard from the life science content area.

Discipline: SCIENCE
Content Area: LIFE SCIENCE
Standard SCI.LS1--Organisms: Students use science and engineering practices, crosscutting concepts, and an understanding of structures and processes from molecules to organisms to make sense of phenomena and solve problems.

The code, "**Standard SCI.LS1--Organisms"** is translated as follows: **Sci**ence.**L**ife **S**cience Content Area Standard **1--** which pertains to the Core Idea, **Organisms.**

The standards statements in each content area are based on the foundational phrase, "Students use science and engineering practices, crosscutting concepts, and an understanding of ____________ to make sense of phenomena and solve problems." The specific science content topic, in this case it is "structures and processes from molecules to organisms," fills the blank.

The standard statements emphasize that students should be engaging in three-dimensional science learning from kindergarten through grade 12, meaning that they learn the content standards by engaging in the scientific and engineering practice standards while using the perspectives of the crosscutting concepts to think like scientists.

Each content standard statement is further divided into **learning elements** and **performance indicators**. In the figure below, the code **SCI.LS1.A** refers to learning element A of life science standard statement 1. Each standard statement has from 2-5 learning elements.

The **performance indicators** provide a learning progression from grade band to grade band for each learning element. Each performance indicator is associated with a suggested grade level within the elementary school grade bands. The learning element code is also used for the performance indicators with the appropriate grade level attached at the end. For example, **SCI.LS1.A.1** refers to the developmentally appropriate understanding of structure and function for the K-2 grade band, and it's suggested that this content be learned in grade 1. These are the recommended grade levels to support consistency across the state and student transfers between districts. With local control, districts can assign performance indicators to elementary grade levels that better fit their needs.

Performance indicators for the middle school and high school grade bands are not associated with suggested grade levels, so the grade level codes for these grade bands are "m" for middle school and "h" for high school. Some districts may choose an integrated course format while others may choose to organize classes by discipline. There is not a recommended method.

Recall that all content standard statements have a similar structure with a blank that is filled by a specific standard topic. The performance indicators should be read as filling in the blank in the content standard statement above it. For example, performance indicator **SCI.LS1.A.1** can be read as "Students use science and engineering practices, crosscutting concepts, and an understanding that all organisms have external parts that they use to perform daily functions to make sense of phenomena and solve problems."

Learning Element	**Performance Indicators (By Grade Band)**			
	K-2	**3-5**	**6-8**	**9-12**
SCI.LS1.A: Structure and function	SCI.LS1.A.1 All organisms have external parts that they use to perform daily functions.	SCI.LS1.A.4 Plants and animals have both internal and external macroscopic structures that allow for growth, survival, behavior, and reproduction.	SCI.LS1.A.m All living things are made up of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.	SCI.LS1.A.h Systems of specialized cells within organisms help perform essential functions of life. Any one system in an organism is made up of numerous parts. Feedback mechanisms maintain an organism's internal conditions within certain limits and mediate behaviors.
SCI.LS1.B: Growth and Development of Organisms.	SCI.LS1.B.1 Parents and offspring often engage in behaviors that help the offspring survive.	SCI.LS1.B.3 Reproduction is essential to every kind of organism. Organisms have unique and diverse life cycles.	SCI.LS1.B.m Animals engage in behaviors that increase the odds of reproduction. An organism's growth is affected by both genetic and environmental factors.	SCI.LS1.B.h Growth and division of cells in organisms occurs by mitosis and differentiation for specific cell types.

It is important to note that there are no performance indicators listed for 4K. Our committee suggests that educators use the Wisconsin Model Early Learning Standards to guide their work as they take advantage of the natural connections to science that come up every day in an effective 4K experience. Some suggestions for 4K teachers include supporting student experiences by encouraging students to ask questions and make observations. 4K classes in which teachers ask “What did you notice?” “What do you wonder?” “What does this remind you of?” and “What does it feel like, sound like, smell like, taste like, look like?” are more likely to come alive with authentic exploration that allows young children opportunities to figure things out and develop their own explanations as they interact with their world.

The vision for the new Wisconsin State Science Standards outlines the importance of providing opportunities for students to apply scientific thinking, skills, and understanding to real-world phenomena and problems. In order to achieve this, the standards document includes real world connections that are specific to Wisconsin and connections to engineering, technology, and society for each content standard statement. The figure below shows an example of connections to the **SCI.LS1 -- Organisms** standard that are listed after the performance indicators for each grade band. Teachers are encouraged to connect to local phenomena and meaningful engineering problems that make sense in their instruction and their community for their students.

SCI.LS1: CONNECTIONS				
Wisconsin Connections Could Include	Burdock has spines or prickles that protect the seeds, but some plants like the winged samara from the maple tree help the seed disperse. Black Walnut seeds and White Spruce cones have different kinds of armor-like protection.(LS1.A.1) Badgers' claws (LS1.A.1)	Native WI Animal Study - Grey Wolf, Badger, Beaver, Red Fox (LS1.C.5) Wood turtle burrows under the bank of a river in the mud and emerges in March or April, responding to temperature in the spring (LS1.A.4)	Biofuels (LS1.C.m) Climate change effect on crop growth (LS1.C.m) Genetically modified crops influencing growth (LS1.C.m) Alertness of deer to surroundings (LS1.B.m, LS1.D.m) "Yarding" behavior of deer in winter (LS1.D.m) Migration (geese, cranes, summer/winter range of deer in north) (LS1.B.m) Hibernation (Bears)(LS1.B.m),	Use Wisconsin Fast Plants to investigate and model energy dynamics in living systems (LS1.C.h) Coppice cutting and forest regeneration (LS1.B.h) trees communicate and assist each other. (LS1.D.h) Native WI Animal Study (Grey Wolf, Badger, Beaver, Red Fox)(LS1.A.h, LS1.D.h). Sickle cell anemia and prevalence by different demographics
Engineering, Technology & Society Connections	Biomimicry Biomedical engineering - artificial limbs	Biomedical engineering - artificial hearing, eyesight, etc.	Biofuels Genetically modified organisms	National Academy of Engineering Grand Challenge - Reverse engineering the brain

As stated earlier, these standards are designed to encourage instruction and learning that is three dimensional, i.e., instruction and learning that includes content taught through engagement in science and engineering practices in the context of crosscutting concepts. This is a new way of doing business in the world of science education. The standard documents include performance expectations (taken from the Next Generation Science Standards) that are provided <u>as examples</u> of ways to weave particular content, practices, and concepts together for the purpose of assessing student learning in a three dimensional context. These statements are not meant to guide curriculum and instruction - that process should be guided by local leaders discussing how to best connect these three dimensions based on their instructional preferences and student needs. Groups of science educators may wish to create their own three dimensional performance expectations. See the figure below for examples.

SCI.LS1: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	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.* 1-LS1-2: Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

The statements are coded to indicate grade levels and the associated content standard. For example, the performance expectation **K-LS1-1** was created as an example of a kindergarten (K) expectation associated with standard LS1. The number at the end simply indicates that this is kindergarten sample performance expectation number 1 to assist in communication.

Structure, Development, and Language of the Science and Engineering Practice Standards

There are eight science and engineering practice standards, built from Appendix F of the Next Generation Science Standards. These practice standards detail the work of scientists and engineers, suggesting the types of skills students should be using as they learn core concepts and how to think like scientists and engineers. Each standard is further divided into learning elements and performance indicators. The coding of the science and engineering practice standard statements, learning elements, and performance indicators follows the same pattern as the content standards with one exception: The performance indicators for the K-2 and 3-5 grade bands are not identified by grade level. A sample is shown in the figure below.

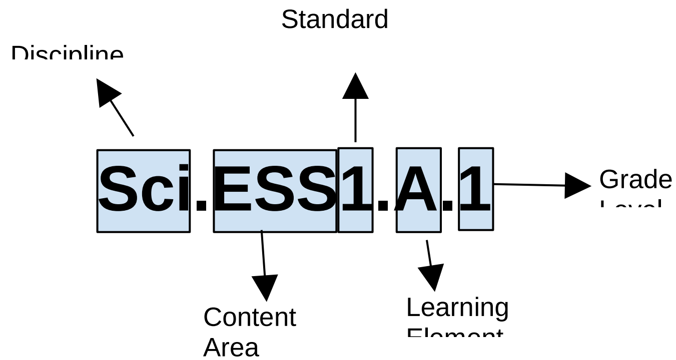
Discipline: SCIENCE				
Content Area: SCIENCE AND ENGINEERING PRACTICES				
Standard SCI.SEP1: Students will be able to ask questions and define problems.				
	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP1.A: Questions Based on Observations	SCI.SEP1.A.K-2 Ask questions based on observations to find more information about the natural and/or designed world(s)	SCI.SEP1.A.3-5 Ask questions about what would happen if a variable is changed.	SCI.SEP1.A.m Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.	SCI.SEP1.A.h Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Structure, Development, and Language of the Crosscutting Concepts Standards

There are seven crosscutting concepts standards. These crosscutting concepts detail how scientists and engineers think as they approach phenomena and problems in the world. They form the basis for the type of questions asked and analysis done as students are engaging in authentic professional practice around core science ideas. The coding of the crosscutting concept standard statements and performance indicators follows the same pattern as the science and engineering practice standards, with one exception. Since the crosscutting concept standards are not divided into "learning elements," the codes have one less numerical part. A sample is shown in the figure below.

Discipline: SCIENCE			
Content Area: Crosscutting Concepts			
Standard SCI.CC1--Patterns: Students will understand that observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.			
Performance Indicators (By Grade Band)			
K-2	**3-5**	**6-8**	**9-12**
SCI.CC1.K-2 Children recognize that patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence	SCI.CC1.3-5 Students identify similarities and differences in order to sort and classify natural objects and designed products. They identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions.	SCI.CC1.m Students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.	SCI.CC1.h Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.

Summary: How to read the standards codes for a performance indicator



2017 Draft Wisconsin Standards for Science

Discipline: SCIENCE				
Content Area: LIFE SCIENCE				
Standard SCI.LS1--Organisms: Students use science and engineering practices, crosscutting concepts, and an understanding of structures and processes from molecules to organisms to make sense of phenomena and solve problems.				
Learning Element	**Performance Indicators (By Grade Band)**			
	K-2	**3-5**	**6-8**	**9-12**
SCI.LS1.A: Structure and function	SCI.LS1.A.1 All organisms have external parts that they use to perform daily functions.	SCI.LS1.A.4 Plants and animals have both internal and external macroscopic structures that allow for growth, survival, behavior, and reproduction.	SCI.LS1.A.m All living things are made up of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.	SCI.LS1.A.h Systems of specialized cells within organisms help perform essential functions of life. Any one system in an organism is made up of numerous parts. Feedback mechanisms maintain an organism's internal conditions within certain limits and mediate behaviors.
SCI.LS1.B: Growth and Development of Organisms.	SCI.LS1.B.1 Parents and offspring often engage in behaviors that help the offspring survive.	SCI.LS1.B.3 Reproduction is essential to every kind of organism. Organisms have unique and diverse life cycles.	SCI.LS1.B.m Animals engage in behaviors that increase the odds of reproduction. An organism's growth is affected by both genetic and environmental factors.	SCI.LS1.B.h Growth and division of cells in organisms occurs by mitosis and differentiation for specific cell types.
SCI.LS1.C: Organization for Matter and Energy Flow in Organisms	SCI.LS1.C.K Animals obtain food they need from plants or other animals. Plants need water and light.	SCI.LS1.C.5 Food provides animals with the materials and energy they need for body repair, growth, warmth, and motion. Plants acquire material for growth chiefly from air, water, and process	SCI.LS1.C.m Plants use the energy from light to make sugars through photosynthesis. Within individual organisms, food is broken down through a series of chemical reactions that rearrange molecules and release energy.	SCI.LS1.C.h A result of cellular respiration is the flow of matter and energy through different organizational levels of an organism as elements are recombined to form different products and transfer energy. Hydrocarbons from the sugars produced through photosynthesis can be used to make amino acids and other molecules that can be assembled into proteins or DNA.

		matter and obtain energy from sunlight, which is used to maintain conditions necessary for survival.		
SCI.LS1.D: Information Processing	SCI.LS1.D.1 Animals sense and communicate information and respond to inputs with behaviors that help them grow and survive.	SCI.LS1.D.4 Different sense receptors are specialized for particular kinds of information; Animals use their perceptions and memories to guide their actions.	SCI.LS1.D.m Each sense receptor responds to different inputs, transmitting them as signals, that travel along nerve cells to the brain. The signals are then processed in the brain resulting in immediate behavior or memories.	SCI.LS1.D.h Organisms can process and store a variety of information through specific chemicals and interconnected networks.
SCI.LS1: CONNECTIONS				
Wisconsin Connections	Seeds from burdock, maple trees, black walnut trees, and white spruce have unique features to aid in dispersion or protection (A.1) Badgers' claws are long and sharp to allow them to dig quickly (A.1) Use Wisconsin native species as examples to address animals unique means to communicate (D.1)	Wood turtles burrow under the bank of a river in the mud and emerges in March or April, responding to temperature in the spring (A.4) Native WI animal study such as grey wolf, badger, beaver, red fox (C.5) Native WI plant study	Migration (geese, cranes, summer/winter range of deer in north) (B.m) Hibernation (Bears)(B.m) The effect of changes in climate on crop growth (C.m) Alertness of deer to surroundings (B.m, D.m) "Yarding" behavior of deer in winter (D.m)	Investigate body's feedback (homeostatis) processes when going out into different WI weather (A.h) Coppice cutting and forest regeneration (B.h) Use Wisconsin Fast Plants to investigate and model energy dynamics in living systems (C.h) Genetically modified crops influencing growth (C.h) Trees communicate and assist each other (D.h)
Engineering, Technology & Society Connections	Biomimicry Biomedical engineering - artificial limbs	Biomedical engineering - artificial hearing, eyesight, etc.	Structures of different organisms help determine their efficiency as biofuels Genetically modified organisms	National Academy of Engineering Grand Challenge - Reverse engineering the brain

SCI.LS1: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	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. 1-LS1-2: Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
Grades 3-5	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. 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. 5-LS1-1: Support an argument that plants get the materials they need for growth chiefly from air and water.
Grades 6-8	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. 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. MS-LS1-3: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. 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. MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. 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. 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. 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.

Grades 9-12	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. HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. HS-LS1-4: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. HS-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. 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. 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.

Standard SCI.LS2--Ecosystems: Students use science and engineering practices, crosscutting concepts, and an understanding of interactions, energy and dynamics in ecosystems to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.LS2.A: Interdependent Relationships in Ecosystems	SCI.LS2.A.2 Plants depend on water and light to grow. Plants depend on animals for pollination or to move their seeds around.	SCI.LS2.A.5 The food of almost any animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants, while decomposers restore some materials	SCI.LS2.A.m Organisms and populations are dependent on their environmental interactions both with other living things and with nonliving factors, any of which can limit their growth. Competitive, predatory, and mutually beneficial interactions vary across ecosystems but the patterns are shared.	SCI.LS2.A.h Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem. The combination of the factors that affect an organism's success can be measured as a multidimensional niche.

		back to the soil.		
SCI.LS2.B: Cycles of Matter and Energy Transfer in Ecosystems		SCI.LS2.B.5 Matter cycles between the air and soil and among organisms as they live and die.	SCI.LS2.B.m The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem.	SCI.LS2.B.h Photosynthesis and cellular respiration provide most of the energy for life processes. Only a fraction of matter consumed at the lower level of a food web is transferred up, resulting in fewer organisms at higher levels. At each link in an ecosystem elements are combined in different ways and matter and energy are conserved. Photosynthesis and cellular respiration are key components of the global carbon cycle.
SCI.LS2.C: Ecosystem Dynamics, Functioning, and Resilience		SCI.LS2.C.3 When the environment changes some organisms survive and reproduce, some move to new locations, some move into transformed environments, and some die.	SCI.LS2.C.m Ecosystem characteristics vary over time. Disruptions to any part of an ecosystem can lead to shifts in all of its populations. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.	SCI.LS2.C.h If a biological or physical disturbance to an ecosystem occurs, including one induced by human activity, the ecosystem may return to its more or less original state or become a very different ecosystem, depending on the complex set of interactions within the ecosystem.
SCI.LS2.D: Social Interactions and Group Behavior		SCI.LS2.D.3 Being part of a group helps animals obtain food, defend themselves, and cope with changes.	SCI.LS2.D.m 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.	SCI.LS2.D.h Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.
SCI.LS2: CONNECTIONS				
Wisconsin Connections	As with LS1, native Wisconsin organisms could be emphasized (A.2)	Phosphorous flows into the streams and lakes and impacts algae growth (B.5) Red winged blackbirds	Exploring reasons for lake trout decline in Lake Michigan (A.m) Role of predators (i.e. wolves, coyotes, bears) limiting population of deer (A.m)	Look at WI DNR data for white tail deer and determining deer management related to carrying capacity (A.h) Isle Royale wolves/moose data (A.h)

		alert others of a hawk overhead (D.3) Garter Snakes hibernate in groups to retain temperature (D.3)	Weather/climate limiting population of deer, turkeys, opossums, snowshoe hares (A.m) Eagle reproduction rate in Lake Superior and Lake Michigan (A.m) Effect of deer populations on forest biodiversity (C.m)	Evaluate WI habitats for biodiversity, including support and planning for urban, suburban, and rural biodiversity efforts (A.h, D.h) Cycles of matter at farms (e.g. manure spreading) (B.h) Earthworm effects on WI forests (C.h) Baraboo River dam removal restoration project as an example of ecosystem resilience (C.h)
Engineering, Technology & Society Connections	Sustainable building design, such as green roofs Hydroponics	Impacts of engineering solutions to problems: dams, infrastructure, etc. Rain gardens	Biodomes Manure digesters	Bioengineering: Designing systems to use microbes to break down waste Stormwater solutions to in towns/cities as well as for school's impervious surfaces

SCI.LS2: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	2-LS2-1: Plan and conduct an investigation to determine if plants need sunlight and water to grow. 2-LS2-2: Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
Grades 3-5	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.
Grades 6-8	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. MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Grades 9-12	HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. 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. 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. HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem 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. 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.

Standard SCI.LS3--Heredity: Students use science and engineering practices, crosscutting concepts, and an understanding of heredity, inheritance and the variation of traits to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.LS3.A: Inheritance of Traits	SCI.LS3.A.1 Young organisms are very much, but not exactly, like their parents and also resemble other organisms of the same kind.	SCI.LS3.A.3 Many characteristics of organisms are inherited from their parents. Other characteristics result from individual's interactions with the	SCI.LS3.A.m Genes chiefly regulate a specific protein, which affect an individual's traits.	SCI.LS3.A.h DNA carries instructions for forming species' characteristics. Each cell in an organism has the same genetic content, but the genes expressed by cells can differ.

		environment. Many characteristics involve both inheritance and environment.		
SCI.LS3.B: Variation of Traits	SCI.LS3.B.1 Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.	SCI.LS3.B.3 Different organisms vary in how they look and function because they have different inherited information; the environment also affects the traits that an organism develops.	SCI.LS3.B.m In sexual reproduction, each parent contributes half of the genes acquired by the offspring resulting in variation between parent and offspring. Genetic information can be altered because of mutations, which may result in beneficial, negative, or no change to proteins in or traits of an organism.	SCI.LS3.B.h The variation and distribution of traits in a population depend on genetic and environmental factors. Genetic variation can result from mutations caused by environmental factors or errors in DNA replication, or from chromosomes swapping sections during meiosis
SCI.LS3: CONNECTIONS				
Wisconsin Connections	Collect samples of native and non-native Wisconsin organisms (e.g. maple leaves or Japanese beetles) to compare (A.1, B.1)	WI Fast Plants have genetic variation in pigment in the stems (A.3; B.3)	Breeding of livestock (B.m) Cross-pollinations of crops, fruit trees (B.m)	Genetic engineering of bioluminescence (A.h) Sickle cell anemia and prevalence by different demographics (B.h) Fast plants (A.h, B.h) Genetic analysis using online bioinformatics tools (B.h)
Engineering, Technology & Society Connections			Bioluminescent genetic engineering Artificial selection to emphasize particular traits	Genetically modified organisms NAE Grand Challenge - engineer better medicines
SCI.LS3: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS				
Grades K-2	1-LS3-1: Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like,their parents.			

Grades 3-5	3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. 3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.
Grades 6-8	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. 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.
Grades 9-12	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 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.

Standard SCI.LS4--Evolution: Students use science and engineering practices, crosscutting concepts, and an understanding of <u>the unity and diversity that results from biological evolution</u> to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.LS4.A: Evidence of Common Ancestry and Diversity	SCI.LS4.A.2 A range of different organisms lives in different places.	SCI.LS4.A.3 Some living organisms resemble organisms that once lived on Earth. Fossils provide evidence about the types of organisms and environments that existed long ago.	SCI.LS4.A.m The fossil record documents the existence, diversity, extinction, and change of many life forms and their environments through Earth's history. The fossil record and comparisons of anatomical similarities between organisms enables the inference of lines of	SCI.LS4.A.h The ongoing branching that produces multiple lines of descent can be inferred by comparing DNA sequences, amino acid sequences, and anatomical and embryological evidence of different organisms

			evolutionary descent.	
SCI.LS4.B: Natural Selection		SCI.LS4.B.3 Differences in characteristics between individuals of the same species provide advantages in surviving and reproducing.	SCI.LS4.B.m Both natural and artificial selection result from certain traits giving some individuals an advantage in surviving and reproducing, leading to predominance of certain traits in a population.	SCI.LS4.B.h Natural selection occurs only if there is variation in the genes and traits between organisms in a population. Traits that positively affect survival can become more common in a population.
SCI.LS4.C: Adaptation		SCI.LS4.C.3 Particular organisms can only survive in particular environments	SCI.LS4.C.m Species can change over time in response to changes in environmental conditions through adaptation by natural selection acting over generations. Traits that support successful survival and reproduction in the new environment become more common.	SCI.LS4.C.h Evolution results primarily from genetic variation of individuals in a species, competition for resources, and proliferation of organisms better able to survive and reproduce. Adaptation means that the distribution of traits in a population, as well as species expansion, emergence or extinction, can change when conditions change.
SCI.LS4.D: Biodiversity and Humans		SCI.LS4.D.3 Populations of organisms live in a variety of habitats. Change in those habitats affects the organisms living there.	SCI.LS4.D.m Changes in biodiversity can influence humans' resources and ecosystem services they rely on.	SCI.LS4.D.h Biodiversity is increased by formation of new species and reduced by extinction. Humans depend on biodiversity but also have adverse impacts on it. Sustaining biodiversity is essential to supporting life on Earth.
SCI.LS4: CONNECTIONS				
Wisconsin Connections	Compare WI organisms to a state or country with a very different climate; virtually connect with a classroom in that climate (A.2)	Trilobite fossils in Wisconsin (state fossil)(A.3) Cooper's Hawks east of the Mississippi are larger than west of the Mississippi due to	Mammoths and mastodons in the Ice Age (A.m) Beaver population influence on trout fishing and other biodiversity (D.m) Loss of wetlands (D.m)	Simulation or investigation of diatom and other populations in rivers to see pollution impact (C.h) Look at data on fishing limits and catch sizes and effect on fish populations over time (D.h) Biodiversity index calculations of school yard (D.h)

		different prey (grounds squirrels vs. small birds) and navigating open spaces vs. dense forests (B.3)	Prairies to agriculture land and back (D.m) Old growth forest loss (D.m) Flow of deer genes across Wisconsin and Mississippi Rivers (C.m)	Whooping cranes history (D.h) Antibiotic resistance concerns in hospitals and beyond, e.g. in the Milwaukee waterways there are several strains of antibiotic resistant microbes; farmers look for antibiotic alternatives
Engineering, Technology & Society Connections	Biomimicry, e.g. what can we design based on how animals keep warm or protect themselves?	Engineering better habitats for zoo animals	Artificial selection in breeding of livestock and crop production, e.g. propagating new apple varieties	Aeronautical engineering and the study of adaptations in bird flight over time Vaccines Crop diseases
SCI.LS4: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS				
Grades K-2	2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitat.			
Grades 3-5	3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. 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. 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. 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			
Grades 6-8	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. 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 relationship 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. 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. MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. 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.
Grades 9-12	HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. 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. 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. HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations 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. HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Content Area: PHYSICAL SCIENCE

Standard SCI.PS1: Students use science and engineering practices, crosscutting concepts, and an understanding of matter and its interactions to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.PS1.A: Structures and Properties of Matter and Nuclear Processes	SCI.PS1.A.2 Matter exists as different substances that have different observable properties. Different properties are suited to different purposes. Objects can be built up from smaller parts.	SCI.PS1.A.5 Matter exists as particles that are too small to see. Matter is always conserved even if it seems to disappear. Measurements of a variety of observable properties can be used to identify particular materials.	SCI.PS1.A.m The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.	SCI.PS1.A.h The sub-atomic structural model and interactions between electric charges at the atomic scale can be used to explain the structure and interactions of matter, including chemical reactions and nuclear processes. Repeating patterns of the periodic table reflect patterns of outer electrons. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy to take the molecule apart. Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.
SCI.PS1.B: Chemical Reactions	SCI.PS1.B.2 Heating and cooling substances cause changes that are sometimes reversible and sometimes not.	SCI.PS1.B.5 Chemical reactions that occur when substances are mixed can be identified by the emergence of substances with different properties. In chemical reactions the total mass remains the same.	SCI.PS1.B.m Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.	SCI.PS1.B.h Chemical processes are understood in terms of collisions of molecules, rearrangement of atoms, and changes in energy as determined by properties of elements involved.

SCI.PS1: CONNECTIONS

Wisconsin Connections	Lakes freeze in the winter and thaw again in the spring (B.2)	Soil chemistry - what is are normal properties? What needs to be added to support crop growth? Connect to local co-ops (A.5, B.5) Current and historical ore mining methods relate to the properties of the materials (A.5) Study of solutions could include white salt film left on roads in early spring (B.5)	Analyze changes in chemical composition of bodies of water over time and the results of abnormal chemical reactions (A.m, B.m) How salt on roads works, when it does not work, and evaluating alternatives (A.m) Chemical reactions of the dairy industry (B.m)	The LaCrosse, Point Beach, and Kewaunee Nuclear Plants provide electrical power to communities across Wisconsin -- power generation, safety, and waste, as compared to other types of power plants (A.h) Evaluating the conversion of cellulosic biomass to ethanol as a potential renewable energy source (A.h) IceCube Neutrino research project at UW-Madison (A.h)
Engineering, Technology & Society Connections	Materials Science and Engineering: evaluating properties of materials for certain purposes (such as making a shelter)	Evaluating different materials for bridge design and repair	Metal rockets - special design considerations for range of temperatures Hot and cold packs	Plastics and polymers: design and optimize polymers for certain applications Explore and improve designs for water softeners, noting why we need them in Wisconsin Creating biofuels and comparing combustion of different fuel types
SCI.PS1: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS				
Grades K-2	2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. 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. 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. 2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.			

Grades 3-5	5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. 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. 5-PS1-3. Make observations and measurements to identify materials based on their properties. 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances
Grades 6-8	MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. 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. MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. 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. 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. MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
Grades 9-12	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. 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. 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. 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. 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. 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.

Standard SCI.PS2: Students use science and engineering practices, crosscutting concepts, and an understanding of forces, interactions, motion and stability to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.PS2.A: Forces and Motion	SCI.PS2.A.K Pushes and pulls can have different strengths and directions, and can change the speed or direction of an object's motion or start or stop it. A bigger push or pull makes things speed up or slow down more quickly.	SCI.PS2.A.3 The effect of unbalanced forces on an object results in a change of motion. Patterns of motion can be used to predict future motion.	SCI.PS2.A.m The role of the mass of an object must be qualitatively accounted for in any change of motion due to the application of a force (Newton's first and second law).. 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 (Newton's third law).	SCI.PS2.A.h Newton's 2nd law (F=ma) and the conservation of momentum can be used to predict changes in the motion of macroscopic objects 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.
SCI.PS2.B: Types of Interactions	SCI.PS2.B.K When objects touch or collide, they push on one another and can result in a change of motion.	SCI.PS2.B.3 Some forces act through contact, some forces (e.g. magnetic, electrostatic) act even when the objects are not in contact.	SCI.PS2.B.m Forces that act at a distance involve fields that can be mapped by their relative strength and effect on an object	SCI.PS2.B.h Forces at a distance are explained by fields that can transfer energy and can be described in terms of the arrangement and properties of the interacting objects and the distance between them. These forces can be used to describe the relationship between electrical and magnetic fields.

		SCI.PS2.B.5 The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.		Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
SCI.PS2: CONNECTIONS				
Wisconsin Connections	Green Bay Packers collisions (A.K, B.K) How hard you hit a hockey puck relating to how far it goes (A.K) School playground (A.K)	Local summer fairs, carnivals, and amusement park rides (A.3, B.5)	Spaceport Sheboygan - the only one in the Midwest (A.m) Oshkosh Corp design of armored vehicles to withstand forces (A.m) Increased static electricity in Wisconsin's dry winters (B.m)	Experimental Aircraft Association in Oshkosh - connections to private and military aircraft (A.h) Northern lights in Northern WI and magnetic fields (B.h)
Engineering, Technology & Society Connections	Newton cars (where a weight is launched off the "car" with a rubber band)	Design toys or transportation methods that use gravitational, magnetic, or other forces Simple machines	Engineering to solve impact problems: car safety design; sports helmet design, etc. Local construction projects Design paper airplanes and scientifically evaluate performance	Maglev trains Designing electrostatic devices (e.g. recycling sorters), and electromagnetic devices (e.g. generators) Problem solving through/within robotics
SCI.PS2: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS				
Grades K-2	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. 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.			

Grades 3-5	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. 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. 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. 3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets. 5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.
Grades 6-8	MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. 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. MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. 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. 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.

Grades 9-12	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. HS-PS2-2. Use mathematical representations (qualitative and quantitative) to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. 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. HS-PS2-4. Use mathematical representations (qualitative and quantitative) of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. 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. HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Standard SCI.PS3: Students use science and engineering practices, crosscutting concepts, and an understanding of energy to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.PS3.A: Definitions of Energy and Conservation of Energy and Energy Transfer	SCI.PS3.A NA	SCI.PS3.A.4 Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.	SCI.PS3.A.m Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.	SCI.PS3.A.h The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of energy associated with the motion or configuration of particles (objects).

SCI.PS3.B: Relationships Between Energy and Forces	SCI.PS3.B.K Bigger pushes and pulls cause bigger changes in an object's motion or shape.	SCI.PS3.B.4 When objects collide, contact forces transfer energy so as to change the objects' motions.	SCI.PS3.B.m When two objects interact, each one exerts a force on the other, and these forces can transfer energy between the interacting objects..	SCI.PS3.B.h Fields contain energy that depends on the arrangement of the objects in the field.
SCI.PS3.C: Energy in Chemical Processes and Everyday Life	SCI.PS3.C.K Sunlight warms Earth's surface.	SCI.PS3.C.4, 5 Energy can be "produced," "used," or "released" by converting stored energy. Plants capture energy from sunlight, which can later be used as fuel or food.	SCI.PS3.C.m Sunlight is captured by plants and used in a reaction to produce sugar molecules, which can be reversed by burning those molecules to release energy.	SCI.PS3.C.h Photosynthesis is the primary biological means of capturing radiation from the sun; energy cannot be destroyed, it can be converted to less useful forms. Systems move toward stable states.
SCI.PS3: CONNECTIONS				
Wisconsin Connections	Observe patterns in how much sunlight warms objects in the schoolyard in different seasons and with different weather (C.K)	What makes wind and solar power viable energy sources in Wisconsin? Compare their efficiency in Wisconsin to other climates and latitudes (A.4) How is energy "produced, used, or released" in your area? (C.4, C.5)	Temperatures above 0°C cause a positive pressure inside of a tree which can result in the flow of sap (A.m) Biofuels (D.m)	Evaluate energy transfers within systems such as farms, local dams, or power grids (A.m), and how that transfer compares to native organisms (A.h, C.h)
Engineering, Technology & Society Connections	Design a solar oven Design a shade that allows some light through but still keeps an area cool	Design a turbine blade for wind or water power Solving problems through electronic circuit design	Design an insulated container for food or other perishable items, e.g. vaccines in areas with hot climates and limited refrigeration	Investigate possibilities for making solar power more affordable (National Academy of Engineering Grand Challenge) Explore artificial photosynthesis

SCI.LPS3: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface. K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.
Grades 3-5	4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. 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.
Grades 6-8	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 (emphasis on qualitative descriptions of relationships). MS-PS3-2. Develop a model to describe that when the distance between two objects changes, different amounts of potential energy are stored in the system (e.g. gravitational, magnetic or electrostatic potential energy). MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. 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. 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.

Grades 9-12	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. 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 position of particles (objects). 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. 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). 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.

Standard SCI.PS4: Students use science and engineering practices, crosscutting concepts, and an understanding of waves and their applications in technologies for information transfer to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.PS4.A: Wave Properties	SCI.PS4.A.1 Sound can make matter vibrate, and vibrating matter can make sound	SCI.PS4.A.4 Waves are regular patterns of motion, which can be made in water by disturbing the surface. Waves of the same type can differ in amplitude and wavelength. Waves can make objects move.	SCI.PS4.A.m A simple wave model has a repeating pattern with a specific wavelength, frequency, and amplitude, and mechanical waves need a medium through which they are transmitted. This model can explain many phenomena including sound and light. Waves can transmit energy.	SCI.PS4.A.h The wavelength and frequency of a wave are related to one another by the speed of the wave, which depends on the type of wave and the medium through which it is passing. Waves can be used to transmit information and energy.
SCI.PS4.B: Electromagnetic Radiation	SCI.PS4.B.1 Objects can be seen only when light is available to illuminate them.	SCI.PS4.B.4 Objects can be seen when light reflected from their surface enters our eyes.	SCI.PS4.B.m The construct of a wave is used to model how light interacts with objects.	SCI.PS4.B.h Both an electromagnetic wave model and a photon model explain features of electromagnetic radiation broadly and describe common applications of electromagnetic radiation.

SCI.PS4.C: Information Technologies and Instrumentation	SCI.PS4.C.1 People use devices to send and receive information.	SCI.PS4.C.4 Patterns can encode, send, receive and decode information.	SCI.PS4.C.m Waves can be used to transmit digital information. Digitized information is comprised of a pattern of 1s and 0s.	SCI.PS4.C.h Large amounts of information can be stored and shipped around as a result of being digitized.
SCI.PS4: CONNECTIONS				
Wisconsin Connections	Clintonville's odd noises due to the earth moving (A.1) Sounds of different seasons - from ice to birds to mosquitoes (A.1)	Wave observations and their impacts at local bodies of water (A.4)	Explore sounds of insects above and below water and how that relates to predation (A.m) Explore how the Wisconsin Emergency Broadcast System uses waves to communicate and consider ways to improve their system (C.m)	Investigate the placement of cell towers, strength of signals, and service quality across WI (C.m) Earth or ice quake detection using the speed of waves (A.h)
Engineering, Technology & Society Connections	Design a "better" cup and string phone Use light or sound to communicate a message over a distance	Design strategies to aid color blind people in distinguishing between colors Build or examine speakers or headphones and be able to determine how they generate sound	Explore how waves are used in ultrasound machines, fish finders, ocean sonar equipment, remote controls, etc. in order to use waves to solve a problem in our daily lives (e.g. communication, digital transmission, etc.) Design a tornado resistant structure	Determine how using observations at different electromagnetic wavelengths helps astronomers explore the universe Explore how amplitude modulation and frequency modulation transmit information using radio waves, and why each might be used Compare how DVDs, flash drives, and other electronic storage devices work and why each might be used
SCI.PS4: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS				
Grades K-2	1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. 1-PS4-2. Make observations to construct an evidence-based account that objects can be seen only when illuminated.			

	1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light. 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.
Grades 3-5	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. 4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. 4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.
Grades 6-8	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. MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. 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.
Grades 9-12	HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information. 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. 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.

Content Area: EARTH AND SPACE SCIENCE				
Standard SCI.ESS1: Students use science and engineering practices, crosscutting concepts, and an understanding of Earth's place in the universe to make sense of phenomena and solve problems.				
	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.ESS1.A: The Universe and Its Stars	SCI.ESS1.A.1 Patterns of movement of the sun, moon, and stars as seen from Earth can be observed, described, and predicted.	SCI.ESS1.A.5 Stars range greatly in size and distance from Earth and this can explain their relative brightness	SCI.ESS1.A.m The solar system is part of the Milky Way, which is one of many billions of galaxies.	SCI.ESS1.A.h Light spectra from stars are used to determine their characteristics, processes, and lifecycles. Solar activity creates the elements through nuclear fusion. The development of technologies has provided the astronomical data that provide the empirical evidence for the Big Bang theory.
SCI.ESS1.B: Earth and the Solar System.	SCI.ESS1.B.1 Seasonal patterns of sunrise and sunset can be observed, described, and predicted.	SCI.ESS1.B.5 The Earth's orbit and rotation, and the orbit of the moon around the Earth cause observable patterns.	SCI.ESS1.B.m The solar system contains many varied objects held together by gravity. Solar system models explain and predict eclipses, lunar phases, and seasons	SCI.ESS1.B.h Kepler's laws describe common features of the motions of orbiting objects. Observations from astronomy and space probes provide evidence for explanations of solar system formation. Changes in Earth's tilt and orbit cause changes in climate such as Ice Ages.
SCI.ESS1.C: The History of Planet Earth	SCI.ESS1.C.2 Some events on Earth occur very quickly; others can occur very slowly.	SCI.ESS1.C.4 Certain features on Earth can be used to order events that have occurred in a landscape.	SCI.ESS1.C.m Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth's history.	SCI.ESS1.C.h The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations.
SCI.ESS1: CONNECTIONS				

Wisconsin Connections	Describe patterns related to Wisconsin's seasons, solar intensity, length of daylight, and location of the sun in the sky at different times of the year (A.1, B.1)	Across Wisconsin, various landforms give evidence of ancient plate tectonics, erosional forces, and more recently - glacial activity. (C.4)	Yerkes Observatory in Williams Bay, WI was built in 1897 and is still the world's largest refractor telescope and continues to be used for astronomical research. (A.m) Wisconsin rock strata shows evidence of Precambrian Penokee mountain range (once as high as the Rockies) that were later eroded down and gave way to Paleozoic shallow seas to form sedimentary rock layers during Cambrian to Devonian Periods. (C.m)	Geographical provinces of Wisconsin (C.h) Wisconsin has experienced numerous plate tectonic events throughout Precambrian Period including continental plate collisions two different occasions (formed Baraboo hills), the building of the Penokee Mountains and their later erosion to a peneplain which was then covered by inland shallow seas of the Cambrian, Ordovician, Silurian, and Devonian periods. (C.h) More recently Wisconsin experienced repeated continental glacial advances and subsequent retreats that left behind landform evidence in the form of moraines, drumlins, eskers, kames, kettles, buried forests, erratic boulders, outwash plains, and glacial lakes.(C.h) The geology and terrain of Wisconsin can provide evidence of our glacial history. The movements of past ice sheets brought about changes in the landscape seen today.(C.h)
Engineering, Technology & Society Connections	Design a "clock" that uses shadows to tell the time of day.	Evaluate the geological features of a community to determine where a bridge, landfill, hydroelectric dam, etc. should be placed	Reverse engineer a telescope	

SCI.ESS1: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted. 1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year. 2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

Grades 3-5	4-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 differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth. 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.
Grades 6-8	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. MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system. 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.
Grades 9-12	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 that eventually reaches Earth in the form of radiation. 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. HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements. 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.
Standard SCI.ESS2: Students use science and engineering practices, crosscutting concepts, and an understanding of Earth's systems to make sense of phenomena and solve problems.	
	Performance Indicators (By Grade Band)

Learning Element	K-2	3-5	6-8	9-12
SCI.ESS2.A: Earth Materials and Systems	SCI.ESS2.A.2 Wind and water change the shape of the land.	SCI.ESS2.A.4,5 Four major Earth systems interact. Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, organisms, and gravity break rocks, soils, and sediments into smaller pieces and move them around.	SCI.ESS2.A.m Energy flows and matter cycles within and among Earth's systems, including the sun and Earth's interior as primary energy sources. Plate tectonics is one result of these processes.	SCI.ESS2.A.h Feedback effects exist within and among Earth's systems.
SCI.ESS2.B: Plate Tectonics and Large-Scale System Interactions	SCI.ESS2.B.2 Maps show where things are located. One can map the shapes and kinds of land and water in any area.	SCI.ESS2.B.4 Earth's physical features occur in patterns, as do earthquakes and volcanoes. Maps can be used to locate features and determine patterns in those events.	SCI.ESS2.B.m Plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history. Maps are used to display evidence of plate movement.	SCI.ESS2.B.h Radioactive decay within Earth's interior contributes to thermal convection in the mantle.
SCI.ESS2.C: The Roles of Water in Earth's Surface Processes	SCI.ESS2.C.2 Water is found in many types of places and in different forms on Earth.	SCI.ESS2.C.5 Most of Earth's water is in the ocean and much of the Earth's freshwater is in glaciers or underground.	SCI.ESS2.C.m Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of sea water drive interconnected ocean currents. Water movement causes weathering and erosion, changing landscape features.	SCI.ESS2.C.h The planet's dynamics are greatly influenced by water's unique chemical and physical properties.

SCI.ESS2.D: Weather and Climate	SCI.ESS2.D.K Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region and time. People record weather patterns over time.	SCI.ESS2.D.3 Climate describes patterns of typical weather conditions over different scales and variations. Historical weather patterns can be analyzed.	SCI.ESS2.D.m Complex interactions determine local weather patterns and influence climate, including the role of the ocean.	SCI.ESS2.D.h The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundation for the global climate system. Global climate models are used to predict future changes, including changes influenced by human behavior and natural factors.
SCI.ESS2.E: Biogeology	SCI.ESS2.E.K Plants and animals can change their local environment.	SCI.ESS2.E.4 Living things can affect the physical characteristics of their environment.	SCI.ESS2.E.m [Content found in LS4.A The fossil record documents the existence, diversity, extinction, and change of many life forms throughout history.	SCI.ESS2.E.h The biosphere and Earth's other systems have many interconnections that cause a continual coevolution of Earth's surface and life on it
SCI.ESS2: CONNECTIONS				
Wisconsin Connections	Beavers change their environment to meet their needs (E.K)	Wisconsin is home to 15,000 inland freshwater lakes (most are glacially formed) and our state borders two of the five Great Lakes, which are the largest collection of freshwater lakes in the world by total area, and contain 21% of Earth's surface fresh water by volume. (C.5) Comparing Wisconsin climate patterns to other parts of the U.S. and world (D.3)	Earthquakes are very rare across Wisconsin having only 19 recorded seismic events since early 1900's according to USGS Data (B.m) Quantitative analysis of Wisconsin weather and climate data (D.m)	Creating simulations and predictions of Wisconsin weather and climate data (D.h)

Engineering, Technology & Society Connections	Engineering adaptations to different climatic regions	NAE Grand Challenge: Providing Access to Clean Water (water purification, small and large scale)	Hydropower	Engineering can support solutions to changing climate

SCI.ESS2: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time. 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-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. 2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area. 2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.
Grades 3-5	3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. 3-ESS2-2. Obtain and combine information to describe climates in different regions of the world. 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. 4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features. 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. 5-ESS2-2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
Grades 6-8	MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives plate tectonics. MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. 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.

	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. MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. 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
Grades 9-12	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. 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. HS-ESS2-3. Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection. 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. HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. 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.

Standard SCI.ESS3: Students use science and engineering practices, crosscutting concepts, and an understanding of Earth and human activity to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.ESS3.A: Natural Resources	SCI.ESS3.A.K Living things need water, air, and resources from the land, and they live in places that have the things they need.	SCI.ESS3.A.4 Energy and fuels humans use are derived from natural sources and their use affects the environment. Some	SCI.ESS3.A.m Humans depend on Earth’s land, oceans, fresh water, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed	SCI.ESS3.A.h Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.

	Humans use natural resources for everything they do.	resources are renewable over time, others are not.	unevenly around the planet as a result of past geologic processes.	
SCI.ESS3.B: Natural Hazards	SCI.ESS3.B.K In a region, some kinds of severe weather are more likely than others. Forecasts allow communities to prepare for severe weather	SCI.ESS3.B.3,4 A variety of hazards result from natural processes; humans cannot eliminate hazards but can reduce their impacts.	SCI.ESS3.B.m Mapping the history of natural hazards in a region and understanding related geological forces.	SCI.ESS3.B.h Natural hazards and other geological events have shaped the course of human history at local, regional, and global scales.
SCI.ESS3.C: Human Impacts on Earth Systems	SCI.ESS3.C.K Things people do can affect the environment but they can make choices to reduce their impacts.	SCI.ESS3.C.5 Societal activities have had major effects on the land, ocean, atmosphere, and even outer space. Societal activities can also help protect Earth's resources and environments.	SCI.ESS3.C.m Human activities have altered the hydrosphere, atmosphere, and lithosphere which in turn has altered the biosphere. Changes to the biosphere can have different impacts for different living things. Activities and technologies can be engineered to reduce people's impacts on Earth.	SCI.ESS3.C.h Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies.
SCI.ESS3.D: Global Climate Change			SCI.ESS3.D.m Evidence suggests human activities affect global warming. Decisions to reduce the impact of global warming depend on understanding climate science, engineering capabilities, and social dynamics.	SCI.ESS3.D.h Global climate models used to predict changes continue to be improved, although discoveries about the global climate system are ongoing and continually needed.
SCI.ESS3: CONNECTIONS				
Wisconsin Connections	We use groundwater in Wisconsin for drinking and to grow food (A.K)	The world's reserves for nonrenewable fuel sources (crude oil, natural gas, and coal) are projected to start running out in the next few generations. Wisconsin uses about	Ecological footprint calculators will allow students to see how their own and family's choices can impact Earth's resources (A, C, D.m) Analyze and interpret historical	Researching historical ice in and ice out data for lakes across the state and relating that to global climate models (D.h)

		37% of its corn crop to produce more than 500 million gallons of ethanol each year. (A)	WI weather service data on severe weather impacts (B.m)	
Engineering, Technology & Society Connections		Designing around impacts of extreme events: Earthquake resistant buildings and structures; Tsunami warning systems, etc.	Energy sources, improving existing means to get energy	National Academy of Engineering Grand Challenge: Develop carbon sequestration methods Sustainable Development

SCI.ESS3: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. 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.
Grades 3-5	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. 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
Grades 6-8	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. 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. MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

	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. MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
Grades 9-12	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. HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. 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.

Content Area: ENGINEERING, TECHNOLOGY, AND THE APPLICATION OF SCIENCE				
Standard: SCI.ETS1: Students use science and engineering practices, crosscutting concepts, and an understanding of Engineering design to make sense of phenomena and solve problems.				
	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.ETS1.A: Defining and Delimiting Engineering Problems	SCI.ETS1.A.K-2 A situation that people want to change or create can be approached as a problem to be solved through engineering. Asking questions, making observations, and gathering information are helpful in thinking about problems. Before beginning to design a solution, it is important to clearly understand the problem.	SCI.ETS1.A.3-5 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). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	SCI.ETS1.A.m The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	SCI.ETS1.A.h Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
SCI.ETS1.B: Developing Possible Solutions	SCI.ETS1.B.K-2 Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	SCI.ETS1.B.3-5 Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared	SCI.ETS1.B.m A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for	SCI.ETS1.B.h When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.

		ideas can lead to improved designs. Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.	testing solutions.	
SCI.ETS1.C: Optimizing the Design Solution	SCI.ETS1.C.K-2 Because there is more than one possible solution to a problem, it is useful to compare and test designs.	SCI.ETS1.C.3-5 Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	SCI.ETS1.C.m Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	SCI.ETS1.C.h Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

SCI.ETS1: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	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. 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. 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.
Grades 3-5	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. 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.

	3-5-ETS1-2. 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.
Grades 6-8	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. MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. 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. 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.
Grades 9-12	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. 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. 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. 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.

Standard: SCI.ETS2: Students use science and engineering practices, crosscutting concepts, and an understanding of the Links Among Engineering, Technology, Science, and Society to make sense of phenomena and solve problems.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.ETS2.A: Interdependence of Science, Engineering, and	SCI.ETS2.A.K-2 Science and engineering involve the use of tools to	SCI.ETS2.A.3-5 Science and technology support each other.	SCI.ETS2.A.m Engineering advances have led to important discoveries in virtually every field of science and	SCI.ETS2.A.h Science and engineering complement each other in the cycle known as research and development (R&D).

Technology	observe and measure things.	Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.	scientific discoveries have led to the development of entire industries and engineered systems. Science and technology drive each other forward	Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise
SCI.ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World	SCI.ETS2.B.K-2 Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials. Taking natural materials to make things impacts the environment.	SCI.ETS2.B.3-5 People's needs and wants change over time, as do their demands for new and improved technologies. Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. When new technologies become available, they can bring about changes in the way people live and interact with one another.	SCI.ETS2.B.m All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Technology use varies over time and from region to region.	SCI.ETS2.B.h Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

SCI.ETS2: EXAMPLE THREE-DIMENSIONAL PERFORMANCE EXPECTATIONS	
Grades K-2	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. 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.

Grades 3-5	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 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
Grades 6-8	MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services. MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
Grades 9-12	HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Discipline: SCIENCE				
Content Area: SCIENCE AND ENGINEERING PRACTICES				
Standard SCI.SEP1: Students will be able to ask questions and define problems.				
	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP1.A: Questions Based on Observations	SCI.SEP1.A.K-2 Ask questions based on observations to find more information about the natural and/or designed world(s)	SCI.SEP1.A.3-5 Ask questions about what would happen if a variable is changed.	SCI.SEP1.A.m Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument. Ask questions to determine relationships between independent and dependent variables and relationships in models. Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.	SCI.SEP1.A.h Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Ask questions to clarify and refine a model, an explanation, or an engineering problem.
SCI.SEP1.B: Questions Answered by Investigations	SCI.SEP1.B.K-2 Ask and/or identify questions that can be answered by an investigation.	SCI.SEP1.B.3-5 Identify scientific (testable) and non-scientific (non-testable) questions.	SCI.SEP1.B.m Ask questions that require sufficient and appropriate empirical evidence to answer. Ask questions that can be	SCI.SEP1.B.h Evaluate a question to determine if it is testable and relevant. Ask questions that can be investigated within the scope of the school laboratory, research facilities, or

		Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships	investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
SCI.SEP1.C: Questions That Challenge Arguments	N/A	N/A	SCI.SEP1.C.m Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.	SCI.SEP1.C.h Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of the design.
SCI.SEP1.D: Defining a Problem	SCI.SEP1.D.K-2 Define a simple problem that can be solved through the development of a new or improved object or tool.	SCI.SEP1.D.3-5 Use prior knowledge to describe problems that can be solved. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	SCI.SEP1.D.m Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	SCI.SEP1.D.h Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Standard SCI.SEP2: Students will be able to develop and use models.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP2.A: Definition and Limitations of Models	SCI.SEP2.A.K-2 Distinguish between a model and the actual object, process, and/or events the model represents.	SCI.SEP2.A.3-5 Identify limitations of models.	SCI.SEP2.A.m Evaluate limitations of a model for a proposed object or tool.	SCI.SEP2.A.h Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria.

	Compare models to identify common features and differences.			Design a test of a model to ascertain its reliability.
SCI.SEP2.B: Models that Represent Amounts, Relationships, Scales, and Patterns	SCI.SEP2.B.K-2 Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	SCI.SEP2.B.3-5 Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. Develop and/or use models to describe and/or predict phenomena.	SCI.SEP2.B.m Develop or modify a model— based on evidence – to match what happens if a variable or component of a system is changed. Use and/or develop a model of simple systems with uncertain and less predictable factors. Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. Develop and/or use a model to predict and/or describe phenomena. Develop a model to describe unobservable mechanisms.	SCI.SEP2.B.h Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
SCI.SEP2.C: Models that Represent a Proposed Object	SCI.SEP2.C.K-2 Develop a simple model based on evidence to represent a proposed object or tool.	SCI.SEP2.C.3-5 Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. Use a model to test cause and effect relationships or interactions concerning the	SCI.SEP2.C.m Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.	SCI.SEP2.C.h Develop a complex model that allows for manipulation and testing of a proposed process or system. Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

		functioning of a natural or designed system.		

Standard SCI.SEP3: Students will be able to plan and carry out investigations.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP3.A: Planning and Conducting Investigations	SCI.SEP3.A.K-2 With guidance, plan and conduct an investigation in collaboration with peers (for K). Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.	SCI.SEP3.A.3-5 Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	SCI.SEP3.A.m Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.	SCI.SEP3.A.h Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible variables or effects and evaluate the confounding investigation's design to ensure variables are controlled. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.
SCI.SEP3.B: Evaluating Data Collection Methods	SCI.SEP3.A.K-2 Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer the question being studied.	SCI.SEP3.A.3-5 Evaluate appropriate methods and/or tools for collecting data.	SCI.SEP3.A.m Evaluate the accuracy of various methods for collecting data.	SCI.SEP3.A.h Select appropriate tools to collect, record, analyze, and evaluate data.

SCI.SEP3.C: Making Observations and Collecting Data	SCI.SEP3.C.K-2 Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons. Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal. Make predictions based on prior experiences.	SCI.SEP3.C.3-5 Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Make predictions about what would happen if a variable changes. Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	SCI.SEP3.C.m Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. Collect data about the performance of a proposed object, tool, process, or system under a range of conditions.	SCI.SEP3.C.h Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.
Standard SCI.SEP4: Students will be able to analyze and interpret data.				
	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP4.A: Record, Describe, and Represent Data	SCI.SEP4.A.K-2 Record information (observations, thoughts, and ideas). Use and share pictures, drawings, and/or writings of observations.	SCI.SEP4.A.3-5 Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.	SCI.SEP4.A.m Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to	SCI.SEP4.A.h Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

	Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. Compare predictions (based on prior experiences) to what occurred (observable events).		identify temporal and spatial relationships. Distinguish between causal and correlational relationships in data. Analyze and interpret data to provide evidence for phenomena.	
SCI.SEP4.B: Use Concepts of Statistics		SCI.SEP4.B.3-5 Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.	SCI.SEP4.B.m Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible.	SCI.SEP4.B.h Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
SCI.SEP4.C: Limitations of Data		SCI.SEP4.C.3-5 NA	SCI.SEP4.C.m Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).	SCI.SEP4.C.h Consider and address more sophisticated limitations of data analysis (e.g., sample selection) when analyzing and interpreting data
SCI.SEP4.D: Compare and Contrast Data Sets		SCI.SEP4.D.3-5 Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.	SCI.SEP4.D.m Analyze and interpret data to determine similarities and differences in findings.	SCI.SEP4.D.h Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
SCI.SEP4.E: Use Data to Refine an Explanation or Design	SCI.SEP4.E.K-2 Analyze data from tests of an object or tool to determine if it works as intended.	SCI.SEP4.E.3-5 Analyze data to refine a problem statement or the design of a proposed object, tool, or process.	SCI.SEP4.E.m Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.	SCI.SEP4.E.h Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. Analyze data to identify design features or

Learning Element	K-2	3-5	6-8	9-12
		Use data to evaluate and refine design solutions.		characteristics of the components of a proposed process or system to optimize it relative to criteria for success.
Standard SCI.SEP5: Students will be able to use mathematics and computational thinking.				
	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP5.A: Qualitative and Quantitative Data	SCI.SEP5.A,B.K-2 Use counting and numbers to identify and describe patterns in the natural and designed world(s).	SCI.SEP5.A,B.3-5 Organize simple data sets to reveal patterns that suggest relationships.	SCI.SEP5.A.m Decide when to use qualitative vs. quantitative data.	SCI.SEP5.A.h Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.
SCI.SEP5.B: Data Sets and Computational Models			SCI.SEP5.B.m Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.	SCI.SEP5.B.h Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.
SCI.SEP5.C: Graphs and Mathematical Representations	SCI.SEP5.C.K-2 Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.	SCI.SEP5.C.3-5 Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.	SCI.SEP5.C.m Use mathematical representations to describe and/or support scientific conclusions and design solutions.	SCI.SEP5.C.h Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
SCI.SEP5.D: Solving a Problems	SCI.SEP5.D.K-2 Use quantitative data to compare two alternative solutions to a problem.	SCI.SEP5.D.3-5 Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.	SCI.SEP5.D.m Create algorithms (a series of ordered steps) to solve a problem. Apply mathematical concepts and/or processes (such as ratio, rate, percent, basic operations, and simple algebra) to scientific	SCI.SEP5.D.h Apply techniques of algebra and functions to represent and solve scientific and engineering problems. Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what

			and engineering questions and problems. Use digital tools and/or mathematical concepts and arguments to test and compare proposed solutions to an engineering design problem.	is known about the real world. Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

Standard SCI.SEP6: Students will be able to construct explanations and design solutions.

	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP6.A: Construct an Explanation	SCI.SEP6.A,B.K-2 Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.	SCI.SEP6.A.3-5 Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).	SCI.SEP6.A.m Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. Construct an explanation using models or representations.	SCI.SEP6.A.h Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
SCI.SEP6.B: Evidence		SCI.SEP6.B.3-5 Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.	SCI.SEP6.B.m Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events.	SCI.SEP6.B.h Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

SCI.SEP6.C: Reasoning	SCI.SEP6.C.K-2 NA	SCI.SEP6.C.3-5 Identify the evidence that supports particular points in an explanation.	SCI.SEP6.C.m Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.	SCI.SEP6.C.h Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
SCI.SEP6.D: Design and Refine	SCI.SEP6.D.K-2 Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. Generate and/or compare multiple solutions to a problem.	SCI.SEP6.D.3-5 Apply scientific ideas to solve design problems. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	SCI.SEP6.D.m Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system. Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and retesting.	SCI.SEP6.D.h Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Standard SCI.SEP7: Students will be able to engage in argument from evidence.				
	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP7.A: Define and Evaluate Arguments	SCI.SEP7.A.K-2 Identify arguments that are supported by evidence. Distinguish between explanations that account for all gathered evidence and those that do not. Analyze why some evidence is relevant to	SCI.SEP7.A.3-5 Compare and refine arguments based on an evaluation of the evidence presented. Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.	SCI.SEP7.A.m Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.	SCI.SEP7.A.h Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

	a scientific question and some is not. Distinguish between opinions and evidence in one's own explanations.			
SCI.SEP7.B: Listen and Critique	SCI.SEP7.B.K-2 Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument.	SCI.SEP7.B.3-5 Respectfully provide and receive critiques from peers about a proposed procedure, explanation or model.by citing relevant evidence and posing specific questions.	SCI.SEP7.B.m Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.	SCI.SEP7.B.h Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining what additional information is required to resolve contradictions
SCI.SEP7.C: Construct an Argument	SCI.SEP7.C.K-2 Construct an argument with evidence to support a claim.	SCI.SEP7.C.3-5 Construct and/or support an argument with evidence, data, and/or a model. Use data to evaluate claims about cause and effect.	SCI.SEP7.C.m Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	SCI.SEP7.C.h Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
SCI.SEP7.D: Make and Defend Claim	SCI.SEP7.D.K-2 Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	SCI.SEP7.D.3-5 Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	SCI.SEP7.D.m Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints. Evaluate competing design	SCI.SEP7.D.h Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student generated evidence. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

			solutions based on jointly developed and agreed-upon design criteria.	

Standard SCI.SEP8: Students will be able to construct explanations and design solutions.				
	Performance Indicators (By Grade Band)			
Learning Element	**K-2**	**3-5**	**6-8**	**9-12**
SCI.SEP8.A: Grade Appropriate Text	SCI.SEP8.A.K-2 Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).	SCI.SEP8.A.3-5 Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence. Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.	SCI.SEP8.A.m Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).	SCI.SEP8.A.h Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
SCI.SEP8.B: Visual Displays	SCI.SEP8.B.K-2 Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.	SCI.SEP8.B.3-5 Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.	SCI.SEP8.B.m Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.	SCI.SEP8.B.h Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.

SCI.SEP8.C: Multiple Sources	SCI.SEP8.C.K-2 Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.	SCI.SEP8.C.3-5 Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.	SCI.SEP8.C.m Gather, read, synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts.	SCI.SEP8.C.h Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.
SCI.SEP8.D: Communicate	SCI.SEP8.D.K-2 Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.	CI.SEP8.D.3-5 Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts.	CI.SEP8.D.m Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	CI.SEP8.D.h Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Discipline: SCIENCE

Content Area: Crosscutting Concepts

Standard SCI.CC1--Patterns: Students will understand that observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Performance Indicators (By Grade Band)

K-2	3-5	6-8	9-12
SCI.CC1.K-2 Children recognize that patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence	SCI.CC1.3-5 Students identify similarities and differences in order to sort and classify natural objects and designed products. They identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions.	SCI.CC1.m Students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.	SCI.CC1.h Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.

Standard SCI.CC2--Cause and Effect: Students will understand that events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

Performance Indicators (By Grade Band)

K-2	3-5	6-8	9-12

SCI.CC2.K-2 Students learn that events have causes that generate observable patterns. They design simple tests to gather evidence to support or refute their own ideas about causes.	SCI.CC2.3-5 Students routinely identify and test causal relationships and use these relationships to explain change. They understand events that occur together with regularity might or might not signify a cause and effect relationship.	SCI.CC2.m Students classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.	SCI.CC2.h Students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.
Standard SCI.CC3--Scale, Proportion, and Quantity: Students will understand when considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales and to recognize proportional relationships between different quantities as scales change.			
Performance Indicators (By Grade Band)			
K-2	**3-5**	**6-8**	**9-12**
SCI.CCS3.K-2 Students use relative scales (e.g., bigger and smaller; hotter and colder; faster and slower) to describe objects. They use standard units to measure length.	SCI.CCS3.3-5 Students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume.	SCI.CCS3.m Students observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small. They understand phenomena observed at one scale may not be observable at another scale, and the function of natural and designed systems may change with scale. They use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude of properties and processes. They represent scientific relationships through the use of algebraic expressions and equations.	SCI.CCS3.h Students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one

			variable on another (e.g., linear growth vs. exponential growth).

Standard SCI.CC4--Systems and System Models: Students will understand that a system is an organized group of related objects or components. Models can be used for understanding and predicting the behavior of systems.

Performance Indicators (By Grade Band)

K-2	3-5	6-8	9-12
SCI.CC4.K-2 Students understand objects and organisms can be described in terms of their parts; and systems in the natural and designed world have parts that work together.	SCI.CC4.3-5 Students understand that a system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. They can also describe a system in terms of its components and their interactions.	SCI.CC4.m Students can understand that systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. They can use models to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. They can also learn that models are limited in that they only represent certain aspects of the system under study.	SCI.CC4.h Students can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They can use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They can also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They can also design systems to do specific tasks.

Standard SCI.CC5--Energy and Matter: Students will understand that tracking energy and matter as they flow into, out of, and within systems helps one understand their system's behavior.

Performance Indicators (By Grade Band)

K-2	3-5	6-8	9-12
SCI.CC5.K-2 Students observe objects may break into smaller pieces, be put together into larger pieces, or change shapes.	SCI.CC5.3-5 Students learn matter is made of particles and energy can be transferred in various ways and between objects.	SCI.CC5.m Students learn matter is conserved because atoms are conserved in physical and chemical processes. They	SCI.CC5.h Students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes

	Students observe the conservation of matter by tracking matter flows and cycles before and after processes and recognizing the total weight of substances does not change.	also learn within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). The transfer of energy can be tracked as energy flows through a designed or natural system.	of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Standard SCI.CC6--Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

Performance Indicators (By Grade Band)			
K-2	**3-5**	**6-8**	**9-12**
SCI.CC6.K-2 Students observe the shape and stability of structures of natural and designed objects are related to their function(s).	SCI.CC6.3-5 Students learn different materials have different substructures, which can sometimes be observed; and substructures have shapes and parts that serve functions.	SCI.CC6.m Students model complex and microscopic structures and systems and visualize how their function depends on the shapes, composition, and relationships among its parts. They analyze many complex natural and designed structures and systems to determine how they function. They design structures to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	SCI.CC6.h Students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal the system's function and/or solve a problem. They infer the functions and properties of natural and designed objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials.

Standard SCI.CC7--Stability and Change: Students will understand that for both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider.

Performance Indicators (By Grade Band)			
K-2	**3-5**	**6-8**	**9-12**

SCI.CC7.K-2 Students observe some things stay the same while other things change, and things may change slowly or rapidly.	SCI.CC7.3-5 Students measure change in terms of differences over time, and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change.	SCI.CC7.m Students explain stability and change in natural or designed systems by examining changes over time, and considering forces at different scales, including the atomic scale. Students learn changes in one part of a system might cause large changes in another part, systems in dynamic equilibrium are stable due to a balance of feedback mechanisms, and stability might be disturbed by either sudden events or gradual changes that accumulate over time	SCI.CC7.h Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability.