HAINESPORT TOWNSHIP SCHOOL DISTRICT

SCIENCE CURRICULUM

GRADES K-8

ADOPTED: 1/4/2024

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HAINESPORT SCHOOL DISTRICT
MISSION STATEMENT

The mission of the Hainesport School District is to provide a safe, supportive and challenging educational environment which will give our children the opportunity to develop the necessary skills to maximize their individual potentials and to empower them to be productive and responsible citizens in an ever-changing world. Essential to the success of the mission are parental involvement, community support and the efforts of a competent and caring staff. The Board of Education expects that all students will achieve the New Jersey Core Content Curriculum Standards at all grade levels.

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VISION FOR SCIENCE EDUCATION

Hainesport Township School District:
Vision for Science Education

“Science, engineering, and technology permeate nearly every facet of modern life, and they also hold the key to meeting many of humanity's most pressing current and future challenges."

(A Framework for K-12 Science Education: Practices, Crosscutting Concepts, & Core Ideas, 2012, p. 1)

The Hainesport Township School District Science Curriculum is designed to prepare students to develop scientific practices in order to be equipped with the knowledge and problem solving skills necessary to assume their roles as concerned, informed, and empowered citizens who are able to apply the three dimensions of science.

Why is the nature of science important to science educators? One of the most telling reasons comes from our goals to develop a public understanding of science. In a society where citizens must make informed decisions about problems that confront them, understanding both scientific knowledge and how that knowledge was obtained is important...To be an informed citizen in today’s society, it is imperative that the nature of science be part of every student’s K-12 science education (p. 39, Konicek-Moran & Keely, 2015).

Science education is based upon three dimensions which include the science and engineering practices, crosscutting concepts, and disciplinary core ideas. According to the National Science Teachers Association (2010), from healthcare to environmental stewardship, a countless number of personal and societal issues require citizens to make informed decisions based on their understanding of science and technology. Today's modern workforce depends on individuals with scientific and technological skills (NRC 2012; NSB 2010). The goal is to guide their knowledge toward a more scientifically based and coherent view of the sciences and engineering, as well as of the ways in which they are pursued and how their results can be used (National Resource Council, 2012, p 11).

Inquiry-Based Constructivist Science Curriculum

To achieve our mission for student learning, our science curriculum actively engages students in scientific inquiry processes, i.e. conducting investigations, collecting evidence, interpreting and analyzing data, and defending conclusions using evidence. The National Science Teachers Association (NSTA) states that, “scientific inquiry reflects how scientists come to understand the natural world, and it is at the heart of how students learn. From a very early age, children interact with their environment, ask questions, and seek ways to answer those questions. Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences” (https://www.nsta.org). Curriculum content at each grade level includes hands-on investigations, guided inquiry, questioning phenomena, and applying this newfound knowledge to real-world situations. These investigations have been designed to help students expand on their natural curiosity to interact with their environment. Throughout these student-driven inquiries, students have opportunities to make meaningful connections with prior knowledge, develop strategies for understanding media and scientific text, and apply their emerging understandings to future investigations.

By creating a classroom culture in which students do rather than just listen, you can promote a wide variety of benefits in students, including improved on-task behavior, increased collaboration, increased self-confidence, greater risk- tasking, and additional opportunities for leadership roles (Griss, 2013; Griss 2016 in K. McGlynn & J. Kozlowski, 2017).

The attitudes that students display as they learn science are also important, as is the development of qualities inherent in the practice of science, such as curiosity, open-mindedness, and integrity. Grade level curriculum experiences provide opportunities to engage in scientific behaviors that encourage students to focus on their doubts and questions. In this way, ideas can be examined and refined to meet the ever-changing nature of scientific theory and the corresponding evolution of scientific knowledge. As children make attempts to understand and explain the world around them, the science classroom provides a forum for building on their temporal understandings and constructing their knowledge about plausible science theory and concepts in powerful ways.

Integration of Science

Science must also be taught with an awareness of its connection to other content areas as well as the needs of an ever-changing global community. We believe children come to school with a myriad of experiences and natural curiosities of the world around them. As teachers of science, it is our responsibility to cultivate these curiosities by expanding upon their experiences with new, authentic explorations that enable them to make connections between their preexisting knowledge and new learning of scientific principles and phenomena. The text A Framework for K-12 Science Education explains it this way:

> The overarching goal of our framework for K-12 science education is to ensure that 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.
> (Framework for K-12 Science Education, 2012)

In-Depth Study of Core Concepts

Teachers must focus on a deeper exploration of fewer concepts and provide ample time to develop meaningful understanding and experience authentic applications. This is accomplished through following the three dimensions outlined in The Next Generations Science Standards: scientific and engineering practices, crosscutting concepts, and core ideas.

When the cross-cutting concepts, such as “cause and effect”, are made explicit for students, they can help students develop a coherent and scientifically-based view of the world around them. Science and Engineering Practices describe what scientists do to investigate the natural world and what engineers do to design and build systems. The practices better explain and extend what is meant by “inquiry” in science and the range of cognitive, social, and physical practices that it requires. Students engage in practices to build, deepen, and apply their knowledge of core ideas and crosscutting concepts. Disciplinary Core Ideas (DCIs) are the key ideas in science that have broad importance within or across multiple science or engineering disciplines. These core ideas build on each other as students progress through grade levels and are grouped into the following four domains: Physical Science, Life Science, Earth and Space Science, and Engineering (www.nextgenscience.org).

Goals for Students

To achieve our vision for effective science education, the following goals have been established for students.

All students will engage in learning experiences that afford them opportunities to:

- Inquire through natural curiosities and situational interests
    - value and appreciate all aspects of science
    - better understand and make sense of the world around them
    - make connections between and among cross-cutting concepts and the science and engineering practices learned, including their application to the real world

- Gather and interpret scientific evidence
    - design and develop models to solve problems and justify claims
    - collaborate and communicate effectively with others
    - utilize evidence to support the analysis of scientific data

- Analyze and apply scientific knowledge
    - critically examine, evaluate, and communicate evidence in order to solve problems and make informed decisions
    - increase awareness of and respect for other viewpoints/perspectives
    - critique results, making adjustments as needed in the design process

Goals for Teachers

Strategies and concepts presented by teachers will apply constructivist theory and give equal attention to process and content, so that all students can actualize this vision. Teachers will cultivate an environment where students flourish as independent, inquiry-based learners. Toward that end, teachers will:

- model scientific thinking, evidenced-based dialogue, questioning, and reflection
- promote student-centered, inquiry-based tasks to actively explore phenomena
- create opportunities for students to use prior knowledge and life experiences to make connections and apply science content/concepts to real life situations
- challenge students to think critically about concepts and events based on information gathered from multiple sources and perspectives
- utilize a multitude of strategies to encourage higher level thinking
- deepen understanding of the roles of real scientists and engineers in our society through the use of informational texts and resources
- allow students to focus on doubts and predictions
- emphasize depth of understanding over correct answers
- encourage creativity, communication, collaboration and critical thinking
- facilitate authentic conversations and interactions

Our vision is to develop a community of learners who value science and use it in their everyday lives for purpose, pleasure and enrichment, both for themselves and for the world around them.

PROGRAM DESCRIPTION

Program Description

The units of study that follow represent a melding of our conceptual framework, the content of the standards and our vision for best practice. Each unit is organized around driving questions that encourage students to revisit the big ideas. These questions provide the context by which the content is investigated. This enables students to construct understanding and apply the larger concepts to their lives.

Students in kindergarten explore science concepts with thematic studies that are integrated throughout their weekly schedule, *Time to Be You and Me: A Year of Discovery, Exploration and Change*. In first and second grades, thematic units of study are used as a vehicle for organizing and integrating science content and concepts throughout the instructional day with designated blocks of time for science instruction. In grades three to five, interdisciplinary units of study are implemented during blocks of time dedicated to science instruction. Key concepts are expanded to other subject areas as appropriate. In grades six through eight, students receive daily instruction by a science teacher in 49 minute periods. Curriculum content is organized into interdisciplinary units of study with disciplinary literacy integrated throughout.

Curriculum **topics** and *units of instruction* for each grade are listed below.

Kindergarten: Physical Science: *Push, Pull, Go* - bringing motion to a personal level as students consider their daily activities and the motions that accompany them throughout the day. Earth Space Science: *Growth and Change* - a study of annual recurring patterns, cycles, events, seasons, celebrations and school experiences. Life Science: *Living Things and Their Needs*, *Cycle of Life* - a study of life cycles (chicks, butterflies, plants) and the impact on our environment.

Grade One: Physical Science: *Light and Sound Waves* - introduces students to the concepts of light and sound waves using experiments to demonstrate cause and effect. Earth Space Science: *Sky* Watchers - looking for, predicting, and describing patterns in the sky. Life Science: *Exploring Organisms* - taking a look at both plants and animals by planting seeds and looking at how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

Grade Two: Physical Science: *Matter -* classifying materials and their observable properties. Earth Space: *Earth Materials* - looking at how wind and water change the land. Life Science: *Ecosystem Diversity -* determining what plants and animals need to grow.

Grade Three: Physical Science: *Forces and Interactions* - looking at cause and effect relationship between forces and objects based upon students' observations of movement and reactions of objects when force is applied to them. Earth and Space Science: *Water and Climate* - looking at weather patterns and changes in climate based upon the movement of water. Life Science: *Structures of Life* - looking at genetics and inherited traits, as well as characteristics of species that help them to survive in their environments (adaptations).

Grade Four: Physical Science: *Energy Works* -studying waves, their speed and effect of motion. Earth and Space Science: *Soil, Rock and Landforms* - identifying fossils, rock layers and formations as well as energy and fuel from natural resources. Life Science: *Animal Adaptations* – studying how plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Grade Five: Physical Science: *Mixtures and Solutions* - introduces students to the properties, behaviors, and changes in substances (chemistry) including concentration and saturation. Earth and Space Science: *Earth and Sun* - an in-depth study of the Earth and Sun as a system, including the observation of the moon, properties of atmosphere, water cycle, and transfer of energy. Life Science: *Living Systems* - introduces students to the concept of subsystems, in addition to in-depth studies of nutrient systems, transport systems and sensory systems.

Grade Six: *Earth in Space* - extends student knowledge about the Earth and its interaction with other celestial bodies (Sun & Moon) through inquiry based activities. *Catastrophic Events* - students investigate the relationship between storms/weather, earthquakes, volcanic activity, climate change, plate tectonics, and convection currents.

Grade Seven: *Ecology* - populations interact with biotic and abiotic factors and compete for resources. *Organisms Macro to Micro/Genes and Molecular Machines* – the study of cells & genetics, evolution & diversity. *Human Body* - the systems of the body are interrelated and process sensory information.

Grade Eight: *Introduction to the Physical Properties of Matter* - emphasis is placed on the science and engineering practices; students collect data and learn proper measuring techniques. *Chemistry: Believe it or Not* - students study parts of the atom as a basis for the investigation of the periodic table of elements. *Electricity, Waves and Information Transfer* - inquiry-based exploration of the properties of electricity, light, and sound. *Energy, Motion & Forces* - the study of Newton's three laws of motion including the different forms of energy and its conversions.

ACCOMMODATIONS AND MODIFICATIONS FOR SPECIAL POPULATIONS

Accommodations and Modifications for Special Populations

As all students are individuals it will be necessary to differentiate instruction daily to meet the needs of every learner. In all cases, teachers should be consistently gathering and utilizing formative assessment data to drive instruction. At times this will necessitate additional whole group lessons, flexible, small group instruction, individual conferring, and/or tiered assignments.

Students who are At-Risk for failure or are English Language Learners should be seen in small groups as much as possible in order to ensure additional opportunities for differentiation, modeling, and guided practice prior to independent practice with concepts or skills. In addition, teachers may request observations from building specialists (ex. reading specialists, math coaches, etc.) or curriculum supervisors regarding feedback and/or recommendations for individuals. Teachers will utilize the I&RS process for students who are not identified for Special Education and who are not making sufficient progress in any subject area.

In certain cases, additional modifications are necessary to meet the needs of all students. Students who are identified through the Special Education, 504, or Tier III Gifted and Talented processes will have additional individualized plans that may include adjusted materials or accommodations in order to access the curriculum and meet the standards. In these cases, teachers will consult IEPs, 504s or Tier III plans for specific guidelines regarding instruction and materials.

Teachers with Special Education students who are not making sufficient process, as evidenced by district benchmark assessments, shall request an observation with the Learning Consultant and Curriculum Supervisor in order to design individualized recommendations regarding additional instructional strategies, specialized programs or placement recommendations.

Accommodations are designed to provide equitable access during instruction, as well as assessment. Accommodations change *how* students learn material and successfully demonstrate learning; they may include adjustments to presentation, scheduling, setting, timing, response and organization.

The following chart lists accommodations that are utilized, as needed, to not only address at-risk students, students identified through the I&RS process, students with 504 plans and special needs, Gifted and Talented students, and English Language Learners, but also as opportunities to differentiate for all students.

Accommodation	Description	Populations - SE, Gifted, At-Risk (I&RS), 504, ELL
Presentation Accommodations	● Listen to audio recordings instead of reading text ● Learn content from audiobooks, movies, videos, and digital media instead of reading print versions ● Use of ASL videos or close captioning ● Work with fewer items per page or line	ALL

	● Work with text in a larger print size ● Use color contrast/color overlay ● Use of a Line Reader Mask Tool ● Have a “designated reader”—someone who reads test questions aloud to students ● Hear instructions spoken aloud ● Record a lesson, instead of taking notes ● Get class notes from another student ● See an outline of a lesson ● Use visual presentations of verbal material, such as word webs ● Get a written list of instructions	
Response Accommodations	● Give responses in a form (spoken or written) that’s easier for them ● Dictate answers to a scribe who writes or types ● Capture responses on an audio recorder ● Use word prediction software ● Use a spelling dictionary or digital spell-checker ● Use a word processor to type notes or give answers in class ● Use ASL and an interpreter to communicate responses ● Use a calculator or table of “math facts”	ALL
Setting Accommodations	● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use special lighting or acoustics ● Take a test in a small group setting ● Use sensory tools such as an exercise band that can be looped around a chair’s legs (so fidgety kids can kick it and quietly get their energy out)	ALL
Timing Accommodations	● Take more time to complete a task or a test ● Have extra time to process spoken information and directions ● Take frequent breaks, such as after completing a task	ALL
Scheduling Accommodations	● Take more time to complete a project ● Take a test in several timed sessions or over several days ● Take sections of a test in a different order ● Take a test at a specific time of day	ALL

Organization Skills Accommodations	● Use an alarm to help with time management ● Mark texts with a highlighter ● Use a planner or organizer to help coordinate assignments ● Receive study skills instruction	ALL
Differentiation	● Choice Boards ● Tiered Assignments	ALL

Comparatively, modifications change *what* a student is expected to learn or be able to do. While specific modifications are to be selected by the team working with the designated student in order to tailor plans on an individual basis, below is a chart listing some of the most common modifications and the populations for which they are typically utilized. The second chart provides examples of content specific modifications that may be utilized. It is important to note that all modifications are implemented in accordance with their respective plans.

Modification	Description	Populations - SE, Gifted, At-Risk (I&RS), 504, ELL
Allow extra time for task completion	Provide additional time for students to complete assigned tasks prior to introducing new content/tasks.	SE, At-Risk, 504, ELL
Allow for repetition and/or clarification of directions as needed	Teachers may need to repeat directions multiple times or consider providing visual support for instructions given auditorily. Teachers may need to rephrase instructions using succinct language. Consideration should also be given to minimizing language and focusing on steps, such as a bulleted or numbered list.	SE, At-Risk, 504, ELL
Break down tasks into manageable units	Tasks should focus on steps that can be completed in a short time period to increase attention to task and provide natural breaking points. Chunking information also aids in memory and making connections to prior knowledge.	SE, At-Risk, 504, ELL
Demonstrate directions and provide a model or example of completed task	This multisensory approach provides visual support for expectations and minimizes the impact of language.	SE, At-Risk, 504, ELL
Frequently check for understanding	While working on assigned tasks, teachers should establish multiple opportunities to check for understanding and provide feedback along the way as opposed to one final submission. Teachers may also ask frequent questions to engage students.	ALL

Modified/Alternate Assessment	Assessments should be commensurate with the students' goals and afford them an opportunity to demonstrate what they know, understand and are able to do. Examples include but are not limited to: ● Cover less material or decreased complexity ● Provide scaffolds including visual support, reading the assessment aloud, or adjusting the number of choices/response options. ● Breaking the assessment down into smaller chunks ● Providing a study guide that is similar to the assessment task ● Adjusted grading criteria ● Allowing student to verbally explain response	SE, At-Risk, 504, ELL
Modify curriculum content based on student ability level	Adjustments to the level of content or skill itself. Examples include adjusting the readability of text, increased/decreased complexity of skill; literal vs. inferential questions, single step vs. multi-step problems/tasks, extensions from a higher grade vs. basic skills from an earlier one.	ALL
Modify pace of instruction to allow for processing time	Teachers should provide instruction at a slow, deliberate pace, stopping frequently to allow time for students to process bits of information.	SE, At-Risk, 504, ELL
Preferential seating	The student's physical location in the setting should be purposeful. Consideration should be given to minimizing distractions, limiting or enhancing sensory stimulation, providing peer models, facilitating access to supports, ease of transition, physical needs, etc.	ALL
Provide access to accurate notes	Based on the needs of the students, notes may be provided prior to the lesson and/or at the conclusion. Options include but are not limited to: ● Guided notes prepared by teacher ● Shared document with peer ● Outline ● Study Guide ● Transcript of video	SE, At-Risk, 504, ELL
Reduce the length of the assignment	Adjust the length of the assignment based on student stamina, attention, working memory, availability of support, etc.	SE, At-Risk, 504, ELL

Reduce the requirement for written responses	When assigning written tasks for students, teachers should consider adjusting expectations as well as consider alternate response options, such as creating a video, voice typing, providing answers verbally, use of technology, etc.	SE, At-Risk, 504, ELL

STEM

Modification	**Description**	**Populations - SE, Gifted, At-Risk (I&RS), 504, ELL**
Use of a Calculator	Use of a calculator to perform computation tasks for students who have demonstrated in evaluations difficulty performing single-digit computation.	SE, At-Risk
Anchor Charts & Computation Tables	Provide students with computation charts to shift the focus from the memorization of the facts (automaticity) to thinking critically about the problem itself. Anchor charts make thinking visible and are used as a management tool for students to self-monitor their learning.	SE, At-Risk, ELL, 504
Manipulatives	Manipulatives give students an opportunity to use concrete objects to practice math concepts. The objects provide more engagement, which helps students stay more connected to the assignment. The size and type of manipulatives can be modified based on student needs (e.g., six sided vs. polyhedral dice or numerical dice vs. dot dice).	SE, Gifted, At-Risk, 504
Use of Graph Paper for Algorithm Set-up	Used to assist students in organizing their rows/columns in an algorithm	SE, At-Risk
Screencasting	Teacher-created videos/screencasts can provide students with re-teaching and/or remodeling opportunities. Students can rewind, re-listen/view as needed for repeated instruction. Student-created screencasts provide an outlet to extend their learning and ideas and provide authentic audiences. When paired, students in the same classroom can assist one another with learning.	SE, At-Risk, Gifted
Provide Answers to Computation	When students are provided the answers to a calculation or word problem at the onset of the work, the focus is placed on the modeling, reasoning and communication of mathematics.	SE, At-Risk, Gifted

Assistive Technology	“Assistive technology device” means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability. Examples include Chrome-based extensions such as Equatio and Google Read and Write.	SE

For additional resources on accommodations and modifications, please visit Understood.org.

NEW JERSEY STUDENT LEARNING STANDARDS

Science and Engineering Practices

Asking Questions and Defining Problems
A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.

Both scientists and engineers also ask questions to clarify the ideas of others.

Planning and Carrying Out Investigations
Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.

Analyzing and Interpreting Data
Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

Developing and Using Models
A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems.

Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions
The products of science are explanations and the products of engineering are solutions.

The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.

The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence
Argumentation is the process by which explanations and solutions are reached.

In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits.

Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

Using Mathematics and Computational Thinking
In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information
Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate.

Critiquing and communicating ideas individually and in groups is a critical professional activity.

Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and design.

Disciplinary Core Ideas

Disciplinary Core Ideas in Physical Science (PS)

PS1: Matter and Its Interactions
- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions
- PS1.C: Nuclear Processes

PS2: Motion and Stability: Forces and Interactions
- PS2.A: Forces and Motion
- PS2.B: Types of Interactions
- PS2.C: Stability and Instability in Physical Systems

PS3: Energy
- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship Between Energy and Forces
- PS3.D: Energy in Chemical Processes and Everyday Life

PS4: Waves and Their Applications in Technologies for Information Transfer
- PS4.A: Wave Properties
- PS4.B: Electromagnetic Radiation
- PS4.C: Information Technologies and Instrumentation

Disciplinary Core Ideas in Life Science (LS)

LS1: From Molecules to Organisms: Structures and Processes
- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms
- LS1.C: Organization for Matter and Energy Flow in Organisms
- LS1.D: Information Processing

LS2: Ecosystems: Interactions, Energy, and Dynamics
- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- LS2.D: Social Interactions and Group Behavior

LS3: Heredity: Inheritance and Variation of Traits
- LS3.A: Inheritance of Traits
- LS3.B: Variation of Traits

LS4: Biological Evolution: Unity and Diversity
- LS4.A: Evidence of Common Ancestry and Diversity
- LS4.B: Natural Selection
- LS4.C: Adaptation
- LS4.D: Biodiversity and Humans

Disciplinary Core Ideas

Disciplinary Core Ideas in Earth and Space Science (ESS)

ESS1: Earth's Place in the Universe
- ESS1.A: The Universe and Its Stars
- ESS1.B: Earth and the Solar System
- ESS1.C: The History of Planet Earth

ESS2: Earth's Systems
- ESS2.A: Earth Materials and Systems
- ESS2.B: Plate Tectonics and Large-Scale System Interactions
- ESS2.C: The Roles of Water in Earth's Surface Processes
- ESS2.D: Weather and Climate
- ESS2.E: Biogeology

ESS3: Earth and Human Activity
- ESS3.A: Natural Resources
- ESS3.B: Natural Hazards
- ESS3.C: Human Impacts on Earth Systems
- ESS3.D: Global Climate Change

Disciplinary Core Ideas in Engineering, Technology, and the Application of Science (ETS)

ETS1: Engineering Design
- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

ETS2: Links Among Engineering, Technology, Science, and Society
- ETS2.A: Interdependence of Science, Engineering, and Technology
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

Crosscutting Concepts

Patterns
Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Cause and Effect: Mechanism and Explanation
Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Scale, Proportion, and Quantity
In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and System Models
Defining the system under study—specifying its boundaries and making explicit a model of that system— provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Energy and Matter Flows, Cycles, and Conservation
Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Structure and Function
The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Stability and Change
For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

STANDARDS AND EXPECTATIONS, GRADES K-8

2020 New Jersey Student Learning Standards: Performance Expectations and DCIs

Kindergarten

K-PS2: Motion and Stability: Forces and Interactions	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]	Push, Pull, Go unit, Lessons 1-4
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.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]	Push, Pull, Go, Lesson 5

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ● With guidance, plan and conduct an investigation in collaboration with peers. (K-PS2-1) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ● Analyze data from tests of an object or tool to determine if it works as intended. (K-PS2-2)	**PS2.A: Forces and Motion** ● Pushes and pulls can have different strengths and directions. (K-PS2-1), (K-PS2-2) ● Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1), (K-PS2-2) **PS2.B: Types of Interactions** ● When objects touch or collide, they push on one another and can change motion. (K-PS2-1) **PS3.C: Relationship Between Energy and Forces** ● A bigger push or pull makes things speed up or slow down more quickly. *(secondary to K-PS2-1)* **ETS1.A: Defining Engineering Problems** ● A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. *(secondary to K-PS2-2)*	**Cause and Effect** ● Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS2-1), (K-PS2-2) --------------------------------------- ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** ● Scientists use different ways to study the world. (K-PS2-1)

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K-PS3: Energy	
Students who demonstrate understanding can:	**Resources**
K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface. [Clarification Statement: Examples of Earth's surface could include sand, soil, rocks, and water] [Assessment Boundary: Assessment of temperature is limited to relative measures such as warmer/cooler.]	April Connection *Rain* Science Connection for *Sadie and the Snowman*
K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.* [Clarification Statement: Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.]	Science Connection for *Sadie and the Snowman*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ● Make observations (firsthand or from media) to collect data that can be used to make comparisons. (K-PS3-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ● Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem. (K-PS3-2)	**PS3.B: Conservation of Energy and Energy Transfer** ● Sunlight warms Earth's surface. (K-PS3-1),(K-PS3-2)	**Cause and Effect** ● Events have causes that generate observable patterns. (K-PS3-1), (K-PS3-2) --- ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** ● Scientists use different ways to study the world. (K-PS3-1)

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K-LS1: From Molecules to Organisms: Structures and Processes	
Students who demonstrate understanding can:	**Resources**
K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.]	May Science Connection *A Butterfly is Born* May Science Connection *Jack's Garden* (Sprout and Grow window)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ● Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-LS1-1)	**LS1.C: Organization for Matter and Energy Flow in Organisms** ● All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. (K-LS1-1)	**Patterns** ● Patterns in the natural and human designed world can be observed and used as evidence. (K-LS1-1) -- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Scientists look for patterns and order when making observations about the world. (K-LS1-1)

K-ESS2: Earth Systems	
Students who demonstrate understanding can:	**Resources**
K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time. [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.]	Calendar: Weather graphs March Science Connection: *Wind*
K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]	May Science Connection *A Butterfly is Born*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ● Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-ESS2-1) **Engaging in Argument from Evidence** Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s). ● Construct an argument with evidence to support a claim. (K-ESS2-2)	**ESS2.D: Weather and Climate** ● Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1) **ESS2.E: Biogeology** ● Plants and animals can change their environment. (K-ESS2-2) **ESS3.C: Human Impacts on Earth Systems** ● Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. *(secondary to K-ESS2-2)*	**Patterns** ● Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1) **Systems and System Models** ● Systems in the natural and designed world have parts that work together. (K-ESS2-2) -- ***Connections to Nature of Science*** **Science Knowledge is Based on Empirical Evidence** ● Scientists look for patterns and order when making observations about the world. (K-ESS2-1)

K-ESS3: Earth and Human Activity	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Examples of relationships could include that deer eat buds and leaves, therefore, they usually live in forested areas; and, grasses need sunlight, so they often grow in meadows. Plants, animals, and their surroundings make up a system.]	January Science Connection: *Emperor's Egg* May Science Connection: *A Butterfly is Born*
K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.* [Clarification Statement: Emphasis is on local forms of severe weather.]	January Shared Reading *Geraldine's Big Snow*
K-ESS3-3. Communicate solutions that will reduce the impact of climate change and humans on the land, water, air, and/or other living things in the local environment.* [Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]	April Science Connection *Our Class is Going Green; The Earth Book*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested. ● Ask questions based on observations to find more information about the designed world. (K-ESS3-2) **Developing and Using Models** Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions. ● Use a model to represent relationships in the natural world. (K-ESS3-1) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new	**ESS3.A: Natural Resources** ● Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. (K-ESS3-1) **ESS3.B: Natural Hazards** ● Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3- 2) **ESS3.C: Human Impacts on Earth Systems** ● Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (K-ESS3-3) **ETS1.A: Defining and Delimiting an Engineering Problem** ● Asking questions, making observations, and	**Cause and Effect** ● Events have causes that generate observable patterns. (K-ESS3-2), (K-ESS3-3) **Systems and System Models** ● Systems in the natural and designed world have parts that work together. (K-ESS3-1) -- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● People encounter questions about the natural world every day. (K-ESS3-2) **Influence of Engineering, Technology, and Science on Society and the Natural World** ● People depend on various technologies in their lives; human life would be very

information. ● Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world. (K-ESS3-2) ● Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (K-ESS3-3)	gathering information are helpful in thinking about problems. *(secondary to K-ESS3-2)* **ETS1.B: Developing Possible Solutions** ● 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. *(secondary to K-ESS3-3)*	different without technology. (K-ESS3- 2)

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Grade 1

1-PS4: Waves and their Applications in Technologies for Information Transfer	
Students who demonstrate understanding can:	**Resources**
1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. [Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]	Light and Sound Unit, Lessons 4-5 Writing in Response to Informational Text Unit: *Light and Sound*
1-PS4-2. Make observations to construct an evidence-based account that objects can be seen only when illuminated. [Clarification Statement: Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.]	Light and Sound Unit, Lesson 1 Writing in Response to Informational Text Unit: *Light and Sound*
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. [Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror). The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.] [Assessment Boundary: Assessment does not include the speed of light.]	Light and Sound Unit, Lessons 2-3
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.* [Clarification Statement: Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drum beats.] [Assessment Boundary: Assessment does not include technological details for how communication devices work.]	Light and Sound Unit, Lesson 6

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ● Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question. (1-PS4-1), (1-PS4-3) **Constructing Explanations and Designing Solutions**	**PS4.A: Wave Properties** ● Sound can make matter vibrate, and vibrating matter can make sound. (1-PS4-1) **PS4.B: Electromagnetic Radiation** ● Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4-2) ● Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach.	**Cause and Effect** ● Simple tests can be designed to gather evidence to support or refute student ideas about causes. (1-PS4-1), (1-PS4-2), (1-PS4-3) -- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science, on Society and the Natural World**

Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ● Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-PS4-2) ● Use tools and materials provided to design a device that solves a specific problem. (1-PS4-4)	Mirrors can be used to redirect a light beam. (1-PS4-3) **PS4.C: Information Technologies and Instrumentation** ● People also use a variety of devices to communicate (send and receive information) over long distances. (1-PS4-4)	● People depend on various technologies in their lives; human life would be very different without technology. (1-PS4-4) -- ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** ● Science investigations begin with a question. (1-PS4-1) ● Scientists use different ways to study the world. (1-PS4-1)

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1-LS1: From Molecules to Organisms: Structures and Processes	
Students who demonstrate understanding can:	**Resources**
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.* [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]	Exploring Organisms Unit, Lessons 1-5, 7
1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. [Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]	Exploring Organisms Unit, Lessons 1-5

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ● Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information. ● Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. (1-LS1-2)	**LS1.A: Structure and Function** ● All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1) **LS1.B: Growth and Development of Organisms** ● Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2) **LS1.D: Information Processing** ● Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)	**Patterns** ● Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-LS1-2) **Structure and Function** ● The shape and stability of structures of natural and designed objects are related to their function(s). (1-LS1-1) --------------------------------------- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ● Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (1-LS1-1) --------------------------------------- ***Connections to Nature of Science***

		Scientific Knowledge is Based on Empirical Evidence ● Scientists look for patterns and order when making observations about the world. (1-LS1-2)

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1-LS3: Heredity: Inheritance and Variation of Traits	
Students who demonstrate understanding can:	**Resources**
1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.	Exploring Organisms Unit, Lessons 2-3

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ● Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	**LS3.A: Inheritance of Traits** ● Young animals are very much, but not exactly, like their parents. Plants also are very much, but not exactly, like their parents. (1-LS3-1) **LS3.B: Variation of Traits** ● Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	**Patterns** ● Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1)

1-ESS1: Earth's Place in the Universe	
Students who demonstrate understanding can:	**Resources**
1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.]	Sky Watchers Unit, Lessons 1-3, 5-6
1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]	Sky Watchers Unit, Lessons 3-4

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ● Make observations (firsthand or from media) to collect data that can be used to make comparisons. (1-ESS1-2) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ● Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (1-ESS1-1)	**ESS1.A: The Universe and its Stars** ● Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1) **ESS1.B: Earth and the Solar System** ● Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2)	**Patterns** ● Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. 1-ESS1-1),(1-ESS1-2) --- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes natural events happen today as they happened in the past. (1-ESS1-1) ● Many events are repeated. (1-ESS1-1)

Grade 2

2-PS1: Matter and Its Interactions	
Students who demonstrate understanding can:	**Resources**
2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]	Matter Unit, Lesson 3 Earth Materials Unit, Lesson 2
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.* [Clarification Statement: Examples of properties could include strength, flexibility, hardness, texture, and absorbency.] [Assessment Boundary: Assessment of quantitative measurements is limited to length.]	Matter Unit, Lesson 4
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. [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.]	Matter Unit, Lessons 1-2
2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]	Matter Unit, Lesson 5

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ● Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ● Analyze data from tests of an object or tool to	**PS1.A: Structure and Properties of Matter** ● Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1) ● Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3) ● A great variety of objects can be built up from a small set of pieces. (2-PS1-3) **PS1.B: Chemical Reactions** ● Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**Patterns** ● Patterns in the natural and human designed world can be observed. (2-PS1-1) **Cause and Effect** ● Events have causes that generate observable patterns. (2-PS1-4) ● Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2) **Energy and Matter** ● Objects may break into smaller pieces and be put together into larger pieces or change shapes. (2-PS1-3)

determine if it works as intended. (2-PS1-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ● Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (2-PS1-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s). ● Construct an argument with evidence to support a claim. (2-PS1-4)		-- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science, on Society and the Natural World** ● Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (2-PS1-2) -- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ● Scientists search for cause and effect relationships to explain natural events. (2-PS1-4)

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2-LS2: Ecosystems: Interactions, Energy, and Dynamics	
Students who demonstrate understanding can:	**Resources**
2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]	Carolina Building Blocks of Science: Ecosystem Diversity
2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*	Carolina Building Blocks of Science: Ecosystem Diversity

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. ● Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ● Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** ● Plants depend on water and light to grow. (2-LS2-1) ● Plants depend on animals for pollination or to move their seeds around. (2-LS2-2) **ETS1.B: Developing Possible Solutions** ● 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. *(secondary to 2-LS2-2)*	**Cause and Effect** ● Events have causes that generate observable patterns. (2-LS2-1) **Structure and Function** ● The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

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2-LS2: Ecosystems: Interactions, Energy and Dynamics	
Students who demonstrate understanding can:	**Resources**
2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats. [Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]	Carolina Building Blocks of Science: Ecosystem Diversity

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ● Make observations (firsthand or from media) to collect data which can be used to make comparisons. (2-LS4-1)	**LS4.D: Biodiversity and Humans** ● There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)	N/A -- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Scientists look for patterns and order when making observations about the world. (2-LS4-1)

2-ESS1: Earth's Place in the Universe	
Students who demonstrate understanding can:	**Resources**
2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly. [Clarification Statement: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and erosion of rocks, which occurs slowly.] [Assessment Boundary: Assessment does not include quantitative measurements of timescales.]	Carolina Building Blocks of Science: Earth Materials

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ● Make observations from several sources to construct an evidence-based account for natural phenomena. (2-ESS1-1)	**ESS1.C: The History of Planet Earth** ● Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)	**Stability and Change** ● Things may change slowly or rapidly. (2-ESS1-1)

2-ESS2: Earth's Systems	
Students who demonstrate understanding can:	**Resources**
2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.* [Clarification Statement: Examples of solutions could include different desigClarificatins of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.]	Carolina Building Blocks of Science: Earth Materials
2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area. [Assessment Boundary: Assessment does not include quantitative scaling in models.]	Carolina Building Blocks of Science: Earth Materials
2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.	Carolina Building Blocks of Science: Earth Materials

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. ● Develop a model to represent patterns in the natural world. (2-ESS2-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ● Compare multiple solutions to a problem. (2-ESS2-1) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new	**ESS2.A: Earth Materials and Systems** ● Wind and water can change the shape of the land. (2-ESS2-1) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ● Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2) **ESS2.C: The Roles of Water in Earth's Surface Processes** ● Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. (2-ESS2-3) **ETS1.C: Optimizing the Design Solution** ● Because there is always more than one possible solution to a problem, it is useful to compare and test designs. *(secondary to 2-ESS2-1)*	**Patterns** ● Patterns in the natural world can be observed. (2-ESS2-2), (2-ESS2-3) **Stability and Change** ● Things may change slowly or rapidly. (2-ESS2-1) -- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ● Developing and using technology has impacts on the natural world. (2-ESS2-1) -- ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** ● Scientists study the natural and material world. (2-ESS2-1)

information. ● 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. (2-ESS2-3)		

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

K-2-ETS1: Engineering Design	
Students who demonstrate understanding can:	**Resources**
K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change (e.g., climate change) to define a simple problem that can be solved through the development of a new or improved object or tool.	Kindergarten - April Science Connection: *Our Class is Going Green, The Earth Book* First Grade - Confronting Climate Change Mini-Unit Second Grade - Carolina Building Blocks of Science: Earth Materials, Carolina Building Blocks of Science: Ecosystem Diversity, Extension Lesson 5
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.	Kindergarten - Push, Pull, Go First Grade - Exploring Organisms Second Grade - Carolina Building Blocks of Science: Earth Materials
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.	Kindergarten - Push, Pull, Go First Grade - Exploring Organisms Second Grade - Carolina Building Blocks of Science: Earth Materials

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions. ● Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1) ● Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) **Developing and Using Models**	**ETS1.A: Defining and Delimiting Engineering Problems** ● A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1) ● Ask questions, make observations, and gather information about a situation people want to change (e.g., climate change) to define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)	**Structure and Function** ● The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. ● Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ● Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)	● Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1) **ETS1.B: Developing Possible Solutions** ● 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. (K-2-ETS1-2) **ETS1.C: Optimizing the Design Solution** ● Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)	

Grade 3

3-PS2: Motion and Stability: Forces and Interactions	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all. Qualitative and conceptual, but not quantitative addition of forces, are used at this level.] [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]	Forces and Interactions Activity 1 and 2
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. [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [Assessment Boundary: Assessment does not include technical terms such as period and frequency.]	Forces and Interactions Activity 2 and 3
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. [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.]	Forces and Interactions, Investigation 1 part 3
3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.* [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]	Forces and Interactions, Designed investigation.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ● Ask questions that can be investigated based on patterns such as cause and effect relationships. (3-PS2-3)	**PS2.A: Forces and Motion** ● Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary:	**Patterns** ● Patterns of change can be used to make predictions. (3-PS2-2) **Cause and Effect** ● Cause and effect relationships are routinely identified. (3-PS2-1) ● Cause and effect relationships are

● Define a simple problem that can be solved through the development of a new or improved object or tool. (3-PS2-4) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ● 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. (3-PS2-1) ● 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. (3-PS2-2)	Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-1) ● The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2) **PS2.B: Types of Interactions** ● Objects in contact exert forces on each other. (3-PS2-1) ● Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3),(3-PS2-4)	routinely identified, tested, and used to explain change. (3-PS2-3) --- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-4) --- ***Connections to Nature of Science*** **Science Knowledge is Based on Empirical Evidence** ● Science findings are based on recognizing patterns. (3-PS2-2) **Scientific Investigations Use a Variety of Methods** ● Science investigations use a variety of methods, tools, and techniques. (3-PS2-1)

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3-LS1: From Molecules to Organisms: Structures and Processes	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Changes organisms go through during their life form a pattern.] [Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.]	Structures of Life: Investigation 2 - Part 1, 2, 3

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ● Ask questions that can be investigated based on patterns such as cause and effect relationships. (3-PS2-3) ● Define a simple problem that can be solved through the development of a new or improved object or tool. (3-PS2-4) **Developing and Using Models** Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ● Develop models to describe phenomena. (3-LS1-1)	**LS1.B: Growth and Development of Organisms** ● Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)	**Patterns** ● Patterns of change can be used to make predictions. (3-LS1-1) -- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Science findings are based on recognizing patterns. (3-LS1-1)

3-LS2: Ecosystems: Interactions, Energy, and Dynamics	
Students who demonstrate understanding can:	**Resources**
3-LS2-1. Construct an argument that some animals form groups that help members survive.	Structures of Life: Investigation 3 - Part 2, 3

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ● Construct an argument with evidence, data, and/or a model. (3-LS2-1)	**LS2.D: Social Interactions and Group Behavior** ● Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. (3-LS2-1)	**Cause and Effect** ● Cause and effect relationships are routinely identified and used to explain change. (3-LS2-1)

3-LS3: Heredity: Inheritance and Variation of Traits	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.]	Structures of Life: Investigation 2 - Part 1, 2
3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment. [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]	Structures of Life: Investigation 2 - Part 1, 2; Investigation 3 - Part 3

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. Clarification: When possible and feasible, digital tools should be used. ● Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS3-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)	**LS3.A: Inheritance of Traits** ● Many characteristics of organisms are inherited from their parents. (3-LS3-1) ● Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2) **LS3.B: Variation of Traits** ● Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1) ● The environment also affects the traits that an organism develops. (3-LS3-2)	**Patterns** ● Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3-1) **Cause and Effect** ● Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2)

3-LS4: Biological Evolution: Unity and Diversity	
Students who demonstrate understanding can:	**Resources**
3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.]	Structures of Life: Investigation 4 - Part 2
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. [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]	Structures of Life: Investigation 2 - Part 1, 2; Investigation 3 - Part 2
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. [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]	Structures of Life: Investigation 2 - Part 1, 2; Investigation 3 - Part 2 ,4, 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.* [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.]	Structures of Life: Investigation 3 - Part 2, 3

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. ● Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS4-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ● When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. *(secondary to 3-LS4-4)* **LS4.A: Evidence of Common Ancestry and Diversity** ● Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (3-LS4-1)	**Cause and Effect** ● Cause and effect relationships are routinely identified and used to explain change. (3-LS4-2), (3-LS4-3) **Scale, Proportion, and Quantity** ● Observable phenomena exist from very short to very long time periods. (3-LS4-1) **Systems and System Models** ● A system can be described in terms of its components and their interactions. (3-LS4-4) --

use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Use evidence (e.g., observations, patterns) to construct an explanation. (3-LS4-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ● Construct an argument with evidence. (3-LS4-3) ● 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. (3-LS4-4)	● Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1) **LS4.B: Natural Selection** ● Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2) **LS4.C: Adaptation** ● For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3) **LS4.D: Biodiversity and Humans** ● Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4)	***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Knowledge of relevant scientific concepts and research findings is important in engineering. (3-LS4-4) -- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes consistent patterns in natural systems. (3-LS4-1)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

3-ESS2: Earth's Systems	
Students who demonstrate understanding can:	**Resources**
3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]	Water and Climate: Investigation 4 - Part 1, 2, 3; Investigation 2 & 3
3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.	Water and Climate: Investigation 3; Investigation 4 - Part 1, 2, 3

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. ● Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships. (3-ESS2-1) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. ● Obtain and combine information from books and other reliable media to explain phenomena. (3-ESS2-2)	**ESS2.D: Weather and Climate** ● Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1) ● Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)	**Patterns** ● Patterns of change can be used to make predictions. (3-ESS2-1),(3-ESS2-2)

3-ESS3: Earth and Human Activity	
Students who demonstrate understanding can:	**Resources**
3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of climate change and/or a weather-related hazard.* [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]	Water and Climate: Investigation 4 - Part 1, 2, 3

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ● 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. (3-ESS3-1)	**ESS3.B: Natural Hazards** ● A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1) *(Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)*	**Cause and Effect** ● Cause and effect relationships are routinely identified, tested, and used to explain change. (3-ESS3-1) -- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ● Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones). (3-ESS3-1) -- ***Connections to Nature of Science*** **Science is a Human Endeavor** ● Science affects everyday life. (3-ESS3-1)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Grade 4

4-PS3: Energy	
Students who demonstrate understanding can:	**Resources**
4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]	FOSS: Energy Works Unit
4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. [Assessment Boundary: Assessment does not include quantitative measurements of energy.]	FOSS Energy Works Unit
4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]	FOSS Energy Works Unit
4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]	FOSS Energy Works Unit

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ● Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ● Make observations to produce data to serve as the	**PS3.A: Definitions of Energy** ● The faster a given object is moving, the more energy it possesses. (4-PS3-1) ● Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2),(4-PS3-3) **PS3.B: Conservation of Energy and Energy Transfer** ● Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets	**Energy and Matter** ● Energy can be transferred in various ways and between objects. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4) -- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering and Technology on Society and the Natural World** ● Engineers improve existing technologies or develop new ones. (4-PS3-4) --

basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) ● Apply scientific ideas to solve design problems. (4-PS3-4)	heated and sound is produced. (4-PS3-2), (4-PS3-3) ● Light also transfers energy from place to place. (4-PS3-2) ● Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4) **PS3.C: Relationship Between Energy and Forces** ● When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3) **PS3.D: Energy in Chemical Processes and Everyday Life** ● The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4) **ETS1.A: Defining Engineering Problems** ● 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. *(secondary to 4-PS3-4)*	***Connections to Nature of Science*** **Science is a Human Endeavor** ● Most scientists and engineers work in teams. (4-PS3-4) ● Science affects everyday life. (4-PS3-4)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

4-PS4: Waves and their Applications in Technologies for Information Transfer	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]	FOSS Energy Works Unit
4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. [Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]	FOSS Energy Works Unit
4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.* [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]	FOSS Energy Works Unit

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ● Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1) ● Develop a model to describe phenomena. (4-PS4-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Generate and compare multiple solutions to a	**PS4.A: Wave Properties** ● Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. *(Note: This grade band endpoint was moved from K–2.)* (4-PS4-1) ● Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1) **PS4.B: Electromagnetic Radiation** ● An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2) **PS4.C: Information Technologies and Instrumentation** ● Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can	**Patterns** ● Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1) ● Similarities and differences in patterns can be used to sort and classify designed products. (4-PS4-3) **Cause and Effect** ● Cause and effect relationships are routinely identified. (4-PS4-2) -- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3)

problem based on how well they meet the criteria and constraints of the design solution. (4-PS4-3)	receive and decode information—convert it from digitized form to voice—and vice versa. (4-PS4-3) **ETS1.C: Optimizing The Design Solution** ● Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. *(secondary to 4-PS4-3*)	-- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Science findings are based on recognizing patterns. (4-PS4-1)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

4-LS1: From Molecules to Organisms: Structures and Processes	
Students who demonstrate understanding can:	**Resources**
4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]	Amazing Adaptations Unit
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. [Clarification Statement: Emphasis is on systems of information transfer.] [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]	Amazing Adaptations Unit

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ● Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ● Construct an argument with evidence, data, and/or a model. (4-LS1-1)	**LS1.A: Structure and Function** ● Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1) **LS1.D: Information Processing** ● Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)	**Systems and System Models** ● A system can be described in terms of its components and their interactions. (4-LS1-1), (4-LS1-2)

4-ESS1: Earth's Place in the Universe	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]	Foss: Soil, Rocks and Landforms Unit

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Identify the evidence that supports particular points in an explanation. (4-ESS1-1)	**ESS1.C: The History of Planet Earth** ● Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)	**Patterns** ● Patterns can be used as evidence to support an explanation. (4-ESS1-1) --------------------------------------- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes consistent patterns in natural systems. (4-ESS1-1)

4-ESS2: Earth's Systems	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]	FOSS: Soil, Rocks and Landforms Unit
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features. [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]	Social Studies: Zoom/ Geography Unit

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ● Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1) **Analyzing and Interpreting Data** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. ● Analyze and interpret data to make sense of phenomena using logical reasoning. (4-ESS2-2)	**ESS2.A: Earth Materials and Systems** ● Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ● The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2) **ESS2.E: Biogeology** ● Living things affect the physical characteristics of their regions. (4-ESS2-1)	**Patterns** ● Patterns can be used as evidence to support an explanation. (4-ESS2-2) **Cause and Effect** ● Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1)

4-ESS3: Earth and Human Activity	
Students who demonstrate understanding can:	**Resources**
4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; nonrenewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]	FOSS: Soil, Rocks and Landforms Unit
4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes and climate change have on humans.* [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]	FOSS: Soil, Rocks and Landforms Unit

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods. ● Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)	**ESS3.A: Natural Resources** ● Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1) **ESS3.B: Natural Hazards** ● A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) *(Note: This Disciplinary Core Idea can also be found in 3.WC.)* **ETS1.B: Designing Solutions to Engineering Problems** ● Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2)	**Cause and Effect** ● Cause and effect relationships are routinely identified and used to explain change. (4-ESS3-1) ● Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS3-2) --------------------------------------- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Knowledge of relevant scientific concepts and research findings is important in engineering. (4-ESS3-1) **Influence of Engineering, Technology, and Science on Society and the Natural World** ● Over time, people's needs and wants change, as do their demands for new and improved technologies. (4-ESS3-1) ● Engineers improve existing technologies or

		develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Grade 5

5-PS1: Matter and Its Interactions	
Students who demonstrate understanding can:	**Resources**
5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]	FOSS Mixtures and Solutions Unit: Investigation 1 Separating Mixtures; Investigation 2 Reaching Saturation; Investigation 4 Fizz Quiz FOSS Earth and Sun Unit: Investigation 3 Earth's Atmosphere
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. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]	FOSS Mixtures and Solutions Unit: Investigation 2 Reaching Saturation; Investigation 4 Fizz Quiz
5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]	FOSS Mixtures and Solutions Unit: Investigation 1 Separating Mixtures; Investigation 2 Reaching Saturation
5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.	FOSS Mixtures and Solutions Unit: Investigation 4 Fizz Quiz

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ● Develop a model to describe phenomena. (5-PS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer	**PS1.A: Structure and Properties of Matter** ● Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or	**Cause and Effect** ● Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) **Scale, Proportion, and Quantity** ● Natural objects exist from the very small to the immensely large. (5-PS1-1) ● Standard units are used to measure and describe physical quantities such as

questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ● 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. (5-PS1-4) ● Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. ● Measure and graph quantities such as weight to address scientific and engineering questions and problems. (5-PS1-2)	objects. (5-PS1-1) ● The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) ● Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3) **PS1.B: Chemical Reactions** ● When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) ● No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2)	weight, time, temperature, and volume. (5-PS1-2), (5-PS1-3) -- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes consistent patterns in natural systems. (5-PS1-2)

5-PS2: Motion and Stability: Forces and Interactions	
Students who demonstrate understanding can:	**Resources**
Support an argument that the gravitational force exerted by Earth on objects is directed down. [Clarification Statement: “Down” is a local description of the direction that points toward the center of the spherical Earth.] [Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]	FOSS Earth and Sun Unit: Investigation 2 Planetary Systems

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ● Support an argument with evidence, data, or a model. (5-PS2-1)	**PS2.B: Types of Interactions** ● The gravitational force of Earth acting on an object near Earth’s surface pulls that object toward the planet’s center. (5-PS2-1)	**Cause and Effect** ● Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1)

5-PS3: Energy	
Students who demonstrate understanding can:	**Resources**
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. [Clarification Statement: Examples of models could include diagrams, and flow charts.]	Writing in Response to Reading Unit: Food For Energy FOSS Living Systems Unit: Investigation 1 Systems; Investigation 2 Nutrient Systems

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ● Use models to describe phenomena. (5-PS3-1)	**PS3.D: Energy in Chemical Processes and Everyday Life** ● The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms** ● Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary to 5-PS3-1)*	**Energy and Matter** ● Energy can be transferred in various ways and between objects. (5-PS3-1)

5-LS1: From Molecules to Organisms: Structures and Processes	
Students who demonstrate understanding can:	**Resources**
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]	FOSS Living Systems Unit: Investigation 1 Systems; Investigation 3 Transport Systems

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ● Support an argument with evidence, data, or a model. (5-LS1-1)	**LS1.C: Organization for Matter and Energy Flow in Organisms** ● Plants acquire their material for growth chiefly from air and water. (5-LS1-1)	**Energy and Matter** ● Matter is transported into, out of, and within systems. (5-LS1-1)

5-LS2: Ecosystems: Interactions, Energy, and Dynamics	
Students who demonstrate understanding can:	**Resources**
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]	FOSS Living Systems Unit: Investigation 1 Systems

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. ● Develop a model to describe phenomena. (5-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** ● The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** ● Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Systems and System Models** ● A system can be described in terms of its components and their interactions. (5-LS2-1) --------------------------------------- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ● Science explanations describe the mechanisms for natural events. (5-LS2-1)

5-ESS1: Earth's Place in the Universe	
Students who demonstrate understanding can:	**Resources**
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. [Assessment Boundary: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).]	FOSS Earth and Sun Unit: Investigation 2 Planetary Systems Writing in Response to Reading Unit: Stargazing
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. [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]	FOSS Earth and Sun Unit: Investigation 1 The Sun; Investigation 2 Planetary Systems

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. ● Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. (5-ESS1-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ● Support an argument with evidence, data, or a model. (5-ESS1-1)	**ESS1.A: The Universe and its Stars** ● The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System** ● The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	**Patterns** ● Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena. (5-ESS1-2) **Scale, Proportion, and Quantity** ● Natural objects exist from the very small to the immensely large. (5-ESS1-1)

5-ESS2: Earth's Systems	
Students who demonstrate understanding can:	**Resources**
5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]	FOSS Earth and Sun Unit: Investigation 4 Heating Earth; Investigation 5 Water Planet
5-ESS2-2. Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. [Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]	FOSS Earth and Sun Unit: Investigation 5 Water Planet

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ● Develop a model using an example to describe a scientific principle. (5-ESS2-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. ● Describe and graph quantities such as area and volume to address scientific questions. (5-ESS2-2)	**ESS2.A: Earth Materials and Systems** ● Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **ESS2.C: The Roles of Water in Earth's Surface Processes** ● Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)	**Scale, Proportion, and Quantity** ● Standard units are used to measure and describe physical quantities such as weight and volume. (5-ESS2-2) **Systems and System Models** ● A system can be described in terms of its components and their interactions. (5-ESS2-1)

5-ESS3: Earth and Human Activity	
Students who demonstrate understanding can:	**Resources**
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources, environment, and address climate change issues.	FOSS Earth and Sun Unit: Investigation 5 Water Planet FOSS Living Systems: Investigation 1 Systems

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods. ● Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)	**ESS3.C: Human Impacts on Earth Systems** ● Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)	**Systems and System Models** ● A system can be described in terms of its components and their interactions. (5-ESS3-1) -- ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** ● Science findings are limited to questions that can be answered with empirical evidence. (5-ESS3-1)

3-5-ETS1: Engineering Design	
Students who demonstrate understanding can:	**Resources**
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.	FOSS Mixtures and Solutions Unit: Investigation 1 Separating Mixtures; Investigation 2 Reaching Saturation; Investigation 3 Concentration FOSS Earth and Sun Unit: Investigation 4 Heating Earth
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.	FOSS Mixtures and Solutions Unit: Investigation 1 Separating MIxtures; Investigation 2 Reaching Saturation; Investigation 3 Concentration FOSS Earth and Sun Unit: Investigation 4 Heating Earth
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	FOSS Mixtures and Solutions Unit: Investigation 1 Separating Mixtures FOSS Earth and Sun Unit: Investigation 4 Heating Earth

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ● 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. (3-5-ETS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds	**ETS1.A: Defining and Delimiting Engineering Problems** ● 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. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions** ● Research on a problem, such as climate change,	**Influence of Engineering, Technology, and Science on Society and the Natural World** ● People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1) ● Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ● 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. (3-5-ETS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)	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. (3-5-ETS1-2) ● At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) ● Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution** ● Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	

Middle School, Grades 6-8

MS-PS1: Matter and Its Interactions				
Students who demonstrate understanding can:	**Grade**			**Resources**
	6	**7**	**8**	
MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]			X	Introduction to the Physical Properties of Matter
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. [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]			X	Introduction to the Physical Properties of Matter Chemistry: It's Not Magic, It's Chemistry
MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]	X		X	"What do they do with all that energy?" Web quest or guided reading books Two Sides of Energy Resources Chart (WebQuest)
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. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]			X	Introduction to the Physical Properties of Matter Electricity & Waves- Lesson 3 (Transforming & Transferring Electrical Energy)
MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]			X	Chemistry: It's Not Magic, It's Chemistry

MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* [Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]			X	Electricity & Waves: Lesson 3 (Transforming & Transferring Electrical Energy) - Investigation 3.2

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop a model to predict and/or describe phenomena. (MS-PS1-1), (MS-PS1-4) ● Develop a model to describe unobservable mechanisms. (MS-PS1-5) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. ● Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MS-PS1-6) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information	**PS1.A: Structure and Properties of Matter** ● Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) ● Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2), (MS-PS1-3) ● Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) ● In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4) ● Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1) ● The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS1.B: Chemical Reactions** ● Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	**Patterns** ● Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2) **Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) **Scale, Proportion, and Quantity** ● Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1) **Energy and Matter** ● Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5) ● The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6) **Structure and Function** ● Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3) --------------------------------------- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering,**

in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods. ● Gather, read, and 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. (MS-PS1-3)	(MS-PS1-2), (MS-PS1-3), (MS-PS1-5) ● The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5) ● Some chemical reactions release energy, others store energy. (MS-PS1-6) **PS3.A: Definitions of Energy** ● The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.*(secondary to MS-PS1-4)* ● The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4) **ETS1.B: Developing Possible Solutions** ● A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to MS-PS1-6) **ETS1.C: Optimizing the Design Solution** ● 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 the characteristics may be incorporated into the new design. *(secondary to MS-PS1-6)* ● The iterative process of testing the most promising	**and Technology** ● Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3) **Influence of Science, Engineering and Technology on Society and the Natural World** ● The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time. (MS-PS1-3) -- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ● Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

	solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. *(secondary to MS-PS1-6)*	

MS-PS2: Motion and Stability: Forces and Interactions				
Students who demonstrate understanding can:	Grade			Resources
	6	7	8	
MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.* [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]			X	Force, Motion and Energy
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. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]			X	Force, Motion and Energy
MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]			X	Electricity & Waves- Lesson 4 (Electricity in Motion)
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. [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]	X		X	SSE Lesson 1, 4, 7, 8, 10 Introduction to the Physical Properties of Matter Force, Motion and Energy
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. [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.]			X	Electricity & Waves- Lesson 4 (Electricity in Motion)

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<tr><th>Science and Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th></tr>
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Asking Questions and Defining Problems
Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.
Ask questions that can be 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. (MS-PS2-3)
Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds from grades K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1)
Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds from grades K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.
Construct and present oral and written arguments 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. (MS-PS2-4)
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PS2.A: Forces and Motion

For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton’s third law). (MS-PS2-1)
The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

PS2.B: Types of Interactions

Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)
Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5)

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Cause and Effect
Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3), (MS-PS2-5)
Systems and System Models
Models can be used to represent systems and their interactions— such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1), (MS-PS2-4)
Stability and Change
Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence
Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2), (MS-PS2-4)
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MS-PS3: Energy				
Students who demonstrate understanding can:	Grade			Resources
	6	7	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. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]			X	Force, Motion and Energy
MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]			X	Force, Motion and Energy Electricity, Waves, & Information Transfer - Lesson 1 (Battery Powered: Electricity Basics) What Can We Do About It? Save the Planet: Energy, Environment and Change
MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]			X	Electricity, Waves, & Information Transfer - Lesson 3 (Transforming & Transferring Electrical Energy) What Can We Do About It? Save the Planet: Energy, Environment and Change
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. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]			X	Introduction to the Physical Properties of Matter
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. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory			X	Electricity, Waves, & Information Transfer - Lesson 3 (Transforming & Transferring Electrical Energy)

or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]				What Can We Do About It? Save the Planet: Energy, Environment and Change

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop a model to describe unobservable mechanisms. (MS-PS3-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions. ● 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 much data is needed to support a claim. (MS-PS3-4) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.	**PS3.A: Definitions of Energy** ● Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1) ● A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2) ● Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3), (MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** ● When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5) ● The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) ● Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3) **PS3.C: Relationship Between Energy and Forces** ● When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2) **ETS1.A: Defining and Delimiting an Engineering Problem** ● 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	**Scale, Proportion, and Quantity** ● Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1), (MS-PS3-4) **Systems and System Models** ● Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (MS-PS3-2) **Energy and Matter** ● Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5) ● The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3) -- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4), (MS-PS3-5)

• Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds. • Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)	of scientific principles and other relevant knowledge that is likely to limit possible solutions. *(secondary to MS-PS3-3)* **ETS1.B: Developing Possible Solutions** • 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 criteria and constraints of a problem. *(secondary to MS-PS3-3)*	

MS-PS4: Waves and Their Applications in Technologies for Information Transfer				
Students who demonstrate understanding can:	Grade			Resources
	6	7	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. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]			X	Electricity, Waves, & Information Transfer - Lesson 5 (Detecting Waves); Lesson 6 (Wave Transmission)
MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]			X	Electricity, Waves, & Information Transfer - Lesson 5 (Detecting Waves); Lesson 6 (Wave Transmission)
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. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]			X	Electricity, Waves, & Information Transfer - Lesson 7 (Communicating and Storing Information with Waves)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena. (MS-PS4-2) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 6–8 builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.	**PS4.A: Wave Properties** ● A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) ● A sound wave needs a medium through which it is transmitted. (MS-PS4-2) **PS4.B: Electromagnetic Radiation** ● When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) ● The path that light travels can be traced as straight	**Patterns** ● Graphs and charts can be used to identify patterns in data. (MS-PS4-1) **Structure and Function** ● Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2) ● Structures can be designed to serve particular functions. (MS-PS4-3) --

● Use mathematical representations to describe and/or support scientific (MS-PS4-1). **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods. ● Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)	lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) ● A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) ● However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2) **PS4.C: Information Technologies and Instrumentation** ● Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)

MS-LS1: From Molecules to Organisms: Structures and Processes				
Students who demonstrate understanding can:	Grade			Resources
	6	7	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. [Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.]		X		**OMM Kit** - What are Organisms; Exploring Cells; Microscope Activities with types of cells and living organisms (i.e. WOWBug, Blackworm, Daphnia, and Hydra) ***Genes and Molecular Machines***
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. [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.]		X		**OMM Kit** - Exploring Cells and Microorganisms (Elodea, Euglena, Paramecium, Volvox, Amoeba) and Hydra, Microscope Activities with types of cells Diffusion/Osmosis Labs (teacher created) OMM Kit - Cell Division
MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.]		X		**HBS Kit** - systems overlap throughout parts 1, 2, and 3. **OMM Kit** - Blackworm Circulation; Daphnia Nervous System Activity: Botanical Heartthrobs, Blackworms and Plant Extracts
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. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]		X		***Genes and Molecular Machines*** Bird Beak Activity Opposable Thumb Missing Link Activity

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]		X		***Genes and Molecular Machines***
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. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]		X		Food Web Activities: Milkweed Community Project, Guided Reading, Book Tour: Milkweed, Monarchs and More
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. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]		X		Cellular Respiration Activities
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. [Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.]		X		5 Senses Lab Neuroscience 101, Ted Ed Video-How Memories Form and How We Lose Them Stimulus Response Demo, Blackworm Response

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena. (MS-LS1-2) ● Develop a model to describe unobservable mechanisms. (MS-LS1-7) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 6–8 builds	**LS1.A: Structure and Function** ● All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1) ● Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2) ● In multicellular organisms, the body is a system of	**Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8) ● Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4), (MS-LS1-5) **Scale, Proportion, and Quantity** ● Phenomena that can be observed at one

on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

- Conduct an investigation to produce data to serve as the basis for evidence that meets the goals of an investigation. (MS-LS1-1)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- 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. (MS-LS1-5), (MS-LS1-6)

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)
- Use 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. (MS-LS1-4)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

- Gather, read, and synthesize information from

multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)

LS1.B: Growth and Development of Organisms

- Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)

LS1.C: Organization for Matter and Energy Flow in Organisms

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

LS1.D: Information Processing

- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS-LS1-8)

PS3.D: Energy in Chemical Processes and Everyday Life

- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. *(secondary to MS-LS1-6)*
- Cellular respiration in plants and animals involve

scale may not be observable at another scale. (MS-LS1-1)

Systems and System Models

- Systems may interact with other systems; they may have subsystems and be a part of larger complex systems. (MS-LS1-3)

Energy and Matter

- Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7)
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)

Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS1-1)

Connections to Nature of Science

Science is a Human Endeavor

- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

Scientific Knowledge is Based on

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. (MS-LS1-8)	chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. *(secondary to MS-LS1-7)*	**Empirical Evidence** ● Science knowledge is based upon logical connections between evidence and explanations. (MS-LS1-6)

MS-LS2: Ecosystems: Interactions, Energy, and Dynamics				
Students who demonstrate understanding can:	Grade			Resources
	6	7	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. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]		X		Bird Beak Activity Milkweed Community Project A Long Walk to Water
MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]		X		Food Web Activities (teacher created) Milkweed Community Project, Guided Reading, Guided Reading, Book Tour: Milkweed, Monarchs and More
MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]		X		OMM Kit - Create a Pond Watershed Presentation : Milkweed Community Project, Guided Reading, Guided Reading, Book Tour: Milkweed, Monarchs and More
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]		X		Milkweed Community Project A Long Walk to Water
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]	**X**	X*		EIS Lesson 13- develop and design solutions to prevent water erosion- student choice A Long Walk to Water *Monarch unit

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop a model to describe phenomena. (MS-LS2-3) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). ● Construct 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. (MS-LS2-4) ● Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)	**LS2.A: Interdependent Relationships in Ecosystems** ● Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) ● In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) ● Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) ● Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2) **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** ● Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**	**Patterns** ● Patterns can be used to identify cause and effect relationships. (MS-LS2-2) **Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1) **Energy and Matter** ● The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3) **Stability and Change** ● Small changes in one part of a system might cause large changes in another part. (MS-LS2-4), (MS-LS2-5) -- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time. (MS-LS2-5) -- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3) **Science Addresses Questions About the Natural and Material World**

	● Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) ● Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5) **LS4.D: Biodiversity and Humans** ● 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. *(secondary to MS-LS2-5)* **ETS1.B: Developing Possible Solutions** ● There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary to MS-LS2-5)*	● Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5) **Scientific Knowledge is Based on Empirical Evidence** ● Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)

MS-LS3: Heredity: Inheritance and Variation of Trait				
Students who demonstrate understanding can:	**Grade**			**Resources**
	6	**7**	**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. [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]		X		***Genes and Molecular Machines*** Box of Facts Genetic Project: Box of Facts Grade
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. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]		X		***Genes and Molecular Machines***

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena. (MS-LS3-1), (MS-LS3-2)	**LS1.B: Growth and Development of Organisms** ● Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. *(secondary to MS-LS3-2)* **LS3.A: Inheritance of Traits** ● Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1) ● Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore	**Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2) **Structure and Function** ● Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)

	genes) inherited. (MS-LS3-2) **LS3.B: Variation of Traits** ● In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2) ● In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)	

MS-LS4: Biological Evolution: Unity and Diversity				
Students who demonstrate understanding can:	Grade			Resources
	6	7	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. [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]	X	X		EDS Lesson 1, 9, 12 Evidence for Evolution Activity
MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]		X		Evidence for Evolution Activity - Puzzle Activity Puzzle Questions
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. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]		X		***Genes and Molecular Machines*** Evidence for Evolution Activity
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. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]		X		***Genes and Molecular Machines*** **Stickleback Fish and Rock Pocket Mice**
MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]		X		***Genes and Molecular Machines*** **Dogs and More Dogs (NOVA video)** **Dogs That Changed the World (PBS Video)**
MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in		X		***Genes and Molecular Machines*** Bird Beak Buffet

populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]				Stickleback Fish and Rock Pocket Mice

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3) ● Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. ● Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2) ● Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4) **Obtaining, Evaluating, and Communicating Information**	**LS4.A: Evidence of Common Ancestry and Diversity** ● The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1) ● Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2) ● Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3) **LS4.B: Natural Selection** ● Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4) ● In *artificial* selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5) **LS4.C: Adaptation** ● Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new	**Patterns** ● Patterns can be used to identify cause and effect relationships. (MS-LS4-2) ● Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1), (MS-LS4-3) **Cause and Effect** ● Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4), (MS-LS4-5), (MS-LS4-6) --- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS4-5) --- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1) **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes that objects and events

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. ● Gather, read, and 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. (MS-LS4-5)	environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)	in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1), (MS-LS4-2) **Science Addresses Questions About the Natural and Material World** ● Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5)

MS-ESS1: Earth's Place in the Universe				
Students who demonstrate understanding can:	Grade			Resources
	6	7	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. [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]	X			SSE Lesson 1, 2, 3, 4, 5, 10 EDS Lesson 1, 9, 11, 12
MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]	X			SSE Lesson 1, 7, 8, 10 Starry Night- planetary motion around the sun EDS Lesson 1, 9, 11, 12
MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system. [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]	X			SSE Lesson 1,6, 8 10 EDS Lesson 1, 9, 11, 12
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. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]	X	X		EDS Lesson 1, 9, 11, 12 Evidence for Evolution Activity

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract	**ESS1.A: The Universe and Its Stars** ● Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.	**Patterns** ● Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1)

phenomena and design systems. ● Develop and use a model to describe phenomena. (MS-ESS1-1), (MS-ESS1-2) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● 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. (MS-ESS1-4)	(MS-ESS1-1) ● Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2) **ESS1.B: Earth and the Solar System** ● The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2), (MS-ESS1-3) ● This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1) ● The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2) **ESS1.C: The History of Planet Earth** ● The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)	**Scale, Proportion, and Quantity** ● Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3), (MS-ESS1-4) **Systems and System Models** ● Models can be used to represent systems and their interactions. (MS-ESS1-2) -- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-ESS1-3) -- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-1), (MS-ESS1-2)

MS-ESS2: Earth's Systems				
Students who demonstrate understanding can:	Grade			Resources
	6	7	8	
MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]	X			EDS Lesson 1, 5 & 12 Rocks Interactive website
MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]	X			EDS Lesson 1, 3, 4, 5, 6, 7, 8, 11 &12
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. [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]	X			EDS Lesson 1, 4, 11 &12 Catastrophe at Pompeii Tectonic Plates CD-rom- Continental Drift Theory Seafloor Spreading
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. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]	X			OpenSciEd - Weather, Climate & Water Cycling*
MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the	X			OpenSciEd - Weather, Climate & Water Cycling*

reported diagrams from weather stations.]				
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. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]	X			OpenSciEd - Weather, Climate & Water Cycling*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena. (MS-ESS2-1),(MS-ESS2-6) ● Develop a model to describe unobservable mechanisms. (MS-ESS2-4) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. ● 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. (MS-ESS2-5) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to provide evidence for phenomena. (MS-ESS2-3) **Constructing Explanations and Designing Solutions**	**ESS1.C: The History of Planet Earth** ● Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (HS.ESS1.C GBE) *(secondary to MS-ESS2-3)* **ESS2.A: Earth's Materials and Systems** ● All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1) ● The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ● Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3) **ESS2.C: The Roles of Water in Earth's Surface Processes** ● Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation,	**Patterns** ● Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3) **Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5) **Scale Proportion and Quantity** ● Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS2- 2) **Systems and System Models** ● Models can be used to represent systems and their interactions—such as inputs, processes and outputs— and energy, matter, and information flows within systems. (MS-ESS2-6) **Energy and Matter** ● Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4) **Stability and Change** ● Explanations of stability and change in natural or designed systems can be constructed by examining the changes

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● 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 nature operate today as they did in the past and will continue to do so in the future. (MS-ESS2-2)	condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) ● The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5) ● Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4) ● Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6) ● Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2) **ESS2.D: Weather and Climate** ● Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6) ● Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) ● The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)	over time and processes at different scales, including the atomic scale. (MS-ESS2-1) --- ***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** ● Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3)

MS-ESS3: Earth and Human Activity				
Students who demonstrate understanding can:	Grade			Resources
	6	7	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. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]	X			EDS Lesson 1, 3, 10 &12 Catastrophe at Pompeii Geothermal video- heat produced inside earth Tectonic Plates CD-rom- subduction zones created through tectonics and volcanism
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. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]	X			EDS Lesson 1, 2, 3, 4, 7 & 12 Catastrophe at Pompeii OpenSciEd - Weather, Climate & Water Cycling*
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]	X	X		Catastrophe at Pompeii Intro growth of population per capita and natural resource http://wapo.st/1Tfp1QZ "What do they do with all that energy?" Web quest or guided reading books Two Sides of Energy Resources Chart (WebQuest) http://wapo.st/1Tfp1QZ A Long Walk to Water
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. [Clarification Statement: Examples of evidence include grade-appropriate databases on	X			Intro growth of population per capita and natural resource http://wapo.st/1Tfp1QZ "What do they do with all that energy?"

human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]				Web quest or guided reading books Two Sides of Energy Resources Chart (WebQuest) http://www.conserve-energy-future.com/GlobalWarmingCauses.php A Long Walk to Water
MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused climate change over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]	X	X	X	6th Grade - EIS Lesson 7 & 8- Sun's energy, radiation, sunspots, solar flares Atmosphere reading & discuss parts including Ozone layer Create a research project on climate change- definition of, causes of natural vs man-made, effects of and solutions for preventing or reducing it http://www.conserve-energy-future.com/GlobalWarmingCauses.php What Can We Do About It?: Energy, Environment, and Change

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models. ● Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on grades K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2)	**ESS3.A: Natural Resources** ● Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) **ESS3.B: Natural Hazards** ● Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2) **ESS3.C: Human Impacts on Earth Systems**	**Patterns** ● Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) **Cause and Effect** ● Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1), (MS-ESS3-4) **Stability and Change** ● Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on grades K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● 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. (MS-ESS3-1) ● Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on grades K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). ● Construct 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. (MS-ESS3-4)	● Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) ● Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3- 3), (MS-ESS3-4) **ESS3.D: Global Climate Change** ● Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)	-- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● 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. (MS-ESS3-1), (MS-ESS3-4) ● The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time. (MS-ESS3-2), (MS-ESS3-3) -- ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** ● Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)

MS-ETS1: Engineering Design				
Students who demonstrate understanding can:	Grade			Resources
	6	7	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.	X	X	X	SSE Lesson 6, 9, 10 EDS Lesson 2 Prosthesis Application: POSI Contact A Long Walk to Water What Can We Do About It? Save the Planet: Energy, Environment and Change
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	X	X	X	SSE Lesson 10 EDS Lesson 2 A Long Walk to Water Introduction to the Physical Properties of Matter Electricity, Waves, and Information Transfer What Can We Do About It? Save the Planet: Energy, Environment and Change
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.	X	X	X	EDS Lesson 2 A Long Walk to Water Newton's Laws Electricity, Waves, & Information Transfer (Conversion Contraption Project) What Can We Do About It? Save the Planet: Energy, Environment and Change
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.	X	X	X	EDS Lesson 2 A Long Walk to Water Introduction to the Physical Properties of

				Matter Newton's Laws Electricity, Waves, & Information Transfer- (Conversion Contraption Project)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models. ● 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. (MS-ETS1-1) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.	**ETS1.A: Defining and Delimiting Engineering Problems** ● 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. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** ● A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) ● There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) ● Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) ● Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** ● 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. (MS-ETS1-3) ● The iterative process of testing the most promising solutions and modifying what is proposed on the	**Influence of Science, Engineering, and Technology on Society and the Natural World** ● 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. (MS-ETS1-1) ● The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

• Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	

PACING GUIDES AND UNIT OVERVIEWS

Pacing Guide, Kindergarten

Month	Social Sciences/Health Connections and Science Units of Study
September	Chrysanthemum Pledge of Allegiance Johnny Appleseed Goes A' Planting
October	I Am Fire In 1492 This is the Way We Go to School Safety Signs Living Things and Their Needs Science Unit
November	A Tree for All Seasons Pilgrims of Plymouth
December	Hanukkah Christmas My First Kwanzaa
January	New Year's Day Sadie and the Snowman Happy Birthday Martin Luther King The Emperor's Egg Germs and Medicine My First Chinese New Year
February	Groundhog Day Let's Read About...George Washington Let's Read About...Abraham Lincoln Take Care of Your Teeth
March	Nutrition Push, Pull, Go Science Unit
April	Easter/Passover Rain Our Class Is Going Green The Earth Book Chick Life Cycle
May	Jack's Garden What Mommies Do Best A Butterfly is Born Service Learning Project (Kindergarten "K"onversation)
June	What Daddies Do Best The American Flag

Pacing Guide, Grades 1-2

<table>
<tr><th></th><th>Grade 1*</th><th>Grade 2*</th></tr>
<tr><td>September</td><td>Unit 1: Classroom Community</td><td rowspan="2">Unit 1: Diversity Among Us</td></tr>
<tr><td>October</td><td>Unit 1: Sky Watchers</td></tr>
<tr><td>November</td><td rowspan="2">Unit 2: School Community</td><td rowspan="2">Unit 1: Matter</td></tr>
<tr><td>December</td></tr>
<tr><td>January</td><td>Unit 2: Light and Sound Waves</td><td rowspan="2">Unit 2: Immigrants and Pioneers</td></tr>
<tr><td>February</td><td>Unit 3: Family and Neighborhood Community</td></tr>
<tr><td>March</td><td>Confronting Climate Change</td><td rowspan="2">Unit 2: Earth Materials</td></tr>
<tr><td>April</td><td rowspan="2">Unit 3:
Exploring Organisms</td></tr>
<tr><td>May</td><td>Unit 3: Native Americans
Service Project</td></tr>
<tr><td>June</td><td>Service Project</td><td>Unit 3: Ecosystem Diversity and Climate Change Extension</td></tr>
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Social Studies and Science interdisciplinary units of study are alternately implemented during the same block of time, which is dedicated to the study of Social Sciences

**Science units of study are designated in the gray boxes*

Pacing Guide, Grades 3-5

<table>
<tr><th></th><th>Grade 3*</th><th>Grade 4*</th><th>Grade 5*</th></tr>
<tr><td>September</td><td>Communities</td><td>United We Stand</td><td>Kids in Action</td></tr>
<tr><td>October</td><td rowspan="4">Water and Climate</td><td rowspan="2">Amazing Adaptations</td><td rowspan="2">Earth and Sun</td></tr>
<tr><td rowspan="2">November</td></tr>
<tr><td rowspan="2">America: A Patchwork of Cultures – A Study of Immigration in America</td><td rowspan="2">Mixtures & Solutions</td></tr>
<tr><td>December</td></tr>
<tr><td rowspan="2">January</td><td>Families</td><td rowspan="3">Energy Works!</td><td rowspan="2">Our Town in Action</td></tr>
<tr><td rowspan="2">Forces and Interactions</td></tr>
<tr><td rowspan="2">February</td><td rowspan="4">Living Systems</td></tr>
<tr><td>Transportation & Communication</td><td rowspan="2">Soils, Rocks and Landforms</td></tr>
<tr><td>March</td><td rowspan="3">Structures of Life</td></tr>
<tr><td>April</td><td rowspan="4">Roaming Through the Regions: A Geographical Study of the United States</td></tr>
<tr><td rowspan="2">May</td><td rowspan="3">History in Action</td></tr>
<tr><td rowspan="2">Zoom: A Study of Geography, Economics and Regions</td></tr>
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</table>

Social Studies and Science interdisciplinary units of study are alternately implemented during the same block of time, which is dedicated to the study of Social Sciences.

**Science units of study are designated in the gray boxes*

Pacing Guide, Grades 6-8

<table>
<tr><th></th><th>6th Grade</th><th>7th Grade</th><th>8th Grade</th></tr>
<tr><td>September</td><td rowspan="4">Space Systems Exploration</td><td rowspan="2">Ecology

(Including A Long Walk to Water: Interdisciplinary Unit for Science and Social Studies)</td><td rowspan="3">Safety & Introduction to the Physical Properties of Matter

Introduction to Energy (Including What Can We Do About it?

Save the Planet Energy, Environment and Change)</td></tr>
<tr><td>October</td></tr>
<tr><td>November</td><td rowspan="4">Organisms Macro to Micro/Genes & Molecular Machines</td></tr>
<tr><td>December</td><td rowspan="3">Chemistry - Believe it or Not</td></tr>
<tr><td>January</td><td rowspan="6">Earth’s Dynamic Systems

(Including Catastrophe at Pompeii: Interdisciplinary Unit for Science and Social Studies)

Open Sci Ed: Weather, Climate and Water</td></tr>
<tr><td>February</td></tr>
<tr><td>March</td><td rowspan="4">Human Body Systems</td><td rowspan="3">Electricity, Waves, & Information Transfer</td></tr>
<tr><td>April</td></tr>
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Overview of Science Units, Grades K-2

Physical Science Overview: Push, Pull, Go

Grade: Kindergarten

Month: March

Amount of Time: 10-12 days

Brief Description of Unit: In the Push, Pull, Go unit students will explore through inquiry, discussion, engineering, and problem solving. The unit begins with an overview of concepts, skills, and attitudes followed by a series of five lesson investigations. Students will perform and manipulate models to learn about motion, force, energy, gravity, and friction. K'NEX pieces are used to build ramps, swing sets, and tops. They will also practice measuring distance, making predictions, and identifying systems. To conclude the unit, students design and build an invention that combines different motions to create a single system. They will define problems and share ideas about how they can be fixed.

Lesson Titles:
1. Push, Pull, Roll
2. Push, Pull, Swing
3. Push, Pull, Tumble
4. Push, Pull, Spin
5. Push, Pull, Invent

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
K-PS2-1; K-PS2-2

<u>Crosscutting Concepts</u>
Cause and Effect
Patterns
Energy and Matter

Driving Questions:
1. What is motion?
2. What causes objects to move fast or slow?
3. How can we use force to change the speed and direction of an object in motion?
4. How can you stop an object in motion?
5. How do moving objects get energy?
6. How does force affect the motions that we observe each day?
7. What is a system?
8. How does changing a system affect the way it moves?
9. What do we learn by comparing our structures to others in the class?

Science Connections to be Included:
Standard K-PS3-1; April Science Connection, *Rain*
Standard K-PS3-1; January Science Connection, *Sadie and the Snowman*
Standard K-PS3-2; January Science Connection, *Sadie and the Snowman*

Earth Space Science Overview: Science Connections - Growth and Change

Grade: Kindergarten

Month: Varied, integrated throughout the year

Amount of Time: Varies by connection

Brief Description of Unit: A major element of this unit is the integration of calendar and weather routines & patterns, which are part of the daily kindergarten experience. These are not only recorded by students, but also analyzed and interpreted using various data points. In addition, Science Connections are based on the year-long theme of *Growth and Change: A study of annual recurring patterns, cycles, events, seasons, celebrations, and school experiences*. Each connection includes the reading of a special science-related book followed by a required activity that explains Earth Space Science connections, including climate change. Extensions are also included in each lesson to extend/reinforce concepts. These activities include items such as poems/songs, additional experiments, and interdisciplinary connections.

Section/Lesson Titles:
1. *The Emperor's Egg* - January Science Connection
2. *Sadie and the Snowman* - January Science Connection
3. *Our Class is Going Green* & *The Earth Book*- April Science Connection
4. *Chick Life Cycle* - April Science Connection
5. *A Butterfly is Born* - May Science Connection

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
K-ESS3-1; K-ESS3-2; K-ESS3-3

<u>Crosscutting Concepts</u>
Cause and Effect
Systems and System Models
Influence of Engineering, Technology, and Science, on Society and the Natural World

Driving Questions:
1. What weather patterns do we experience over time?
2. How does weather forecasting help us prepare for daily life?
3. What do living things need to survive?
4. Where do organisms live and why do they live there?
5. How do living things change the environment to meet their needs?
6. How can we help care for our Earth?

Note to Teachers:
The science unit, *Living Things and Their Needs,* will also address standards K-ESS2-2, K-ESS3-1 and K-ESS3-3.

Life Science Overview: Living Things and Their Needs

Grade: Kindergarten

Month: October

Amount of Time: 2 weeks

Brief Description of Unit: *Living Things and Their Needs* provides students the opportunity to investigate and observe what plants and animals need to survive. Students begin by identifying living and nonliving things and discussing characteristics of living things and what they need to survive. They investigate these needs through the germination and growth of their own plants and through behavioral observations of live classroom animals, bessbugs. Students are introduced to the concept of environmental change and explore the impact that environmental change has on living things. This unit concludes with students developing a solution that will reduce the impact of humans on the environment.

Section/Lesson Titles:
1. Lesson 1: Living and Nonliving Things
2. Lesson 2: Needs of Living Things
3. Lesson 3: Living Things and Their Environment
4. Lesson 4: Protecting the Environment

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectation</u>
K-LS1-1, K-ESS2-2, K-ESS3-1, K-2-ETS1-1

<u>Crosscutting Concept</u>
Patterns

Driving Questions:
1. What do living things need to survive?
2. How do the needs of living things differ?
3. How do plants and animals obtain what they need to survive?

Science Connections to be Included:
In addition to this unit of study, the following Science Connections allow students to experience the life cycle of both chicks and butterflies:
K-LS1-1: April Science Connection *Chick Life Cycle*
K-LS1-1: May Science Connection *A Butterfly is Born*

Physical Science Overview: Light and Sound Waves

Grade: 1

Month: January

Amount of Time: 4 weeks

Brief Description of Unit: The two-part unit of study focuses on the physical concepts of light and sound, and that both phenomena travel in waves. Students will begin the unit by exploring how light travels and interacts with other materials. Next, they will explore sound and how it travels. Finally, students will compare and contrast what they learned about light and sound.

Section/Lesson Titles:
1. Light
2. Sound

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
1-PS4-1, 1-PS4-2, 1-PS4-3, 1-PS4-4

<u>Crosscutting Concepts</u>
Cause and Effect
Influence of Engineering, Technology, and Science, on Society and the Natural World

Driving Questions:
1. Where do light and sound come from?
2. How do light and sound travel?
3. How do sounds change?
4. How do we communicate with light and sound?
5. How do light and sound affect our everyday lives?

Earth Space Science Overview: Sky Watchers

Grade: 1

Month: October

Amount of Time: 5 weeks

Brief Description of Unit: This three-section unit of study focuses on patterns of movement in the sky. Students will begin the unit identifying what objects are found in the sky. From there, they will begin an investigation about the sun and other stars. The third and final section is focused on the moon. Students will be keeping a moon-watcher's journal to help them reflect on the changes that occur to the moon throughout this unit of study.

Section/Lesson Titles:
1. The Sky
2. Investigating the Sun
3. What Can You Observe About the Moon?

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
1-ESS1-1, 1-ESS1-2, 1-ESS1-1

<u>Crosscutting Concepts</u>
Patterns
Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Driving Questions:
1. What causes day and night?
2. How do objects in the sky affect the phases of the moon?
3. How does the movement of the Earth and sun affect the seasons?
4. How does heat affect our environment?
5. How are the sun, moon, and Earth interrelated? How does one affect the other?
6. How do patterns in the sky affect our daily lives?

Earth Space Science Overview: Confronting Climate Change Mini-Unit

Month: March

Amount of Time: 3 Days

Brief Description of Unit: This unit introduces students to the problem of climate change and global warming affecting our Earth. It provides opportunities for students to understand the problem and think about ways that humans can help. The first lesson describes the difference between weather and climate and how the Earth's climate is growing warmer. It includes an investigation into how ice will react to warmer water. Students will then learn how warming of the earth's poles is threatening the survival of many polar animals. By the end of the first lesson, students will have an understanding of the definition of climate change. The second lesson continues to describe the problem of climate change with further questioning and explanation as to what is causing the earth to warm and the impact humans and modern conveniences have on the Earth. This lesson features a flash debate, which students will be familiar with by this point in the year. Finally, students will explore ways that they can help solve the global warming problem through personal and group effort, designing solutions and communicating with others to spread awareness.

Note to Teachers: Three morning meeting lessons will accompany and launch this unit.

Performance Expectations and Crosscutting Concepts Addressed:
Performance Expectations
K-2-ETS1-1

Crosscutting Concepts
Patterns
Cause and effect
Systems and System Models
Stability and change

Driving Questions:
1. What is the difference between weather and climate?
2. How is Earth's climate changing?
3. What is global warming?
4. Who and what is affected by climate change?
5. How have humans impacted the Earth's climate?
6. What can humans do to help balance the Earth and slow the effects of global warming?

Life Science Overview: Exploring Organisms

Grade: 1

Month: April/May/June

Amount of Time: 4-6 weeks

Brief Description of Unit: This unit introduces students to the importance of structure and function in plants and animals. It also addresses the connection that exists between parents and their offspring for both plants and animals. Students will investigate the difference between living and nonliving things while also discovering the needs that all of life depends upon. They will have the opportunity to explore the parental roles that exist in the animal kingdom, compare and contrast the variations that exist between parents and babies, and observe patterns seen between parents and offspring. Students will learn through observation that variations exist between the parents and offspring of all members of the plant and animal worlds. Throughout the unit, they will also tie in the basic concepts of structure and function that help different species survive and will be challenged at the end of the unit, to apply their learning to help solve a real-life problem that exists for human parents in the care of their offspring.

This unit will also be supplemented with lessons from *Seed to Plant* to enrich and add variety to the classroom garden. In addition, the study of animals is enhanced with the life cycle of a ladybug and additional informational texts and research on animal classifications. These resources allow students to further explore the patterns in the natural world as well as the structure and function of both plants and animals.

Section/Lesson Titles:
1. Needs for Survival
2. Raising Young
3. Parents and Their Young
4. Structures and Functions for Survival

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
1-LS1-1, 1-LS1-2, 1-LS3-1

<u>Crosscutting Concepts</u>
Patterns
Structure and Function
Influence of Engineering, Technology, and Science on Society and the Natural World

Driving Questions:
1. What do plants and animals need to grow/survive?
2. What is the difference between a living and nonliving object?
3. How are plants alike and different?
4. What are the similarities and differences between a seedling and an adult plant?
5. How can we use characteristics of animals to classify them?
6. What are the similarities and differences between parents and their offspring?
7. How do plants and/or animals use their external structures to help them survive?

Physical Science Overview: Matter

Grade: 2

Month: November-December

Amount of Time: 4 weeks

Brief Description of Unit: This unit of study introduces students to the three states of matter: solids, liquids, and gasses. Students will investigate the different properties of matter. Students will create mixtures by combining solids with solids and solids with liquids. Through observation, discussion, and investigation students will gain an understanding of chemical and physical changes.

Section/Lesson Titles:
1. Same Pieces, Different Look
2. What's the Matter?
3. Solids, Liquids, and Mixtures
4. Describing Matter
5. Heating Matter

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
2-PS1-1, 2- PS1-2, 2- PS1-3, 2-PS1-4

<u>Crosscutting Concepts</u>
Energy and Matter
Pattern
Cause and Effect

Driving Questions:
1. What are things made of?
2. How does matter change states?
3. What happens when two states of matter are combined?
4. How can the differences in matter be useful?
5. How does heat energy cause physical changes to matter?
6. How does heat energy cause chemical changes to matter?

Earth Space Overview: Earth Materials

Grade: 2

Month: January - February

Amount of Time: 6 weeks

Brief Description of Unit: This unit of study explores water, rocks, sand, soil, landforms, and bodies of water. Students begin to formulate an understanding that land is constantly changing, usually over a long period of time. Students also start to realize that wind and water erosion can change the shape of the land. Students will explore four earth materials (water, sand, soil, and rocks). They will use maps, models, and graphs to discover how water can shape the land, where water can be found, and how water cycles on earth. As a culminating activity, students will apply what they've learned to develop a plan and build a model island incorporating bodies of water and landforms which will be presented to the class.

Section/Lesson Titles:
1. Water World
2. Rock Attributes: How Are Rocks Different?
3. What is Sand?
4. What is Soil?
5. Changes in Land
6. Making Model Landforms

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
2-ESS1-1, 2-ESS2-1, 2-ESS2-2, 2-PSI-1

<u>Crosscutting Concepts</u>
Patterns
Stability and change

Driving Questions:
1. What is the water cycle?
2. How can water, wind and ice change the shape of land?
3. What are the properties/attributes of rock, sand and soil?
4. How can changes to Earth's materials occur over long periods of time?
5. How are natural Earth materials broken down from rock over time?
6. What are the characteristics of landforms and how do they change over time?

Life Science Overview: Ecosystem Diversity

Grade: 2

Month: May - June

Amount of Time: 6 weeks

Brief Description of Unit: This unit of study compares diverse habitats and considers the basic needs of various species of living things. Students are introduced to the following habitats: ocean, desert, grasslands, tundra, woodlands, and tropical rainforest. By planting seeds, students discover the similarities in the needs of plants and animals. In groups, students demonstrate their understanding of habitats by creating an aquatic or terrestrial habitat of their own. In conclusion, students learn about the impact of human actions on habitats.

An extension to this unit, which addresses climate change, investigates the impact of human behavior on the environment and asks students to design or innovate upon a tool to combat its effects by humans.

In addition, the study of animals is enhanced with the life cycle of a frog. Students research, document, and record observations on the transformation from tadpole to frog.

Section/Lesson Titles:
1. Organisms and Habitats
2. Plant Growth
3. Plant and Animal Interactions
4. Diversity of Life
5. Human Impact
6. Climate Change Extension

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
2-LS2-1, 2-LS2-2, 2-LS4-1, K-2-ETS1

<u>Crosscutting Concepts</u>
Cause and Effect
Structure and Function

Driving Questions:
1. What do living things need in order to survive?
2. How do different organisms survive in different habitats?
3. What do plants need to grow and survive?
4. How do different plants live in different habitats?
5. How do plants make more plants?
6. What do organisms need to survive in a terrestrial and aquatic habitat?
7. How can human action affect a habitat?

Overview of Science Units, Grades 3-5

Physical Science Overview: Forces and Interactions

Grade: 3

Month: January-February

Amount of Time: 4 weeks

Brief Description of Unit: This unit of study focuses on motion of objects as it relates to the effects of balanced and unbalanced forces. Students will examine cause and effect relationships between forces and objects after observing the movement and reactions of objects when forces are applied to them. Students will be given the opportunity to test the negative and positive charges of various classroom items by investigating the items that attract each other or repel. The culminating activity will have students work collaboratively to design a model using magnetism to solve a problem.

Section/Lesson Titles:
1. Balanced Forces
2. Unbalanced Forces
3. Changes in Motion
4. Magnetism and Electricity
5. Magnetic Solutions

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
3-PS2-1, 3-PS2-2, 3-PS2-3, 3-PS2-4

<u>Crosscutting Concepts</u>
Cause and Effect
Patterns

Driving Questions:
1. What are balanced and unbalanced forces?
2. How do unbalanced forces act on an object?
3. What is the connection between magnetism and electricity?
4. How can magnets be used to solve problems?

Earth Space Science Overview: Water and Climate

Grade: 3

Month: October-December

Amount of Time: 8 weeks

Brief Description of Unit: This unit will provide students with the experiences to explore the properties of water, the water cycle and weather, interactions between water and other earth materials. Students will engage in science and engineering practices in the context of water, weather, and climate and explore the crosscutting concepts of patterns; cause and effect scale, proportion, and quantity; systems and system models. Students will be introduced to the nature of science, how science affects everyday life, and the influence of engineering, technology, and science on society and the natural world.

Section/Investigation Titles:
1. Water Observations
2. Hot Water, Cold Water
3. Weather and Water
4. Seasons and Climate
5. Waterworks

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
3-ESS2-1, 3-ESS2-2, 3-ESS3-1

<u>Crosscutting Concepts</u>
Patterns
Cause and Effect
Scale, proportion, and quantity
Systems and system models

Driving Questions:
1. How does water move?
2. How does the movement of water and the water cycle affect weather and climate?
3. What happens outdoors when rain falls on natural materials?
4. How does temperature affect water?
5. How can we predict weather?
6. How does surface area affect evaporation?
7. How do people prepare for or deal with natural weather hazards?

Life Science Overview: Structures Of Life

Grade: 3

Month: March-June

Amount of Time: 14 weeks

Brief Description of Unit: This unit has four investigations of life science concepts. These concepts include--plants and animals are organisms and exhibit a variety of strategies for life; organisms are complex and have a variety of observable structures and behaviors; organisms have varied but predictable life cycles and reproduce their own kind; and individual organisms have traits that are advantageous to surviving in their environments. Students observe, compare, categorize, and care for a selection of organisms.

Section/Investigation Titles:
1. Origin of Seeds
2. Growing Further
3. Meet the Crayfish
4. The Human Body

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
3-LS1-1, 3-LS2-1, 3-LS3-1, 3-LS3-2, 3-LS4-1, 3-LS4-2, 3-LS4-3, 3-LS4-4

<u>Crosscutting Concepts:</u>
Patterns
Cause and Effect
Scale, proportion, and quantity
Systems and system models
Structure and function

Driving Questions:
1. How are seeds alike and different?
2. What effect does water have on seeds?
3. How do seeds disperse?
4. What structures does a seedling have to help it grow and survive?
5. Do all organisms have the same life cycle?
6. How do crayfish structures and behaviors help crayfish survive?
7. How are the structures of crayfish and other animals alike and different?
8. What is needed to sustain a food chain?
9. How are fingerprints alike and different?

Physical Science Overview: Energy Works!

Grade: 4

Month: November/December

Amount of Time: Approximately 30 days

Brief Description of Unit: Students explore potential, kinetic, and alternative forms of energy. This includes experiences with converting energy and transferring energy. Students conduct experiments using water waves and how energy passes through objects. Through research and discussion, students become aware of the relative advantages and disadvantages of alternative energy versus fossil fuels. Students will build models to demonstrate their learning.

Section/Lesson Titles:
1. Where do you get your energy?
2. What are potential energy and kinetic energy?
3. How can we show energy is transferred and converted?
4. How does energy move in water waves?
5. What are alternative forms of energy? (addresses climate change)
6. What have we learned about energy?

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
4-PS3-1, 4-PS3-2, 4PS3-3, 4-PS3-4, 4PS4-1, 4PS4-2, 4-PS4-3, 4-ESS3-1, 4-ESS3-2

<u>Crosscutting Concepts</u>
Cause and Effect
Energy and Matter

Driving Questions:
1. What is the difference between potential and kinetic energy?
2. What are energy sources?
3. What are the differences between fossil fuels and alternative energy?
4. What are the advantages and disadvantages between alternative energy?
5. How does energy move in waves?

Earth Space Science Overview: Soils, Rocks, and Landforms

Grade: 4

Month: March/April

Amount of Time: 35 days

Brief Description of Unit: The Soils, Rocks, and Landforms unit provides students with firsthand experiences with soils and rocks and modeling experiences using tools such as topographic maps and stream tables to study changes to rocks and landforms at Earth's surface. Students will study and identify the differences in soil, based on location. Students learn how weathering affects erosion and deposition of rocks. Students focus on earth materials as renewable and nonrenewable natural resources including the advantages and disadvantages.

Section/Investigation Titles:
1. Soils and Weathering
2. Landforms
3. Mapping Earth's Surface
4. Natural Resources

Performance Expectations and Crosscutting Concepts Addressed:

<u>Performance Expectations</u>
4-ESS1-1, 4-ESS2-1, 4-ESS2-2, 4-ESS3-1, 4-ESS3-2

<u>Crosscutting Concepts</u>
Patterns
Cause and Effect
Scale, Proportion, and Quantity
Systems and System Models
Structure and Function
Stability and Change

Driving Questions:
1. What is soil?
2. What causes large rocks to break down into smaller rocks?
3. How do weathered rock pieces move from one place to another?
4. What variables affect erosion and deposition?
5. How can we represent the different elevations of landforms?
6. What are renewable and nonrenewable sources of energy? What are the advantages and disadvantages of each?

Life Science Overview: Amazing Adaptations

Grade: 4

Month: May/June

Amount of Time: 17 days

Brief Description of Unit: In this unit of study, students develop an understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. Students explore how the brain receives information through sight, processes it, and learns from these experiences to make a memory.

Section/Lesson Titles:
1. Animal Adaptations (includes addressing climate change)
2. Light and Perception

Performance Expectations and Crosscutting Concepts Addressed:
Performance Expectations
4-LS1-1, 4-LS1-2, 4-PS4-2

Crosscutting Concepts
Systems and Systems Models
Patterns
Cause and Effect

Driving Questions:
1. How do internal and external features of an animal help it survive, grow and reproduce in its environment?
2. How do animals use their perceptions and memories to make decisions, learn and survive?
3. How do animals and humans receive, process, store, and respond to information from the environment in order to survive and grow?
4. What impact does global warming have on animals and their environment?

Earth Space Science Overview: Earth and Sun

Grade: 5

Month: October/November

Amount of Time: 13 Lessons

Brief Description of Unit: In the Earth and Sun Module, the students are introduced to the concepts of the Earth and Sun. The students determine the position of the Sun throughout the day through tracking of shadows. They also investigate how the length and direction of shadows change during the day depending on the position of the Sun in the sky. They discover what causes day and night. Students will use models to understand the Earth's place in the solar system, compared to the Moon and Sun. They complete observations of the Moon's appearance, along with the phases of the Moon and the cause of those phases. Students explore the properties of air, the layers of the atmosphere, and examine the variables that affect the weather. They examine heat transfer through conduction and convection, along with color and energy transfer. Students explore the water cycle, including the causes of condensation and evaporation. Finally, students examine the difference between weather and climate including the effects of climate change on the Earth.

Section/Investigation Titles:
1. The Sun
2. Planetary Systems
3. Earth's Atmosphere
4. Water Planet

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
ESS1.A, ESS1.B, ESS2.A, ESS2.C, ESS3.C, PS1.A, PS2.B, ETS1.B, ETS1.C

<u>Crosscutting Concepts</u>
Patterns
Cause and Effect
Scale, Proportion, and Quantity
Systems and Systems Models
Energy and Matter

Driving Questions:
1. How and why does your shadow change during the day?
2. What causes day and night?
3. How can you explain why we see some natural objects only in the night sky, some only in the day sky, and some at both times?
4. How would you describe the size of and distance between Earth, the Moon, and the Sun?
5. How does the shape of the Moon change over 4 weeks?
6. How do the parts of the solar system interact?
7. Why do stars appear to move across the night sky?
8. What is Earth's atmosphere?
9. How do meteorologists measure and record weather variables?
10. What happens to earth materials when they are exposed to sunlight?

11. What causes condensation to form?
12. What is the water cycle?
13. What is the difference between weather and climate?

Physical Science Overview: Mixtures and Solutions

Grade: 5

Month: November/December

Amount of Time: 23 Lessons

Brief Description of Unit: Students learn fundamental ideas of chemistry: mixture, solution, concentration, saturation, and reaction. Students investigate how materials interact with each other when simple materials are put together. They will also learn techniques for separating the resulting mixtures and solutions.

Section/Investigation Titles:
1. Separating Mixtures
2. Concentration
3. Reaching Saturation
4. Fizz Quiz

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
5-PS1-1, 5-PS1-2, 5-PS1-3, 5-PS1-4, 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3

<u>Crosscutting Concepts</u>
Patterns
Cause and Effect
Scale, Proportion, and Quantity
Systems and Systems Models
Energy and Matter

Driving Questions:
1. What is the difference between mixtures and solutions and how can they be separated?
2. How can we tell if a solution is saturated?
3. How can we determine the mass of the solution to determine the amount of material dissolved in the solution?
4. What is concentration and how can we determine which of two solutions is more concentrated?
5. How do we know when a chemical reaction has occurred?

Physical Science Overview: Living Systems

Grade: 5

Month: February/April

Amount of Time: 18 Lessons

Brief Description of Unit: Students will think about systems on different scales - nutrient and transport systems within an organism that moves matter and provides energy to the individual organism, and feeding relationships in ecosystems that move matter among plants, animals, decomposers, and the environment. Through various experiences, students will understand that plants get the materials they need for growth primarily from water and air, and that energy in animals' food was once energy from the Sun. Students also explore how human activities in agriculture, industry, and everyday life can have major effects on these systems.

Section/Investigation Titles:
1. Systems
2. Nutrient Systems
3. Transport Systems
4. Sensory Systems

Performance Expectations and Crosscutting Concepts Addressed:
<u>Performance Expectations</u>
5-PS3-1, 5-LS1-1, 5-LS2-1, 5-ESS2-1, 5-ESS3-1

<u>Crosscutting Concepts</u>
Patterns
Cause and Effect
Scale, Proportion, and Quantity
Systems and Systems Models
Energy and Matter

Driving Questions:
1. How can you identify a system and is planet Earth a system?
2. What organisms are both predators and prey in the kelp forest ecosystem?
3. What happens when compost worms interact with organic litter?
4. What does yeast need to break its dormancy?
5. How do plants and animals get the nutrients they need?
6. How are nutrients transported to plants and humans?
7. Why do people breathe?
8. What behaviors are instinctive and learned?
9. What features of organisms attract attention?
10. What are the parts of a marine ecosystem?

Overview of Science Units, Grades 6-8

Unit Overview - Space Systems Exploration

Grade: 6

Month: September to January

Amount of Time: 4 months (1 period per day)

Brief Description of Unit: Students of all ages have an innate curiosity about our solar system and the broader universe. Space Systems Exploration taps into this curiosity by helping students clarify what they already know about space. Every day, students experience phenomena surrounding space systems. Watching the Sun rise and set, dressing for the appropriate season, planning a trip to the beach around the tidal schedule, and observing changes in the night sky are just a few ways that students engage with the Sun-Earth-Moon system. Though they may not realize it, students are also part of a larger system, the solar system, which is part of an even larger system, the Milky Way Galaxy, which is part of an even larger system, the universe. Often, it is difficult for students to conceptualize phenomena occurring in systems that are too large or too small for them to study directly. During the Space Systems Exploration unit, students develop and use models to investigate the interactions of these systems. They also analyze and interpret data to become more familiar with the celestial bodies that compose these systems. Students use evidence and scientific reasoning throughout the unit to construct scientific explanations about space science phenomena.

Section Titles:
Lesson 1 Pre-Assessment: Space Systems Exploration
Lesson 2 The Sun-Earth-Moon System
Lesson 3 Why Earth's Tilt Matters
Lesson 4 Investigating Lunar Patterns
Lesson 5 Solar and Lunar Eclipses
Lesson 6 Modeling the Solar System
Lesson 7 Gravity: Bending Space-Time
Lesson 8 Gravity's Role in the Universe
Lesson 9 The Challenges of Space Exploration
Lesson 10 Assessment: Space Systems Exploration

Performance Expectations and Crosscutting Concepts Addressed:
NGSS: MS-ESS1-1, MS-ESS1-2, MS-ESS1-3, MS-PS2-4, MS-ETS1-1, MS-ETS1-2.
Crosscutting Concepts: Cause and Effect, Patterns, Scale, Proportion and Quantity

- Systems and system models
- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Scientific knowledge assumes an order and consistency in natural systems

- Interdependence of science, engineering, and technology
- Influence of science, engineering, and technology on society and the natural world

Driving/Essential Questions:

- What can we observe and learn about the universe from our Earthly perspective?
- How does human activity affect the environment?
- What is the Earth's role in the Universe?
- How does the Sun, Earth and Moon work together?
- How does the Sun affect the Earth?
- Why does the Earth continue to change over time?

Science and Engineering Practices to Reinforce:

- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Unit Overview - Earth's Dynamic Systems

Grade: 6

Month: January to May

Amount of Time: 4 months (1 period per day)

Brief Description of Unit: Although it may not be readily apparent to students, Earth is a dynamic planet. Geoscience processes (geologic processes) change Earth's surface at various time and spatial scales. Geoscience processes also record information about Earth's history. Often, it is difficult for students to conceptualize phenomena occurring in systems that are too large or small for them to study directly. During the Earth's Dynamic Systems unit, students develop and use models to describe processes, analyze and interpret data from the real world, and use empirical evidence to construct scientific explanations about the world around them. The unit helps students develop a better understanding of geologic systems; how those systems change over time, and how engineering, technology, and applications of science are connected to each other and to students' daily lives. As students progress through the unit, they take increasing responsibility for their own learning. Eventually, students plan and conduct their own procedures and analyze the results they obtain.

Section Titles:

1. Lesson 1 Pre-Assessment: Earth's Dynamic Systems
2. Lesson 2 When the Earth Shakes
3. Lesson 3 Analyzing Earthquake Data
4. Lesson 4 Investigating Plate Movement
5. Lesson 5 Cycling Matter and Energy
6. Lesson 6 Volcanoes: Building Up
7. Lesson 7 Volcanoes: Eruption including Catastrophe at Pompeii: Interdisciplinary Unit with Social Studies (see unit below)
8. Lesson 8 Changing Earth's Surface
9. Lesson 9 Analyzing the Fossil Record
10. Lesson 10 Distribution of Resources on Earth
11. Lesson 11 Evidence of a Dynamic Earth
12. Lesson 12 Assessment: Earth's Dynamic Systems .

Performance Expectations and Crosscutting Concepts Addressed:

NGSS: MS-ESS1-4, MS-ESS2-1, MS-ESS2-2, MS-ESS2-3, MS-ESS3-1, MS-ESS3-2, MS-LS4-1, MS-ETS1-1,MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

Crosscutting Concepts:

- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Structure and function

- Stability and change
- Connections to engineering, technology, and applications of science: influence of science, engineering, and technology on society and the natural world
- Connections to nature of science: scientific knowledge assumes an order and consistency in natural systems

Driving/Essential Questions:
- What are catastrophic events and how do humans affect them?
- What causes weather?
- What are convection currents?
- What are the planetary processes?
- What is the Earth made of and why does it look the way it does?
- Where do catastrophic events occur most and why in those locations?

Science and Engineering Practices to Reinforce:
- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Unit Overview - Catastrophe at Pompeii
The Connection Between Science and History Interdisciplinary Unit

Grade: 6

Month: May

Amount of Time: 4-5 lessons

Brief Description of Unit:

This interdisciplinary unit has been developed to integrate the study of catastrophic events and how they have shaped history. The springboard for this unit is the historical account of the eruption of Mt. Vesuvius, the focus of the unit is on the meaningful application of the content across disciplines. Resources have been developed to assist teachers with implementation, including options for differentiation.

In Social Studies, this unit coincides with the Authority Unit. Literature offers the opportunity to humanize history, bringing it closer to home, and to illuminate the contours of the past. The first hand account of the event as described in Eruption of Mt. Vesuvius will help the students to visualize the events as they unfolded. Students then use artifacts to deepen their understanding of the time. Students will experience the events through a read-aloud and discussion of the I Survived account of Pompeii. Using this book as a read aloud throughout the unit on ancient Rome provides a seamless link between the science and social curriculum. Throughout the story, the author describes the culture of ancient Rome, and also provides vivid detail about the volcanic explosion. Students will come away with the content knowledge needed to understand the complex ramifications of catastrophic events in history.

In science, this unit coincides with the Earth's Dynamic Systems Unit. Students begin their study by utilizing informational text to determine what causes a volcano to erupt. The students then apply this knowledge to the same primary source that was introduced in the social studies class earlier in the year, *The Destruction of Pompeii.* Collaboratively, the students analyze warning signs and the impact these catastrophic events have on people as well as history. Through the unit, students gain a deeper understanding of the types of volcanoes and the environmental conditions that lead to their formation.

Unit Goals:

- Compare and contrast social hierarchies in classical civilizations as they relate to power, wealth, and equality.
- Evaluate the importance and enduring legacy of the major achievements of Rome over time.
- Explain how and why the interrelationships among improved agricultural production, population growth, urbanization, and commercialization led to the rise of powerful states and kingdoms

Driving/Essential Questions:

- What can we learn about ancient civilizations by looking at artifacts?
- What qualities of civilization are similar and different over time?
- What is the connection between geography and civilizations?

Performance Expectations:
NGSS:MS-ESS2-3, MS-ESS3-1, MS-ESS3-2, MS-ESS3-3
Social Studies Standards:6.2.8.D.3.a, 6.2.8.D.3.c, 6.2.8.C.4.a

NJSLS ELA Companion Standards

Career Ready Practices:
CRP1. Act as a responsible and contributing citizen and employee.
CRP2. Apply appropriate academic and technical skills.
CRP4. Communicate clearly and effectively and with reason.
CRP5. Consider the environmental, social and economic impacts of decisions.
CRP6. Demonstrate creativity and innovation.
CRP7. Employ valid and reliable research strategies.
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9. Model integrity, ethical leadership and effective management.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Science and Engineering Practices to Reinforce:
- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Unit Overview - Ecology

Grade: 7

Month: September-October

Amount of Time: 6 weeks

Brief Description of Unit: Ecosystems
In an ecosystem, populations of organisms interact with biotic and abiotic factors and compete for resources. Effects can occur both within and across populations. Organisms form relationships as a result of their environment.

Section Titles:
1. Interactions of Living/Nonliving Things (Including A Long Walk to Water: Interdisciplinary Unit for Science and Social Studies)
2. Symbiotic Relationships
3. Flow of Energy

Performance Expectations and Crosscutting Concepts Addressed:
NGSS- MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-LS2-5, MS-ESS3-3, MS-ESS3-5
Crosscutting Concepts:
- Patterns
- Scale, proportion, and quantity
- Energy and matter
- Stability and change

Driving/Essential Questions:
- How does matter and energy transfer through an ecosystem?
- How does the limitation of resources affect an ecosystem?
- How and why do symbiotic relationships form in order for survival?
- How does climate change affect natural resources?

Science and Engineering Practices to Reinforce:
- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Unit Overview - OMM (Cells, Microscopes, & Genetics)

Grade: 7

Month: October - February

Amount of Time: 5 months

Brief Description of Unit:
The focus of this unit is that living things are made of cells that contribute to the function, growth, and development of an organism   Through hands-on activities, students become aware of the differences between the cells of various organisms. They see cells as part of the organism and the interrelationship that exists between the cells. They learn the cell processes of diffusion, osmosis, photosynthesis, and cellular respiration. Students will discover how traits travel through generations and predict the probability of traits being passed to future generations. Through this study, they will also come to understand how mutations occur, their purpose, and the role they play in genetic diseases.

Students will observe and analyze fossil evidence that supports the existence, diversity, extinction, and change in species over time. They will explore the processes of natural selection and adaptations and their role in the evolution of species over time. The students will explore the human impact on evolution with the process of selective breeding.

Section Titles
1. Reproduction of organisms
2. DNA to trait
3. Inheritance of Genetics
4. Variation of Genetics (mutations and diseases)
5. Evidence of Ancestry and Diversity
6. Natural and Artificial Selection
7. Adaptations within a species

Performance Expectations and Crosscutting Concepts Addressed:
MS-LS1-1, MS-LS1-2,, MS-LS1-4, MS-LS1-5, MS-LS1-6, MS-LS1-7, 1. MS-LS3-1, MS-LS3-2, MS-LS4-1, MS-LS4-2, MS-LS4-3, MS-LS4-4, MS-LS4-5, MS-LS4-6
Crosscutting Concepts:
- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Structure and function
- System and system models

Driving/Essential Questions:
- How do organisms live, grow, respond to their environment, and reproduce?

- How do the structures of organisms enable life’s functions?
- How are the characteristics of one generation passed to the next or related to the previous?
- How can we predict the probability of traits being passed on?
- How does variety occur within a species and how does it affect survival and reproduction of organisms?
- How does biodiversity affect humans?
- What evidence supports that species are related?
- If there is a shift with environmental change, what physical and/or biological challenges are imposed on organisms?
- How can humans influence the inheritance of desired traits?

Science and Engineering Practices to Reinforce:

- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Unit Overview - Human Body Systems

Grade: 7

Month: March- June

Amount of Time: 4 months

Brief Description of Unit:
Students will learn the interrelationship between the body systems and how they enable the body to function, maintain homeostasis, and process sensory information. They will come to understand that organic molecules are the building blocks of the human body.

Section Titles:
1. Growth and development of organisms
2. Information processing in organisms

Performance Expectations and Crosscutting Concepts Addressed:
NGSS: MS-LS1-3, MS-LS1-8
Crosscutting Concepts:
- Patterns
- Cause and effect
- System and system models
- Structure and function
- Energy and matter

Driving/Essential Questions:
- How do the structures of organisms enable life's functions?
- How do organisms grow and develop?
- How do organisms detect, process, and use information about the environment within the body?

Science and Engineering Practices to Reinforce:
- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Unit Overview - A Long Walk to Water:
Interdisciplinary Unit for Science and Social Studies*

Grade: 7

Month: During Ecology Unit (September - October)

Amount of Time: 18 days

Brief Description of Unit:
This interdisciplinary unit has been developed to integrate the study of culture, geography, current events, engineering and microorganisms. Although the springboard for this unit, A Long Walk to Water, is a literary piece, the focus of the unit is on the meaningful application of the content across disciplines. In Social Studies, this unit follows the unit on African history and geography. Connections to those issues are brought up throughout the reading and discussion of the novel. Students will come away with the content knowledge needed to understand the complex issues happening in the world both at home and abroad. In Science, the water filtration project was developed to give students an opportunity to develop an engineering design to clean water. This unit follows a Protist Unit in which students use microscopes to explore microorganisms found in a nearby creek. To set the groundwork, students explore the Flint Water Crisis to learn of the health effects of poor water quality and lead. As world populations grow, water usage will continue to increase while more and more areas of the world experience extreme weather events like drought and flooding. This places increased pressure on water supplies, even in the United States. The unit culminates with a water-related service project.

Unit Goals:
- Demonstrate an understanding of how geography and access to resources affect the human condition.
- Synthesize the relationship between the past and present in our history in order to make decisions that will affect society.
- Demonstrate an ability to make choices for the well being of self and others.
- Explore the interaction between people and their environment and relate discoveries and inventions to our own lives.
- Understand key terms that provide context for geographic concepts and the study of culture.

Driving/Essential Questions:
- What issues have created scarcity in the world?
- What are the outcomes of scarcity, and how do they relate to students' everyday lives?
- How does the study of access to clean water impact understanding of society and how is that relevant to students today?

Performance Expectations:
NGSS:MS-ETS 1-1, MS-ETS 1-2, MS-ETS 1-3, MS-ETS 1-4, MS-ESS3-3, MS-ESS3-4, MS-LS2-1, MS-LS2-4, MS-LS2-5

Social Studies Proficiencies Addressed: 6.2.8.B.4.c, 6.2.8.B.4.e, 6.1.8.A.1.a

Career Ready Practices:
CRP1. Act as a responsible and contributing citizen and employee.
CRP2. Apply appropriate academic and technical skills.
CRP4. Communicate clearly and effectively and with reason.
CRP5. Consider the environmental, social and economic impacts of decisions.
CRP6. Demonstrate creativity and innovation.
CRP7. Employ valid and reliable research strategies.
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9. Model integrity, ethical leadership and effective management.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Science and Engineering Practices to Reinforce:
- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Unit Overview - Human Body Systems

Grade: 7

Month: March- June

Amount of Time: 4 months

Brief Description of Unit:
Students will learn the interrelationship between the body systems and how they enable the body to function, maintain homeostasis, and process sensory information. They will come to understand that organic molecules are the building blocks of the human body.

Section Titles:
1. Growth and development of organisms
2. Information processing in organisms

Performance Expectations and Crosscutting Concepts Addressed:
NGSS: MS-LS1-3, MS-LS1-8
Crosscutting Concepts:
- Patterns
- Cause and effect
- System and system models
- Structure and function
- Energy and matter

Driving/Essential Questions:
- How do the structures of organisms enable life's functions?
- How do organisms grow and develop?
- How do organisms detect, process, and use information about the environment within the body?

Science and Engineering Practices to Reinforce:
- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Unit Overview: *What Can We Do About it?*
Save the Planet: Energy, Environment and Change
Interdisciplinary Unit for Science and Social Studies

Grade: 8

Month: September

Amount of Time: 20 days

Brief Description of Unit:

This interdisciplinary unit has been developed to integrate the study of climate change, environmental science, energy and activism. The springboard for this unit is a series of videos, including an address to the French parliament and several NPR/National Geographic resources. Resources have been developed to assist teachers with implementation, including options for differentiation.

In science, the unit incorporates the introductory lessons of the Energy unit. Students begin by defining energy and exploring the transfer of energy. After comparing potential and kinetic energy, students investigate the difference between renewable and nonrenewable resources. Utilizing several articles and videos, the current increase in temperature and effect on the ecosystem is analyzed. Students investigate alternative forms of energy and research the related pros, cons and associated considerations. Options for a culminating project include a debate, presentation or Socratic circle.

In social studies, the concept of civic engagement is brought to the forefront. The learning uses science to engage the students in the need for activism. Through the analysis of real life examples of youth as change agents, the students will see that they too can make a difference.

Performance Expectations:

NGSS: MS-PS3-2, MS-PS3-3, MS-PS3-5, MS-ETS 1-1, MS-ETS 1-2, MS-ETS 1-3,
Social Studies Standards: 6.3.8.A.1, 6.3.8.A.2, 6.3.8.A.3, 6.3.8.D.1

Science and Engineering Practices to Reinforce:

- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

NJSLS ELA Companion Standards

Career Ready Practices:

CRP1. Act as a responsible and contributing citizen and employee.

CRP2. Apply appropriate academic and technical skills.

CRP4. Communicate clearly and effectively and with reason.
CRP5. Consider the environmental, social and economic impacts of decisions.
CRP6. Demonstrate creativity and innovation.
CRP7. Employ valid and reliable research strategies.
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9. Model integrity, ethical leadership and effective management.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

INTERDISCIPLINARY CONNECTIONS

Interdisciplinary Connections

Interdisciplinary learning develops real-world, multi-faceted knowledge. Integration identifies logical connections between and among the content and learning experiences in all areas of the curriculum. Integrating and connecting various content areas improves learning outcomes and provides more authentic and relevant experiences for students. Interdisciplinary connections both enrich and extend learning. In Hainesport, interdisciplinary connections are studies that cross the boundaries of two or more district disciplines such as mathematics and art or literature and science. By purposefully looking for “essential concepts” and “big ideas,” we purposefully design deliberate integration of the various content areas wherever appropriate. This includes, but is not limited to examining how curriculum themes, project-based learning, understanding by design, essential questions, inquiry approaches, curriculum mapping, and the standards merge, while always keeping students’ best interests at the heart of this work.

In the area of science, students explore life, earth and physical science in each grade level, kindergarten to fifth grade, using various hands-on materials and experiments in authentic contexts. Although the middle school curriculum primarily focuses on one of these strands each year, purposeful connections are made to reinforce prior learning. Content is presented through inquiry units of study and disciplinary literacy is integrated where appropriate. In addition, various informational texts are also integrated in order to increase opportunities for reading and writing in the content areas. Students also collect data during investigations, select tools to use strategically and then look for and make use of structure in order to prove or disprove hypotheses, integrating mathematics wherever possible. Based on this information, students use evidence to support their position in both writing and speaking, integrating diverse media and formats in collaboration with peers. Grade-specific units of instruction incorporate interdisciplinary connections in more detail.

In Kindergarten, all science units are interdisciplinary, thematic based units of study. In the spring, students begin a thematic unit titled Cycle of Life. During this unit, students engage in a Chick Life Cycle Science Unit which satisfies the K-LS1-1 Science standard. During this thematic unit, during literacy, students read the nonfiction text *Chick Life Cycle* as well as fiction texts *An Extraordinary Egg* and *The Chick and the Duckling*. Additionally, in writing, students keep journals that focus on the development of the chicks as they grow.

The following standards are addressed during this thematic unit:

Science Standards:

- K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

ELA Standards:

- RL.K.3. With prompting and support, identify characters, settings, and major events in a story.
- RL.K.9. With prompting and support, compare and contrast the adventures and experiences of characters in familiar stories
- RI.K.1. With prompting and support, ask and answer questions about key details in a text

- RI.K.7. With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).
- RI.K.10. Actively engage in group reading activities with purpose and understanding.
- W.K.2. Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.
- W.K.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- SL.K.2. Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.

In middle school, an interdisciplinary unit has been developed at each grade level that purposefully integrates literacy into the content areas. For instance, in seventh grade, *A Long Walk to Water* has been developed to integrate the study of culture, geography, current events, engineering and microorganisms. Although the springboard for this unit, *A Long Walk to Water,* is a literary piece, the focus of the unit is on the meaningful application of the content across disciplines. In science, students explore the Flint Water Crisis through *Science World* readings and videos to illustrate the health effects of poor water quality and lead. The study culminates with a water filtration project, affording students an opportunity to develop an engineering design to clean water. In Social Studies, this unit follows the study of African history and geography, culminating with a water-related service project and/or related study on the current issues of migration and refugees.

The following standards are addressed in this interdisciplinary unit:

Social Studies Standards:

- 6.2.8.B.4.c. Determine how Africa's physical geography and natural resources presented challenges and opportunities for trade, development, and the spread of religion.
- 6.2.8.B.4.e. Analyze the motivations for civilizations to modify the environment, determine the positive and negative consequences of environmental changes made during this time period, and relate these changes to current environmental challenges.
- 6.1.8.A.1.a. Compare and contrast forms of governance, belief systems, and family structures among African, European, and Native American groups.

Science:

- MS-ETS 1-1. 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-ETS 1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS 1-3. 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-ETS 1-4. 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.

- 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-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-LS2-4. 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.

NJSLS ELA Companion Standards

Additionally, in grades K-5, a STEM interdisciplinary connection unit is taught in technology class. For instance, in grade 1, the STEM connection unit titled, *Making Sound* connects to the Science unit *Light and Sound*. In this technology unit, students connect and extend what they have learned about how sound waves travel in Science. Through the use of technology, students “see” sound waves as well as explore how to manipulate vibrations to produce different types of sound.

Throughout the school year, additional interdisciplinary connections are integrated where appropriate into the Science instructional program that connect two or more of the standard areas below:

English Language Arts/Language Arts Literacy -

Anchor Standards for Reading

Key Ideas and Details
- NJSLSA.R1. Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
- NJSLSA.R2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
- NJSLSA.R3. Analyze how and why individuals, events, and ideas develop and interact over the course of a text.

Craft and Structure
- NJSLSA.R4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
- NJSLSA.R5. Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.
- NJSLSA.R6. Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas
- NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

- NJSLSA.R8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
- NJSLSA.R9. Analyze and reflect on how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.
- NJSLSA.R10. Read and comprehend complex literary and informational texts independently and proficiently with scaffolding as needed.

Anchor Standards for Writing

Text Types and Purposes
- NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
- NJSLSA. W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
- NJSLSA.W3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

Production and Distribution of Writing
- NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
- NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Research to Build and Present Knowledge
- NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
- NJSLSA.W8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
- NJSLSA.W9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

Range of Writing
- NJSLSA.W10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

Anchor Standards for Speaking and Listening

Comprehension and Collaboration
- NJSLSA.SL1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- NJSLSA.SL2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

- NJSLSA.SL3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

Presentation of Knowledge and Ideas
- NJSLSA.SL4. Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
- NJSLSA.SL5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.
- NJSLSA.SL6. Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

Anchor Standards for Language

Conventions of Standard English
- NJSLSA.L1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
- NJSLSA.L2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Knowledge of Language
- NJSLSA L3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

Vocabulary Acquisition and Use
- NJSLSA L4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.
- NJSLSA L5. Demonstrate understanding of word relationships and nuances in word meanings.
- NJSLSA L6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

Mathematics -

- NJSLS. MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.
- NJSLS.MATH.PRACTICE.MP2. Reason abstractly and quantitatively.
- NJSLS.MATH.PRACTICE.MP3. Construct viable arguments and critique the reasoning of others.
- NJSLS.MATH.PRACTICE.MP4. Model with mathematics.
- NJSLS.MATH.PRACTICE.MP5. Use appropriate tools strategically.
- NJSLS.MATH.PRACTICE.MP6. Attend to precision.
- NJSLS.MATH.PRACTICE.MP7. Look for and make use of structure.
- NJSLS.MATH.PRACTICE.MP8. Look for and express regularity in repeated reasoning.

Science -

Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering).
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations (for science) and designing solutions (for engineering).
7. Engaging in argument from evidence.
8. Obtaining, evaluating and communicating information.

Social Studies -

Social Studies Standard 6.3: Active Citizenship in the 21st Century: All students will acquire the skills needed to be active, informed citizens who value diversity and promote cultural understanding by working collaboratively to address the challenges that are inherent in living in an interconnected world.

Technology -

Technology Standard 8.1: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.
Technology Standard 8.2: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world, as they relate to the individual, global society, and the environment.

Comprehensive Health and P.E. (2.2.2-8.C1-3) –

Content Area	Comprehensive Health and Physical Education		
Standard	2.2 Integrated Skills: All students will develop and use personal and interpersonal skills to support a healthy, active lifestyle.		
Strand	C. Character Development		
By the end of grade	**Content Statement**	**CPI #**	**Cumulative Progress Indicator (CPI)**
2	Character traits are often evident in behaviors exhibited by individuals when interacting with others.	2.2.2.C.1	Explain the meaning of Character and how it is reflected in the thoughts, feelings, and actions of oneself and others.
		2.2.2.C.2	Identify types of disabilities and demonstrate appropriate behavior when interacting with people with disabilities.
4	Personal core ethical values impact the health of oneself and others.	2.2.4.C.1	Determine how an individual's character develops over time and impacts personal health.
	Character building is influenced by many factors both positive and negative, such as acceptance, discrimination, bullying, abuse, sportsmanship, support, disrespect, and violence.	2.2.4.C.2	Explain why core ethical values (such as respect, empathy, civic mindedness, and good citizenship) are important in the local and world community.
		2.2.4.C.3	Determine how attitudes and assumptions toward individuals with disabilities may negatively or positively impact them.
6	Personal core ethical values impact the behavior of oneself and others.	2.2.6.C.1	Explain how character and core ethical values can be useful in addressing challenging situations.
	Character building is influenced by many factors both positive and negative, such as acceptance, discrimination, bullying, abuse, sportsmanship, support, disrespect, and violence.	2.2.6.C.2	Predict situations that may challenge an individual's core ethical values.
		2.2.6.C.3	Develop ways to proactively include peers with disabilities at home, at school, and in community activities.
8	Working together toward common goals with individuals of different abilities and from different backgrounds develops and reinforces core ethical values.	2.2.8.C.1	Analyze strategies to enhance character development in individual, group, and team activities.
		2.2.8.C.2	Analyze to what extent various cultures have responded effectively to individuals with disabilities.
	Rules, regulations, and policies regarding behavior provide a common framework that supports a safe, welcoming environment.	2.2.8.C.3	Hypothesize reasons for personal and group adherence, or lack of adherence, to codes of conduct at home, locally, and in the worldwide community.

INSTRUCTIONAL STRATEGIES

Instructional Strategies

In order to achieve the goals of our Science curriculum and address the various learning styles and multiple intelligences of all our students, teachers must maintain a repertoire of appropriate, effective, and flexible strategies and resources. Students learn best through personal hands-on experiences, real-world applications, and by connecting new information to what they already know.

In Science, students are actively involved utilizing an inquiry approach. This approach focuses on questioning and exploring scientific phenomena, conducting investigations, collecting evidence, interpreting and analyzing data, and defending conclusions. Through the process of inquiry, students construct understanding on the premise of needing or wanting to know. Inquiry implies emphasis on the development of inquiry skills and the nurturing of inquiring attitudes or habits of mind that enable students to continue the quest for knowledge throughout life. Teachers act as facilitators by encouraging students to access prior knowledge, take risks, employ strategies, and promote communication while exploring, to construct new knowledge.

This model ultimately leads to self-discovery and an appreciation for learning new content. Students expand on their natural curiosities by connecting prior knowledge and skills to new situations.

Within the Science classroom, teachers will have a variety of types of learners. These students will range from accelerated learners to reluctant or struggling learners. Science teachers will hold high expectations for all students regardless of their aptitude for learning. In order for all children to perform at their personal best, differentiation of instruction is essential. This may include, but is not limited to the following strategies:

- Providing multiple assignments within each unit, tailored for students of different levels of achievement.
- Allowing students to choose, with the teacher's guidance, ways to learn and how to demonstrate what they have learned.
- Cultivating an environment that values inquiry, problem-solving and student driven exploration.
- Providing varied, scientific text and resources with a wide-range of readability levels, interests, and formats.
- Structuring class assignments so they require high levels of critical thinking but permit a range of responses.
- Creating learning opportunities and activities geared to different learning styles, readiness and levels of interest.
- Providing students with opportunities to explore topics in which they have strong interest and find personal meaning.
- The teacher scaffolds the students' attempts and supports student's thinking, giving feedback during conferring and classroom discussions.

Whether teachers differentiate content, process, or product, responding to the unique needs of learners is a paramount part of implementing the Science curriculum at all grade levels.

The regular use of cooperative learning affords all students the opportunity to become active participants in their learning process. Integrating Science with other disciplines across the curriculum encourages students to make connections between content areas and makes learning more meaningful. By employing varied and engaging strategies appropriately, teachers assist students in applying their learning to their everyday lives.

The following instructional strategies table incorporates strategies and suggestions from professional literature, Internet resources, NJSLS, and Hainesport professionals.

INSTRUCTIONAL STRATEGIES

Resource	Description	Suggestions for Application
Brainstorming	Gathering and recording all ideas about a topic in order to create a broad creative pool that will later be organized.	Brainstorming should: ● allow for all students to collaborate in order to foster ownership and engagement; ● represent diverse student-generated ideas about the topic; ● allow students time to activate prior knowledge, make connections and explore new relationships.
Bulletin Board	An interactive visual that provides students an opportunity to explore a particular concept in greater depth.	● Students use the board to share and report about a concept ● Teachers post questions for investigation and reflection
Carouseling	A brainstorming activity where learners travel from station to station in a carousel motion sharing, recording, and reporting ideas or participating in activities.	● At each station, the learners will record a response to a specific teacher-guided prompt ● Students can use carouseling to elaborate on a topic and add details to writing
Cooperative Learning	Small heterogeneous groups of learners working together to achieve a common goal.	Suggested structures: ● Think – Pair – Share ● Investigation ● Partner quiz ● Team interview ● Peer discussion
Differentiated Instruction	Differentiated Instruction is “responsive teaching” that considers the variance in student readiness, interests, and learning profile rather than “one-size-fits-all”. A teacher proactively plans varied approaches to what students need to learn (content), how they will learn it (process), and/or how they can express what they have learned (product) in order to increase the likelihood that each student will learn as much as he or she can as efficiently as possible.	● Tiered-Assignments ● Choice

Flexible Grouping	Utilization of a variety of grouping options, including cooperative groups, whole class, small group, partners and individuals, to achieve goals and concepts.	Flexible grouping should: ● Consider student learning styles ● Meet the needs of individual students ● Facilitate participation in several different grouping options in order to analyze, synthesize, investigate, and challenge technology concepts ● Motivate and challenge students
Graphic Organizers	Visual illustration of verbal and/or written statements; they help the learner organize, comprehend, summarize, and synthesize information.	● Timeline ● Problem/solution outline ● Network ● Herringbone map ● Cycle ● Venn diagram ● Tree diagram ● Mindmap ● Web ● Ranking ladder ● K-W-L chart
Graphic Representations	Information organized and presented graphically; pictorial device demonstrating literacy concepts. Examples: charts, graphs, tables, diagrams, flowcharts, maps.	● Extrapolate data ● Classify and organize information ● Evaluate/record information ● Utilize appropriate format (chart, graph, etc.) ● Summarize/synthesize information
Inquiry-Based Teaching	Students use inquiry to conduct investigations: ● Structured inquiry (students follow precise instructions and answer specific questions in a teacher-directed investigation) ● Guided inquiry (students generate procedure to follow in a teacher-directed investigation) ● Student-directed inquiry (students generate their own procedures in a student-directed investigation)	● Exploration of recipes/menus ● Word sorts

Jigsawing	Each student in turn becomes the “expert” on one topic by working with members from other teams. Upon returning to their team, each “expert” teaches the home group.	<u>May be used for the following</u>: ● Acquiring new concepts ● Reviewing concepts learned ● Learning and sharing different points of view
Journaling & Reflection	Thinking about and organizing information and feelings related to experiences	● Consider individual and group goals ● Provide time to think ● Encourage dialogue ● Food logs, notes, self-assessment
Modeling	The act of demonstrating the strategy, skill or behavior which is to be performed by the students.	● Teacher models (cooking demonstration) ● Student models ● Mentor texts
Problem Based Learning	Posing authentic (real-world) problems using inductive teaching where students work out basic principles for themselves	Problem based learning should: ● be meaningful to the students ● foster higher level thinking ● allow for collaboration ● consider divergent perspectives ● present skills/content in context

Questioning	Purposeful questions require students to use thinking skills; questions can be organized according to Bloom's Taxonomy, higher and lower level, open and closed. ● Know goal; select context ● Plan questions ● Phrase questions clearly ● Allow flexibility ● Avoid yes/no questions ● Allow wait time (at least 3 seconds) ● Avoid saying learner's name before the questions ● Select learners randomly ● Use positive feeling tone ● Respond positively to all answers ● Use probing techniques to elicit more thorough responses ● Redirect and rephrase ● Use learner's questions for instruction	● Ask higher-level, open-ended questions (How & Why) ● Allow students to react to and rephrase other responses
Researching	Use of various materials and methods to answer questions about a topic.	● Extends knowledge of a specific topic ● Utilize reference materials to learn about areas of interest or need ● Present new information to whole class
Scaffolding	Providing temporary support until help is no longer needed	Scaffolding should: ● build on the students' existing knowledge ● come in various forms (examples, explanations, models, organizers, templates, etc.) ● consider individual needs ● be gradually removed to encourage independence ● build confidence
Service Learning	A student or teacher selected activity that provides an opportunity for students to learn and practice skills, while also helping to meet identified needs in the community	Examples of service learning projects include: ● Angel Baskets ● Patchwork blankets ● Soup Kitchen

Simulations (Role Play)	Simulating events or situations to enable students to experiment with concepts or materials	Simulations should: ● provide students with relevant examples ● encourage generalization and application of skills/concepts learned to the real world ● provide for individual creativity ● promote reflection
Stations	Different areas of the classroom where students work on various tasks simultaneously.	At each station, students explore materials, conduct investigations, analyze data, conduct research, synthesize learning, etc.
Surveys/ Interviews	Students conduct surveys or interviews to practice themes/concepts, as well as career related skills	● Generate interview questions ● Create design based on interview/survey responses ● Evaluate individual, group, or societal progress and trends
Thinking Aloud	Verbalizing “inner dialogue” or thought processes used in creation or analysis of work	Thinking aloud should provide students with a strategy for: ● problem-solving; ● decision-making; ● evaluating resources; ● implementing the creative process; ● effectively communicating ideas.
Utilizing & Evaluating Media	Students integrate and evaluate information that brings the real world into the classroom.	● Digital devices ● Videos ● Recipe (books) & databases ● Centers/stations ● Internet ● United Streaming ● Interactive Whiteboards
Utilizing Tools and Manipulatives	Concrete materials such as food, utensils, sewing equipment, etc.	● Use tools like the word wall to make connections ● Utilize materials to facilitate hands-on learning

ASSESSMENT

Assessment

Student assessment is useful to observe and describe performance, diagnose instructional needs, assess progress toward conceptual understanding, plan instruction and communicate progress to others.

A variety of assessment strategies are used to effectively monitor and evaluate individual children's development of concepts and processes. Assessment strategies and tools should closely match instructional strategies and activities, both in format and design.

Assessment should be ongoing and formative, both informing instruction and evaluating progress. Feedback from assessment tasks assists students in setting goals and becoming independent learners. Effective assessment holds students accountable for their learning. Toward this end, assessment needs to be meaningful to both the students and science teachers, and connect to instruction. Authentic, multi-dimensional assessment must be part of the evaluation process. Science teachers using authentic assessment effectively involve students in meaningful literacy tasks that allow them to apply, practice and master strategies for constructing meaning in reading, writing, listening, speaking and viewing.

District-wide assessments, also referred to as common assessments, are utilized in all subject areas to both inform instruction, as well as determine proficiency of skills in particular subject areas. These assessments provide consistency across classrooms and grade level/departments. They may take the form of traditional assessments or performance tasks, but more commonly use standardized administration and scoring procedures to help maintain validity, reliability, and fairness. Typically, teachers administer common assessments to all students in the same course and grade level in the district at prescribed intervals, which vary by subject area. Common assessment instruments measure proficiency on subsets of standards and might include writing samples, literary responses, end-of-unit assessments, open-ended problems/questions, laboratory investigations, and projects. In Science, state assessments are also administered in grades four and eight.

The following table incorporates assessment tools and strategies that will be utilized in assessing students:

Assessment Tools and Strategies

Strategy	Description
Anecdotal Notes	Teacher documents general observations of student/class performance/participation and/or strengths, needs and interactions (social, emotional, academic).
Checklists	A checklist is constructed to target skills and provide a systematic record for each student's performance. This checklist may list behaviors, skills or perceptions, and may have point values assigned to specific behaviors being assessed.
Cooperative Problem Solving	Teacher assigns small groups of students to work together to achieve a common goal or solve a problem.
Debate	Students will support a claim or idea with evidence verbally or in writing, including addressing opposing claims where appropriate.
Exit Slips/Ticket Out the Door	Student responses to open-ended questions completed at the close of a lesson or unit.
Games	Games serve as a critical tool for ongoing assessment. Application of skills, use of strategies, and disposition towards science should be observed as students play science games.
Individual Conferences (Structured and Flexible)	The teacher and student interact in a dialogue about the concept being explored.
Interviews	The teacher and student engage in a dialogue to give insight into the individual's understanding about concepts, applications, ideas, etc.
Journals and Work Samples	These include journal entries, pictorial records of tasks completed, lab reports, data conclusions, analysis, etc.
Models	Students will build a representation of a concept or problem solution from materials or manipulatives, individually or cooperatively.
Notebook Checklist	An organizational tool which assists students in guiding the structure of their notebook journal.
Notebook Quiz	A teacher-created tool used to assess students' ability to navigate an organized student notebook/journal.
Observations	The teacher observes students in a learning situation, checks for evidence of understanding, and analyzes the information so that instructional decisions can be made. Anecdotal notes document these observations.

Open-Ended Response	An open-ended problem is posed in which the student is given a situation and is asked to write a response. This strategy requires the student to demonstrate his/her understanding of the process and the solution. This written response is evaluated according to a predetermined set of criteria.
Oral Presentations or Demonstrations	Presentations provide students with opportunities to demonstrate understanding of scientific concepts. These can be formal or informal, and involve using a rubric or checklist reflecting criteria being assessed.
Performance-Based Tasks	Tasks that require students to undertake an action or create a product that demonstrates their knowledge or skills. Effective performance assessment requires the student to produce and explain an answer rather than select one from given choices.
Pre-test	Recall prior knowledge lesson.
Problem-Solving Based Investigations	A problem is posed which has multiple solutions. Students develop appropriate methods to solve the problem. They may work individually or within a group. The teacher can observe, question, or interview students as they work. Students are expected to generate a product, such as a drawing, display, model, table, graph, or written explanation.
Project Tasks	A specific task is assigned or developed with students to apply scientific concepts or acquire scientific knowledge using a predetermined set of criteria. Students may work individually or in a group.
Questioning	Questions are asked to evaluate students' thinking and reasoning. The questions must require students to explain scientific concepts and support their reasoning.
Quizzes	Short assessments that involve evaluating student work, presented in reflections, workbook pages, and any other tasks which represent a student's understanding.
Rubrics	Also referred to as a rating scale, this procedure provides a set of clear guidelines or acceptable responses for the completion of a task to which a score point is assigned. Unlike checklists, rubrics describe the overall quality of student work at each of several score points. The rubric is a "shorthand" reminder of the essential characteristics of each level of quality. Rubrics can be effectively used to assess most areas of scientific development as well as to model appropriate scientific behaviors. Rubrics can be developed with the students or shared before the assignment so that students are clearly aware of the objectives to be met.
Tests	The following tests may be used to assess student learning: ● Appropriate teacher-made tests ● Student-made tests ● Designated tests accompanying adopted inquiry-based kits
3-D Tasks	A nontraditional assessment that asks students to apply knowledge, vocabulary and processes to novel situations.

Science Practices Assessment Rubric - Middle School

SCIENCE AND ENGINEERING PRACTICES RUBRIC				
SCORING DOMAIN	**EMERGING**	**DEVELOPING**	**PROFICIENT**	**ADVANCED**
ASKING QUESTIONS AND DEFINING PROBLEMS	• Asks general questions that can be investigated.	• Asks specific questions that can be investigated.	• Asks questions that require sufficient and appropriate empirical evidence to answer.	• Asks questions that require sufficient and appropriate empirical evidence to answer and evaluates the testability of the questions.
	• Defines a problem (design) statement that is impractical or inadequate for the intent of the problem.	• Defines a problem (design) statement that is minimally aligned to the intent of the problem.	• Defines a problem (design) statement that is adequately aligned to the intent of the problem.	• Defines a problem (design) statement that is completely aligned to the intent of the problem.
DEVELOPING AND USING MODELS	• Model (labelled drawings, diagrams, etc) relevant to the investigation include major conceptual or factual errors, or are missing. • Discussion on limitations or precision of model as a representation of the system or process is flawed or missing.	• Constructs model (labelled drawings, diagrams, etc.) to represent the process or system to be investigated that include minor errors. • Makes note of limitations or precision of model as a representation of the system or process.	• Constructs accurate model (labelled drawings, diagrams, etc.) to represent the process or system to be investigated. • Explains limitations and precision of model as a representation of the system or process.	• Constructs accurate model (labelled, and precise drawings, diagrams, etc.) to represent the process or system to be investigated and provides an explanation of the representation. • Explains limitations and precision of model as a representation of the system or process and discusses how the model might be improved.
PLANNING THE INVESTIGATION OR DESIGN	• Proposes an investigation that will not produce relevant data to be used as evidence to answer the empirical question(s).	• Proposes an investigation that will minimally produce relevant data to be used as evidence to answer the empirical question(s).	• Proposes an investigation identifying dependent and independent variables that will adequately produce relevant data to be used as evidence to answer the empirical question(s).	• Proposes an investigation identifying dependent and independent variables that will completely produce relevant data to be used as evidence to answer the empirical question(s).
	• Proposes a design plan that does not address the criteria, constraints, and intent of the problem.	• Proposes a design plan and description that minimally addresses the criteria, constraints, and intent of the problem.	• Proposes a design plan and explanation that adequately addresses the criteria, constraints, and intent of the problem.	• Proposes a design plan and detailed explanation that completely addresses the criteria, constraints, and intent of the problem.
CONDUCTING INVESTIGATION OR TESTING DESIGN	• Provides procedures that are not replicable.	• Provides replicable procedures with descriptions of measurements, tools or instruments, but conducts insufficient number of trials.	• Provides replicable procedures with descriptions of measurements, tools or instruments, and conducts adequate number of trials.	• Provides replicable procedures with descriptions of measurements, tools or instruments, and conducts adequate number of trials with a rationale for data collection.

SCORING DOMAIN	**EMERGING**	**DEVELOPING**	**PROFICIENT**	**ADVANCED**
ANALYZING AND INTERPRETING DATA Accurately labeled includes title, column titles, description of units, proper intervals	• Constructs spreadsheets, data tables, charts, or graphs that are not accurately labelled or do not display all the data. • Analyzes data using inappropriate methods or with major errors or omissions.	• Constructs accurately labelled spreadsheets, data tables, charts, or graphs to accurately summarize and display data; but does not allow for examining the relationships between variables. • Accurately analyzes data using appropriate methods with minor omissions and/or mentions limitations of data analysis.	• Constructs accurately labelled spreadsheets, data tables, charts, or graphs to accurately summarize and display data to examine relationships between variables. • Accurately analyzes data using appropriate and systematic methods to identify patterns OR explain limitations of the data analysis (measurement error).	• Constructs accurately labeled spreadsheets, data tables, charts, and/or graphs and uses more than one of these methods to accurately summarize and display data to examine relationships between variables. • Accurately analyzes data using appropriate and systematic methods to identify patterns AND explain limitations of the data analysis (measurement error).
CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS	• Uses inaccurate or inappropriate scientific ideas, principles, and/or evidence (experimental data) to construct, evaluate, or revise an explanation.	• Uses accurate but minimal scientific ideas, principles, and/or evidence (experimental data) to construct, evaluate, or revise an explanation.	• Uses accurate and adequate scientific ideas, principles, and/or evidence (experimental data) to construct, evaluate, or revise an explanation.	• Uses accurate and complete scientific ideas, principles, and/or evidence (experimental data) to construct, evaluate, or revise an explanation.
	• Uses no data to evaluate how well the design addresses the problem and the redesign of the original model or prototype is inappropriate or incomplete.	• Uses minimal data to evaluate how well the design addresses the problem and outlines an appropriate redesign of the original model or prototype.	• Uses adequate data to evaluate how well the design addresses the problem and explains an appropriate redesign of the original model or prototype.	• Uses complete data to evaluate how well the design addresses the problem and provides a detailed rationale for the appropriate redesign of the original model or prototype.
ENGAGING IN ARGUMENTS FROM EVIDENCE	• Constructs argument(s) with an inappropriate claim OR both evidence and reasoning are inadequate or unclear.	• Constructs and/or evaluates argument(s) consisting of minimal claims, limited sources of evidence, OR minimal reasoning.	• Constructs and evaluates argument(s) consisting of appropriate claims, multiple sources of evidence, and adequate reasoning.	• Constructs and evaluates argument(s) consisting of appropriate claims, multiple sources of evidence, and detailed reasoning.
COMMUNICAT-ING FINDINGS	• Findings are inaccurate and/or inconsistent with the evidence.	• Accurately communicates clear but minimal findings consistent with the evidence and mentions the implications OR limitations of the investigation or design.	• Accurately communicates clear and adequate findings consistent with the evidence and explains the implications and/or limitations of the investigation or design.	• Accurately communicates clear and complete findings consistent with the evidence and provides a rationale for the implications and limitations of the investigation or design.

Grade 4, Life Science Open Response Rubric Achievement & Effort

Achievement Grade

3- point response: Student response is reasonably complete, clear and satisfactory.
* Answers should include:
- At least 2 examples of an animal or plant that has structures for adaptation that were taught in class.
- Explanation of how the adaptation of each plant or animal allows it to survive in its habitat.
- Includes whether the adaptation is internal or external.
- Describes the difference between internal and external adaptations.

2- point response: Student response has minor omissions and/or some incorrect or non-relevant information.

1- point response: Student response includes some correct information, but most information included in the response is either incorrect or not relevant.

0- point response: Student attempts the task but the response is incorrect, irrelevant, or inappropriate

Effort Grade

3- point response: Student response is reasonably complete, clear and satisfactory.
* Answers should include:
- Notebook entries show reflection and new learning.
- Notebook includes organization (such as entry date, headings, labels, data and pictures).
- Effort and neatness are evident.

2- point response: Student response has minor omissions and/or some incorrect or non-relevant information.

1- point response: Student response includes some correct information, but most information included in the response is either incorrect or not relevant.

0- point response: Student attempts the task but the response is incorrect, irrelevant, or inappropriate

APPENDICES

- Appendix A: NGSS Progressions
- Appendix B: CCSS Grades 6-8: Literacy In Science and Technical Subjects & NGSS Connections
- Appendix C: Technology Integration
- Appendix D: 21st Century Life and Careers Standards and Expectations for Integration
- Appendix E: Resources

APPENDIX A: NGSS PROGRESSIONS

1. Disciplinary Core Idea Progression (NGSS Appendix E)

2. Science and Engineering Practices in the NGSS (NGSS Appendix F)

3. Crosscutting Concepts (NGSS Appendix G)

APPENDIX E – Progressions Within the Next Generation Science Standards

Following the vision of *A Framework for K-12 Science Education*, the NGSS are intended to increase coherence in K-12 science education. The following excerpt from the *Framework* explains the approach in more detail:

"First, it is built on the notion of learning as a developmental progression. It is designed to help children continually build on and revise their knowledge and abilities, starting from their curiosity about what they see around them and their initial conceptions about how the world works. The goal is to guide their knowledge toward a more scientifically based and coherent view of the natural sciences and engineering, as well as of the ways in which they are pursued and their results can be used.

Second, the framework focuses on a limited number of core ideas in science and engineering both within and across the disciplines. The committee made this choice in order to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented. Delimiting what is to be learned about each core idea within each grade band also helps clarify what is most important to spend time on, and avoid the proliferation of detail to be learned with no conceptual grounding.

Third, the framework emphasizes that learning about science and engineering involves integration of the knowledge of scientific explanations (i.e., content knowledge) and the practices needed to engage in scientific inquiry and engineering design. Thus the framework seeks to illustrate how knowledge and practice must be intertwined in designing learning experiences in K-12 science education." - NRC Framework for K-12 Science Education, 1-3

Disciplinary Core Idea Progression

The *Framework* describes the progression of disciplinary core ideas in the grade band endpoints. The progressions are summarized in this section of the NGSS appendices, which describe the content that occurs at each grade band. Some of the sub-ideas within the disciplinary core ideas overlap significantly. Readers will notice there is not always a clear division between those ideas, so several progressions are divided among more than one sub-idea. The purpose of these diagrams is to briefly describe the content at each grade band for each disciplinary core idea across K-12. This progression is for reference only. The full progressions can be seen in the *Framework*. In addition, the NGSS show the integration of the three dimensions. This document in no way endorses separating the disciplinary core ideas from the other two dimensions.

Earth Space Science Progression

INCREASING SOPHISTICATION OF STUDENT THINKING

	K-2	3-5	6-8	9-12
ESS1.A The universe and its stars	Patterns of movement of the sun, moon, and stars as seen from Earth can be observed, described, and predicted.	Stars range greatly in size and distance from Earth and this can explain their relative brightness.	The solar system is part of the Milky Way, which is one of many billions of galaxies.	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.
ESS1.B Earth and the solar system		The Earth's orbit and rotation, and the orbit of the moon around the Earth cause observable patterns.	The solar system contains many varied objects held together by gravity. Solar system models explain and predict eclipses, lunar phases, and seasons.	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 climate changes such as Ice Ages.
ESS1.C The history of planet Earth	Some events on Earth occur very quickly; others can occur very slowly.	Certain features on Earth can be used to order events that have occurred in a landscape.	Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth's history.	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.
ESS2.A Earth materials and systems	Wind and water change the shape of the land.	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.	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.	Feedback effects exist within and among Earth's systems.
ESS2.B Plate tectonics and large-scale system interactions	Maps show where things are located. One can map the shapes and kinds of land and water in any area.	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.	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.	Radioactive decay within Earth's interior contributes to thermal convection in the mantle.

	K-2	3-5	6-8	9-12
ESS2.C The roles of water in Earth's surface processes	Water is found in many types of places and in different forms on Earth.	Most of Earth's water is in the ocean and much of the Earth's fresh water is in glaciers or underground.	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.	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.
ESS2.D Weather and climate	Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region and time. People record weather patterns over time.	Climate describes patterns of typical weather conditions over different scales and variations. Historical weather patterns can be analyzed.	Complex interactions determine local weather patterns and influence climate, including the role of the ocean.	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.
ESS2.E Biogeology	Plants and animals can change their local environment.	Living things can affect the physical characteristics of their environment.	[Content found in LS4.A and LS4.D]	The biosphere and Earth's other systems have many interconnections that cause a continual co-evolution of Earth's surface and life on it
ESS3.A Natural resources	Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.	Energy and fuels humans use are derived from natural sources and their use affects the environment. Some resources are renewable over time, others are not.	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
ESS3.B Natural hazards	In a region, some kinds of severe weather are more likely than others. Forecasts allow communities to prepare for severe weather.	A variety of hazards result from natural processes; humans cannot eliminate hazards but can reduce their impacts.	Mapping the history of natural hazards in a region and understanding related geological forces.	Natural hazards and other geological events have shaped the course of human history at local, regional, and global scales.
ESS3.C Human impacts on Earth systems	Things people do can affect the environment but they can make choices to reduce their impacts.	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.	Human activities have altered the biosphere, sometimes damaging it, although changes to environments can have different impacts for different living things. Activities and technologies can be engineered to reduce people's impacts on Earth.	Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies.

ESS3.D Global climate change	N/A	N/A	Human activities affect global warming. Decisions to reduce the impact of global warming depend on understanding climate science, engineering capabilities, and social dynamics.	Global climate models used to predict changes continue to be improved, although discoveries about the global climate system are ongoing and continually needed.

Life Science Progression

INCREASING SOPHISTICATION OF STUDENT THINKING

	K-2	3-5	6-8	9-12
LS1.A Structure and function	All organisms have external parts that they use to perform daily functions.	Organisms have both internal and external macroscopic structures that allow for growth, survival, behavior, and reproduction.	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.	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.
LS1.B Growth and development of organisms	Parents and offspring often engage in behaviors that help the offspring survive.	Reproduction is essential to every kind of organism. Organisms have unique and diverse life cycles.	Animals engage in behaviors that increase the odds of reproduction. An organism's growth is affected by both genetic and environmental factors.	Growth and division of cells in organisms occurs by mitosis and differentiation for specific cell types.
LS1.C Organization for matter and energy flow in organisms	Animals obtain food they need from plants or other animals. Plants need water and light.	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 matter and obtain energy from sunlight, which is used to maintain conditions necessary for survival.	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.	The hydrocarbon backbones of sugars produced through photosynthesis are used to make amino acids and other molecules that can be assembled into proteins or DNA. Through cellular respiration, matter and energy flow through different organizational levels of an organism as elements are recombined to form different products and transfer energy.
LS1.D Information Processing	Animals sense and communicate information and respond to inputs with behaviors that help them grow and survive.	Different sense receptors are specialized for particular kinds of information; Animals use their perceptions and memories to guide their actions.	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.	N/A

	K-2	3-5	6-8	9-12
LS2.A Interdependent relationships in ecosystems	Plants depend on water and light to grow, and also depend on animals for pollination or to move their seeds around.	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 back to the soil.	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.	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.
LS2.B Cycles of matter and energy transfer in ecosystems	[Content found in LS1.C and ESS3.A]	Matter cycles between the air and soil and among organisms as they live and die.	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.	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.
LS2.C Ecosystem dynamics, functioning, and resilience	N/A	When the environment changes some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die.	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.	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.
LS2.D Social interactions and group behavior	N/A	Being part of a group helps animals obtain food, defend themselves, and cope with changes.	N/A	Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.

	K-2	3-5	6-8	9-12
LS3.A Inheritance of traits	Young organisms are very much, but not exactly, like their parents and also resemble other organisms of the same kind.	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.	Genes chiefly regulate a specific protein, which affect an individual's traits.	DNA carries instructions for forming species' characteristics. Each cell in an organism has the same genetic content, but genes expressed by cells can differ
LS3.B Variation of traits			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.	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.
LS4.A Evidence of common ancestry and diversity	N/A	Some living organisms resemble organisms that once lived on Earth. Fossils provide evidence about the types of organisms and environments that existed long ago.	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 evolutionary descent.	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.
LS4.B Natural selection	N/A	Differences in characteristics between individuals of the same species provide advantages in surviving and reproducing.	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.	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.
LS4.C Adaptation	N/A	Particular organisms can only survive in particular environments.	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.	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.
LS4.D Biodiversity and humans	A range of different organisms lives in different places.	Populations of organisms live in a variety of habitats. Change in those habitats affects the organisms living there.	Changes in biodiversity can influence humans' resources and ecosystem services they rely on.	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.

Physical Science Progression

INCREASING SOPHISTICATION OF STUDENT THINKING

	K-2	3-5	6-8	9-12
PS1.A Structure of matter (includes PS1.C Nuclear processes)	Matter exists as different substances that have observable different properties. Different properties are suited to different purposes. Objects can be built up from smaller parts.	Because 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.	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.	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.
PS1.B Chemical reactions	Heating and cooling substances cause changes that are sometimes reversible and sometimes not.	Chemical reactions that occur when substances are mixed can be identified by the emergence of substances with different properties; the total mass remains the same.	Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.	Chemical processes are understood in terms of collisions of molecules, rearrangement of atoms, and changes in energy as determined by properties of elements involved.
PS2.A Forces and motion	Pushes and pulls can have different strengths and directions, and can change the speed or direction of its motion or start or stop it.	The effect of unbalanced forces on an object results in a change of motion. Patterns of motion can be used to predict future motion. Some forces act through contact, some forces act even when the objects are not in contact. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	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 2[nd] law (F=ma) and the conservation of momentum can be used to predict changes in the motion of macroscopic objects.
PS2.B Types of interactions			Forces that act at a distance involve fields that can be mapped by their relative strength and effect on an object.	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.
PS2.C Stability & instability in physical systems	N/A	N/A	N/A	N/A
PS3.A Definitions of energy	N/A	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.	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.	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). ---------------- Systems move toward stable states.
PS3.B Conservation of energy and energy transfer	[Content found in PS3.D]			

	K-2	3-5	6-8	9-12
PS3.C Relationship between energy and forces	Bigger pushes and pulls cause bigger changes in an object's motion or shape.	When objects collide, contact forces transfer energy so as to change the objects' motions.	When two objects interact, each one exerts a force on the other, and these forces can transfer energy between them.	Fields contain energy that depends on the arrangement of the objects in the field.
PS3.D Energy in chemical processes and everyday life	Sunlight warms Earth's surface.	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.	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.	Photosynthesis is the primary biological means of capturing radiation from the sun; energy cannot be destroyed, it can be converted to less useful forms.
PS4.A Wave properties	Sound can make matter vibrate, and vibrating matter can make sound.	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.	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.	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.
PS4.B Electromagnetic radiation	Objects can be seen only when light is available to illuminate them.	Object can be seen when light reflected from their surface enters our eyes.	The construct of a wave is used to model how light interacts with objects.	Both an electromagnetic wave model and a photon model explain features of electromagnetic radiation broadly and describe common applications of electromagnetic radiation.
PS4.C Information technologies and instrumentation	People use devices to send and receive information.	Patterns can encode, send, receive and decode information.	Waves can be used to transmit digital information. Digitized information is comprised of a pattern of 1s and 0s.	Large amounts of information can be stored and shipped around as a result of being digitized.

APPENDIX F – Science and Engineering Practices in the NGSS

A Science Framework for K-12 Science Education provides the blueprint for developing the *Next Generation Science Standards* (NGSS). The *Framework* expresses a vision in science education that requires students to operate at the nexus of three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. The *Framework* identified a small number of disciplinary core ideas that all students should learn with increasing depth and sophistication, from Kindergarten through grade twelve. Key to the vision expressed in the *Framework* is for students to learn these disciplinary core ideas in the context of science and engineering practices. The importance of combining science and engineering practices and disciplinary core ideas is stated in the *Framework* as follows:

> *Standards and performance expectations that are aligned to the framework must take into account that students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content.* (NRC *Framework*, 2012, p. 218)

The *Framework* specifies that each performance expectation must combine a relevant practice of science or engineering, with a core disciplinary idea and crosscutting concept, appropriate for students of the designated grade level. That guideline is perhaps the most significant way in which the NGSS differs from prior standards documents. In the future, science assessments will not assess students' understanding of core ideas separately from their abilities to use the practices of science and engineering. They will be assessed together, showing students not only "know" science concepts; but also, students can use their understanding to investigate the natural world through the practices of science inquiry, or solve meaningful problems through the practices of engineering design. The *Framework* uses the term "practices," rather than "science processes" or "inquiry" skills for a specific reason:

> *We use the term "practices" instead of a term such as "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice.* (NRC *Framework*, 2012, p. 30)

The eight practices of science and engineering that the *Framework* identifies as essential for all students to learn and describes in detail are listed below:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Rationale

Chapter 3 of the *Framework* describes each of the eight practices of science and engineering and presents the following rationale for why they are essential.

> *Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science. Participation in these practices also*

helps students form an understanding of the crosscutting concepts and disciplinary ideas of science and engineering; moreover, it makes students' knowledge more meaningful and embeds it more deeply into their worldview.

The actual doing of science or engineering can also pique students' curiosity, capture their interest, and motivate their continued study; the insights thus gained help them recognize that the work of scientists and engineers is a creative endeavor—one that has deeply affected the world they live in. Students may then recognize that science and engineering can contribute to meeting many of the major challenges that confront society today, such as generating sufficient energy, preventing and treating disease, maintaining supplies of fresh water and food, and addressing climate change.

Any education that focuses predominantly on the detailed products of scientific labor—the facts of science—without developing an understanding of how those facts were established or that ignores the many important applications of science in the world misrepresents science and marginalizes the importance of engineering. (NRC *Framework* 2012, pp. 42-43)

As suggested in the rationale, above, Chapter 3 derives the eight practices based on an analysis of what professional scientists and engineers do. It is recommended that users of the NGSS read that chapter carefully, as it provides valuable insights into the nature of science and engineering, as well as the connections between these two closely allied fields. The intent of this section of the NGSS appendices is more limited—to describe what each of these eight practices implies about what students can do. Its purpose is to enable readers to better understand the performance expectations. The "Practices Matrix" is included, which lists the specific capabilities included in each practice for each grade band (K-2, 3-5, 6-8, 9-12).

Guiding Principles

The development process of the standards provided insights into science and engineering practices. These insights are shared in the following guiding principles:

Students in grades K-12 should engage in all eight practices over each grade band. All eight practices are accessible at some level to young children; students' abilities to use the practices grow over time. However, the NGSS only identifies the capabilities students are expected to acquire by the end of each grade band (K-2, 3-5, 6-8, and 9-12). Curriculum developers and teachers determine strategies that advance students' abilities to use the practices.

Practices grow in complexity and sophistication across the grades. The *Framework* suggests how students' capabilities to use each of the practices should progress as they mature and engage in science learning. For example, the practice of "planning and carrying out investigations" begins at the kindergarten level with guided situations in which students have assistance in identifying phenomena to be investigated, and how to observe, measure, and record outcomes. By upper elementary school, students should be able to plan their own investigations. The nature of investigations that students should be able to plan and carry out is also expected to increase as students mature, including the complexity of questions to be studied, the ability to determine what kind of investigation is needed to answer different kinds of questions, whether or not variables need to be controlled and if so, which are most important, and at the high school level, how to take measurement error into account. As listed in the tables in this chapter, each of the eight practices has its own progression, from kindergarten to grade 12. While these progressions are derived from Chapter 3 of the *Framework*, they are refined based on experiences in crafting the NGSS and feedback received from reviewers.

Each practice may reflect science or engineering. Each of the eight practices can be used in the service of scientific inquiry or engineering design. The best way to ensure a practice is being used for science or engineering is to ask about the goal of the activity. Is the goal to answer a question? If so, students are doing science. Is the purpose to define and solve a problem? If so, students are doing engineering. Box 3-2 on pages 50-53 of the *Framework* provides a side-by-side comparison of how scientists and engineers use these practices. This chapter briefly summarizes what it "looks like" for a student to use each practice for science or engineering.

Practices represent what students are expected to do, and are not teaching methods or curriculum. The *Framework* occasionally offers suggestions for instruction, such as how a science unit might begin with a scientific investigation, which then leads to the solution of an engineering problem. The NGSS avoids such suggestions since the goal is to describe what students should be able to do, rather than how they should be taught. For example, it was suggested for the NGSS to recommend certain teaching strategies such as using biomimicry—the application of biological features to solve engineering design problems. Although instructional units that make use of biomimicry seem well-aligned with the spirit of the *Framework* to encourage integration of core ideas and practices, biomimicry and similar teaching approaches are more closely related to curriculum and instruction than to assessment. Hence, the decision was made not to include biomimicry in the NGSS.

The eight practices are not separate; they intentionally overlap and interconnect. As explained by Bell, et al. (2012), the eight practices do not operate in isolation. Rather, they tend to unfold sequentially, and even overlap. For example, the practice of "asking questions" may lead to the practice of "modeling" or "planning and carrying out an investigation," which in turn may lead to "analyzing and interpreting data." The practice of "mathematical and computational thinking" may include some aspects of "analyzing and interpreting data." Just as it is important for students to carry out each of the individual practices, it is important for them to see the connections among the eight practices.

Performance expectations focus on some but not all capabilities associated with a practice. The *Framework* identifies a number of features or components of each practice. The practices matrix, described in this section, lists the components of each practice as a bulleted list within each grade band. As the performance expectations were developed, it became clear that it's too much to expect each performance to reflect all components of a given practice. The most appropriate aspect of the practice is identified for each performance expectation.

Engagement in practices is language intensive and requires students to participate in classroom science discourse. The practices offer rich opportunities and demands for language learning while advancing science learning for all students (Lee, Quinn, & Valdés, in press). English language learners, students with disabilities that involve language processing, students with limited literacy development, and students who are speakers of social or regional varieties of English that are generally referred to as "non-Standard English" stand to gain from science learning that involves language-intensive scientific and engineering practices. When supported appropriately, these students are capable of learning science through their emerging language and comprehending and carrying out sophisticated language functions (e.g., arguing from evidence, providing explanations, developing models) using less-than-perfect English. By engaging in such practices, moreover, they simultaneously build on their understanding of science and their language proficiency (i.e., capacity to do more with language).

On the following pages, each of the eight practices is briefly described. Each description ends with a table illustrating the components of the practice that students are expected to master at the end of each grade band. All eight tables comprise the *practices matrix*. During development of the NGSS, the practices matrix was revised several times to reflect improved understanding of how the practices connect with the disciplinary core ideas.

Practice 1 Asking Questions and Defining Problems

> *Students at any grade level should be able to ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from their models or scientific investigations. For engineering, they should ask questions to define the problem to be solved and to elicit ideas that lead to the constraints and specifications for its solution.* (NRC Framework 2012, p. 56)

Scientific questions arise in a variety of ways. They can be driven by curiosity about the world, inspired by the predictions of a model, theory, or findings from previous investigations, or they can be stimulated by the need to solve a problem. Scientific questions are distinguished from other types of questions in that the answers lie in explanations supported by empirical evidence, including evidence gathered by others or through investigation.

While science begins with questions, engineering begins with defining a problem to solve. However, engineering may also involve asking questions to define a problem, such as: What is the need or desire that underlies the problem? What are the criteria for a successful solution? Other questions arise when generating ideas, or testing possible solutions, such as: What are the possible trade-offs? What evidence is necessary to determine which solution is best?

Asking questions and defining problems also involves asking questions about data, claims that are made, and proposed designs. It is important to realize that asking a question also leads to involvement in another practice. A student can ask a question about data that will lead to further analysis and interpretation. Or a student might ask a question that leads to planning and design, an investigation, or the refinement of a design.

Whether engaged in science or engineering, the ability to ask good questions and clearly define problems is essential for everyone. The following progression of Practice 1 summarizes what students should be able to do by the end of each grade band. Each of the examples of asking questions below leads to students engaging in other scientific practices.

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

Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.
• Ask questions based on observations to find more information about the natural and/or designed world(s).
• Ask and/or identify questions that can be answered by an investigation.
• Define a simple problem that can be solved through the development of a new or improved object or tool.
	Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.
	• Ask questions about what would happen if a variable is changed.
	• Identify scientific (testable) and non-scientific (non-testable) questions.
	• Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
	• 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.
		Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
		• Ask questions
		  ○ that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
		  ○ to identify and/or clarify evidence and/or the premise(s) of an argument.
		  ○ to determine relationships between independent and dependent variables and relationships in models.
		  ○ to clarify and/or refine a model, an explanation, or an engineering problem.
		  ○ that require sufficient and appropriate empirical evidence to answer.
		  ○ that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when
			Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
			• Ask questions
			  ○ that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
			  ○ that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
			  ○ to determine relationships, including quantitative relationships, between independent and dependent variables.
			  ○ to clarify and refine a model, an explanation, or an engineering problem.
			• Evaluate a question to determine if it is testable and

		appropriate, frame a hypothesis based on observations and scientific principles. ○ that challenge the premise(s) of an argument or the interpretation of a data set. • 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.	relevant. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. • Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. • 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.

Practice 2 Developing and Using Models

> *Modeling can begin in the earliest grades, with students' models progressing from concrete "pictures" and/or physical scale models (e.g., a toy car) to more abstract representations of relevant relationships in later grades, such as a diagram representing forces on a particular object in a system.* (NRC Framework, 2012, p. 58)

Models include diagrams, physical replicas, mathematical representations, analogies, and computer simulations. Although models do not correspond exactly to the real world, they bring certain features into focus while obscuring others. All models contain approximations and assumptions that limit the range of validity and predictive power, so it is important for students to recognize their limitations.

In science, models are used to represent a system (or parts of a system) under study, to aid in the development of questions and explanations, to generate data that can be used to make predictions, and to communicate ideas to others. Students can be expected to evaluate and refine models through an iterative cycle of comparing their predictions with the real world and then adjusting them to gain insights into the phenomenon being modeled. As such, models are based upon evidence. When new evidence is uncovered that the models can't explain, models are modified.

In engineering, models may be used to analyze a system to see where or under what conditions flaws might develop, or to test possible solutions to a problem. Models can also be used to visualize and refine a design, to communicate a design's features to others, and as prototypes for testing design performance.

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. • Distinguish between a model and the actual object, process, and/or events the model represents. • Compare models to identify common features and differences. • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). • Develop a simple model based on evidence to represent a proposed object or tool.	Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Identify limitations of models. • 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. • 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 functioning of a natural or designed system.	Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Evaluate limitations of a model for a proposed object or tool. • 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. • 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.	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • 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. • Design a test of a model to ascertain its reliability. • 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. • 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.

Practice 3 Planning and Carrying Out Investigations

> *Students should have opportunities to plan and carry out several different kinds of investigations during their K-12 years. At all levels, they should engage in investigations that range from those structured by the teacher—in order to expose an issue or question that they would be unlikely to explore on their own (e.g., measuring specific properties of materials)—to those that emerge from students' own questions.* (NRC Framework, 2012, p. 61)

Scientific investigations may be undertaken to describe a phenomenon, or to test a theory or model for how the world works. The purpose of engineering investigations might be to find out how to fix or improve the functioning of a technological system or to compare different solutions to see which best solves a problem. Whether students are doing science or engineering, it is always important for them to state the goal of an investigation, predict outcomes, and plan a course of action that will provide the best evidence to support their conclusions. Students should design investigations that generate data to provide evidence to support claims they make about phenomena. Data aren't evidence until used in the process of supporting a claim. Students should use reasoning and scientific ideas, principles, and theories to show why data can be considered evidence.

Over time, students are expected to become more systematic and careful in their methods. In laboratory experiments, students are expected to decide which variables should be treated as results or outputs, which should be treated as inputs and intentionally varied from trial to trial, and which should be controlled, or kept the same across trials. In the case of field observations, planning involves deciding how to collect different samples of data under different conditions, even though not all conditions are under the direct control of the investigator. Planning and carrying out investigations may include elements of all of the other practices.

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • 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. • Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question. • 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	Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that <u>control variables</u> and provide evidence to support explanations or design solutions. • 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. • Evaluate appropriate methods and/or tools for collecting data. • 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	Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use <u>multiple variables</u> and provide evidence to support explanations or solutions. • 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. • Evaluate the accuracy of various methods for collecting data. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test	Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • 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 confounding variables or effects and evaluate the 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. • Select appropriate tools to collect, record, analyze, and evaluate data.

solves a problem or meets a goal. • Make predictions based on prior experiences.	determine which better meets criteria for success.	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.	• 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.

Practice 4 Analyzing and Interpreting Data

> *Once collected, data must be presented in a form that can reveal any patterns and relationships and that allows results to be communicated to others. Because raw data as such have little meaning, a major practice of scientists is to organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data—and their relevance—so that they may be used as evidence.*
>
> *Engineers, too, make decisions based on evidence that a given design will work; they rarely rely on trial and error. Engineers often analyze a design by creating a model or prototype and collecting extensive data on how it performs, including under extreme conditions. Analysis of this kind of data not only informs design decisions and enables the prediction or assessment of performance but also helps define or clarify problems, determine economic feasibility, evaluate alternatives, and investigate failures.* (NRC Framework, 2012, p. 61-62)

As students mature, they are expected to expand their capabilities to use a range of tools for tabulation, graphical representation, visualization, and statistical analysis. Students are also expected to improve their abilities to interpret data by identifying significant features and patterns, use mathematics to represent relationships between variables, and take into account sources of error. When possible and feasible, students should use digital tools to analyze and interpret data. Whether analyzing data for the purpose of science or engineering, it is important students present data as evidence to support their conclusions.

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Record information (observations, thoughts, and ideas). • Use and share pictures, drawings, and/or writings of observations. • 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). • Analyze data from tests of an object or tool to determine if it works as intended.	Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. • Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. • Analyze data to refine a problem statement or the design of a proposed object, tool, or process. • Use data to evaluate and refine design solutions.	Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • 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 identify temporal and spatial relationships. • Distinguish between causal and correlational relationships in data. • Analyze and interpret data to provide evidence for phenomena. • Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. • 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). • Analyze and interpret data to determine similarities and differences in findings. • Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.	Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • 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. • 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. • Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. • Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. • 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 characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5 Using Mathematics and Computational Thinking

> *Although there are differences in how mathematics and computational thinking are applied in science and in engineering, mathematics often brings these two fields together by enabling engineers to apply the mathematical form of scientific theories and by enabling scientists to use powerful information technologies designed by engineers. Both kinds of professionals can thereby accomplish investigations and analyses and build complex models, which might otherwise be out of the question.* (NRC Framework, 2012, p. 65)

Students are expected to use mathematics to represent physical variables and their relationships, and to make quantitative predictions. Other applications of mathematics in science and engineering include logic, geometry, and at the highest levels, calculus. Computers and digital tools can enhance the power of mathematics by automating calculations, approximating solutions to problems that cannot be calculated precisely, and analyzing large data sets available to identify meaningful patterns. Students are expected to use laboratory tools connected to computers for observing, measuring, recording, and processing data. Students are also expected to engage in computational thinking, which involves strategies for organizing and searching data, creating sequences of steps called algorithms, and using and developing new simulations of natural and designed systems. Mathematics is a tool that is key to understanding science. As such, classroom instruction must include critical skills of mathematics. The NGSS displays many of those skills through the performance expectations, but classroom instruction should enhance all of science through the use of quality mathematical and computational thinking.

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Mathematical and computational thinking in K–2 builds on prior experience and progresses to recognizing that mathematics can be used to describe the natural and designed world(s). • Decide when to use qualitative vs. quantitative data. • Use counting and numbers to identify and describe patterns in the natural and designed world(s). • Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs. • Use quantitative data to compare two alternative solutions to a problem.	Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. • Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success. • Organize simple data sets to reveal patterns that suggest relationships. • Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems. • Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.	Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. • Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends. • Use mathematical representations to describe and/or support scientific conclusions and design solutions. • Create algorithms (a series of ordered steps) to solve a problem. • Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific 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.	Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. • Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. • 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 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/m^3, acre-feet, etc.).

Practice 6 Constructing Explanations and Designing Solutions

The goal of science is to construct explanations for the causes of phenomena. Students are expected to construct their own explanations, as well as apply standard explanations they learn about from their teachers or reading. The *Framework* states the following about explanation:

> "*The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.*"(NRC Framework, 2012, p. 52)

An explanation includes a claim that relates how a variable or variables relate to another variable or a set of variables. A claim is often made in response to a question and in the process of answering the question, scientists often design investigations to generate data.

The goal of engineering is to solve problems. Designing solutions to problems is a systematic process that involves defining the problem, then generating, testing, and improving solutions. This practice is described in the *Framework* as follows.

> *Asking students to demonstrate their own understanding of the implications of a scientific idea by developing their own explanations of phenomena, whether based on observations they have made or models they have developed, engages them in an essential part of the process by which conceptual change can occur.*
>
> *In engineering, the goal is a design rather than an explanation. The process of developing a design is iterative and systematic, as is the process of developing an explanation or a theory in science. Engineers' activities, however, have elements that are distinct from those of scientists. These elements include specifying constraints and criteria for desired qualities of the solution, developing a design plan, producing and testing models or prototypes, selecting among alternative design features to optimize the achievement of design criteria, and refining design ideas based on the performance of a prototype or simulation.* (NRC Framework, 2012, p. 68-69)

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. • 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.	Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. • Identify the evidence that supports particular points in an explanation. • Apply scientific ideas to solve design problems. • Generate and compare multiple solutions to a problem based on how	Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • 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. • 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. • Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.	Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. • 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. • 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.

	well they meet the criteria and constraints of the design solution.	• 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 re-testing.	• 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.

Practice 7 Engaging in Argument from Evidence

> *The study of science and engineering should produce a sense of the process of argument necessary for advancing and defending a new idea or an explanation of a phenomenon and the norms for conducting such arguments. In that spirit, students should argue for the explanations they construct, defend their interpretations of the associated data, and advocate for the designs they propose.* (NRC Framework, 2012, p. 73)

Argumentation is a process for reaching agreements about explanations and design solutions. In science, reasoning and argument based on evidence are essential in identifying the best explanation for a natural phenomenon. In engineering, reasoning and argument are needed to identify the best solution to a design problem. Student engagement in scientific argumentation is critical if students are to understand the culture in which scientists live, and how to apply science and engineering for the benefit of society. As such, argument is a process based on evidence and reasoning that leads to explanations acceptable by the scientific community and design solutions acceptable by the engineering community.

Argument in science goes beyond reaching agreements in explanations and design solutions. Whether investigating a phenomenon, testing a design, or constructing a model to provide a mechanism for an explanation, students are expected to use argumentation to listen to, compare, and evaluate competing ideas and methods based on their merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s). • 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 a scientific question and some is not. • Distinguish between opinions and evidence in one's own explanations. • Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument. • Construct an argument with evidence to support a claim. • Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • 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. • Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions. • Construct and/or support an argument with evidence, data, and/or a model. • Use data to evaluate claims about cause and effect. • 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.	Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. • 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. • 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. • 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.	Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • 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. • Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions. • Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. • 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,

		• Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 8 Obtaining, Evaluating, and Communicating Information

> *Any education in science and engineering needs to develop students' ability to read and produce domain-specific text. As such, every science or engineering lesson is in part a language lesson, particularly reading and producing the genres of texts that are intrinsic to science and engineering.* (NRC Framework, 2012, p. 76)

Being able to read, interpret, and produce scientific and technical text are fundamental practices of science and engineering, as is the ability to communicate clearly and persuasively. Being a critical consumer of information about science and engineering requires the ability to read or view reports of scientific or technological advances or applications (whether found in the press, the Internet, or in a town meeting) and to recognize the salient ideas, identify sources of error and methodological flaws, distinguish observations from inferences, arguments from explanations, and claims from evidence. Scientists and engineers employ multiple sources to obtain information used to evaluate the merit and validity of claims, methods, and designs. Communicating information, evidence, and ideas can be done in multiple ways: using tables, diagrams, graphs, models, interactive displays, and equations as well as orally, in writing, and through extended discussions.

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information. • 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). • Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea. • 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. • 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.	Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. • 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. • 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. • Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. • Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. • 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). • 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. • Gather, read, and 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. • Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • 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. • 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. • 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. • 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 (i.e., orally, graphically, textually, mathematically).

Reflecting on the Practices of Science and Engineering

Engaging students in the practices of science and engineering outlined in this section is not sufficient for science literacy. It is also important for students to stand back and reflect on how these practices have contributed to their own development, and to the accumulation of scientific knowledge and engineering accomplishments over the ages. Accomplishing this is a matter for curriculum and instruction, rather than standards, so specific guidelines are not provided in this document. Nonetheless, this section would not be complete without an acknowledgment that reflection is essential if students are to become aware of themselves as competent and confident learners and doers in the realms of science and engineering.

References

Bell, P., Bricker, L., Tzou, Carrie, Lee., T., and Van Horne, K. (2012). Exploring the science framework; Engaging learners in science practices related to obtaining, evaluating, and communicating information. *Science Scope*, 36(3), 18-22.

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Asking Questions and Defining Problems A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.	Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.	Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.	Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
	• Ask questions based on observations to find more information about the natural and/or designed world(s).	• Ask questions about what would happen if a variable is changed.	• Ask questions ◦ that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. ◦ to identify and/or clarify evidence and/or the premise(s) of an argument. ◦ to determine relationships between independent and dependent variables and relationships in models.. ◦ to clarify and/or refine a model, an explanation, or an engineering problem.	• Ask questions ◦ that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. ◦ that arise from examining models or a theory, to clarify and/or seek additional information and relationships. ◦ to determine relationships, including quantitative relationships, between independent and dependent variables. ◦ to clarify and refine a model, an explanation, or an engineering problem.
	• Ask and/or identify questions that can be answered by an investigation.	• Identify scientific (testable) and non-scientific (non-testable) questions. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	• Ask questions that require sufficient and appropriate empirical evidence to answer. • Ask questions that can be 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.	• 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 field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
			• Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.	• Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of

				a design.
	• Define a simple problem that can be solved through the development of a new or improved object or tool.	• 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.	• 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.	• 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.

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Developing and Using Models A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.	Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.	Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.	Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
	• Distinguish between a model and the actual object, process, and/or events the model represents. • Compare models to identify common features and differences.	• Identify limitations of models.	• Evaluate limitations of a model for a proposed object or tool.	• 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. • Design a test of a model to ascertain its reliability.
	• Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	• 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.	• 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.	• 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.

	• Develop a simple model based on evidence to represent a proposed object or tool.	• 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 functioning of a natural or designed system.	• 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.	• 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.

NGSS Science and Engineering Practices* (March 2013 Draft)

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Planning and Carrying Out Investigations Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.	Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.	Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.	Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.	Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
	• 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.	• 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.	• 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.	• 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 confounding variables or effects and evaluate the 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.
	• Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.	• Evaluate appropriate methods and/or tools for collecting data.	• Evaluate the accuracy of various methods for collecting data.	• Select appropriate tools to collect, record, analyze, and evaluate data.
	• Make observations (firsthand or from media) and/or measurements to collect data	• Make observations and/or measurements to produce data to serve as the basis for	• Collect data to produce data to serve as the basis for evidence to answer scientific questions or test	• Make directional hypotheses that specify what happens to a dependent variable when an independent variable is

	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.	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.	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.	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.

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Analyzing and Interpreting Data Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis. Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.	Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.	Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.	Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.	Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
	• Record information (observations, thoughts, and ideas). • Use and share pictures, drawings, and/or writings of observations. • 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).	• Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.	• 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 identify temporal and spatial relationships. • Distinguish between causal and correlational relationships in data. • Analyze and interpret data to provide evidence for phenomena.	• 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.
		• Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.	• Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible.	• 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.
			• 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).	• Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

		• Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.	• Analyze and interpret data to determine similarities and differences in findings.	• Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
	• Analyze data from tests of an object or tool to determine if it works as intended.	• Analyze data to refine a problem statement or the design of a proposed object, tool, or process. • Use data to evaluate and refine design solutions.	• Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.	• 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 characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Using Mathematics and Computational Thinking In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions.	Mathematical and computational thinking in K–2 builds on prior experience and progresses to recognizing that mathematics can be used to describe the natural and designed world(s).	Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.	Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.	Mathematical and computational thinking in 9-12 builds on K-8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
	• Decide when to use qualitative vs. quantitative data.	• Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.		
	• Use counting and numbers to identify and describe patterns in the natural and designed world(s).	• Organize simple data sets to reveal patterns that suggest relationships.	• Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.	• Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.
	• Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.	• Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.	• Use mathematical representations to describe and/or support scientific conclusions and design solutions.	• Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
	• Use quantitative data to compare two alternative solutions to a problem.	• Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.	• 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 and engineering questions and problems. • Use digital tools and/or mathematical concepts and arguments to test and compare	• 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 is known about the real world. • Apply ratios, rates, percentages, and unit conversions in the context of

			proposed solutions to an engineering design problem.	complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m^3, acre-feet, etc.).

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Constructing Explanations and Designing Solutions *The end-products of science are explanations and the end-products of engineering are solutions.* The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.	Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.	Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.	Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.	Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
	• Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.	• Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).	• 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.	• Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
		• Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.	• 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.	• 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.
		• Identify the evidence that supports particular points in an explanation.	• Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.	• 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.
	• Use tools and/or materials to design and/or build a	• Apply scientific ideas to solve design problems.	• Apply scientific ideas or principles to design, construct, and/or test a	• Design, evaluate, and/or refine a solution to a complex real-world

	device that solves a specific problem or a solution to a specific problem. • Generate and/or compare multiple solutions to a problem.	• Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	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 re-testing.	problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

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Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Engaging in Argument from Evidence *Argumentation is the process by which evidence-based conclusions and solutions are reached.* In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.	Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).	Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).	Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).	Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
	• 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 a scientific question and some is not. • Distinguish between opinions and evidence in one's own explanations.	• 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.	• Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.	• 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 of arguments.
	• Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument.	• Respectfully provide and receive critiques from peers about a proposed procedure, explanation or model.by citing relevant evidence and posing specific questions.	• 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.	• 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.
	• Construct an argument with evidence to support a claim.	• Construct and/or support an argument with evidence, data, and/or a model. • Use data to evaluate claims about cause and effect.	• 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.	• Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

	• Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	• 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.	• 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 solutions based on jointly developed and agreed-upon design criteria.	• 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).

NGSS Science and Engineering Practices* (March 2013 Draft)

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Obtaining, Evaluating, and Communicating Information Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs.	Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.	Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.	Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.
	• 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).	• 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.	• 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).	• 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.
	• Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.	• 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.	• 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.	• 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.
	• 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.	• Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.	• 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.	• 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.

	• 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.	• Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	• Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	• 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).

Appendix G – Crosscutting Concepts

> *Crosscutting concepts have value because they provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas.* — Framework p. 233

A Framework for K-12 Science Education: Practices, Core Ideas, and Crosscutting Concepts (*Framework*) recommends science education in grades K-12 be built around three major dimensions: scientific and engineering practices; crosscutting concepts that unify the study of science and engineering through their common application across fields; and core ideas in the major disciplines of natural science. The purpose of this appendix is to describe the second dimension—crosscutting concepts—and to explain its role in the *Next Generation Science Standards* (NGSS).

The *Framework* identifies seven crosscutting concepts that bridge disciplinary boundaries, uniting core ideas throughout the fields of science and engineering. Their purpose is to help students deepen their understanding of the disciplinary core ideas (pp. 2 and 8), and develop a coherent and scientifically based view of the world (p. 83.) The seven crosscutting concepts presented in Chapter 4 of the *Framework* are as follows:

1. *Patterns.* Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

2. *Cause and effect: Mechanism and explanation.* Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. *Scale, proportion, and quantity.* In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

4. *Systems and system models.* Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

5. *Energy and matter: Flows, cycles, and conservation.* Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

6. *Structure and function.* The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

7. *Stability and change.* For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

The *Framework* notes that crosscutting concepts are featured prominently in other documents about what all students should learn about science for the past two decades. These have been called "themes" in *Science for All Americans* (AAA 1989) and *Benchmarks for Science Literacy* (1993), "unifying principles" in *National Science Education Standards* (1996), and "crosscutting ideas" NSTA's *Science Anchors Project* (2010). Although these ideas have been consistently included in previous standards documents the Framework recognizes that "students have often been expected to build such knowledge without any explicit instructional support. Hence the purpose of highlighting them as Dimension 2 of the framework is to elevate their role in the development of standards, curricula, instruction, and assessments." (p. 83) The writing team has continued this commitment by weaving crosscutting concepts into the performance expectations for all students—so they cannot be left out.

Guiding Principles

The *Framework* recommended crosscutting concepts be embedded in the science curriculum beginning in the earliest years of schooling and suggested a number of guiding principles for how they should be used. The development process of the standards provided insights into the crosscutting concepts. These insights are shared in the following guiding principles.

Crosscutting concepts can help students better understand core ideas in science and engineering. When students encounter new phenomena, whether in a science lab, field trip, or on their own, they need mental tools to help engage in and come to understand the phenomena from a scientific point of view. Familiarity with crosscutting concepts can provide that perspective. For example, when approaching a complex phenomenon (either a natural phenomenon or a machine) an approach that makes sense is to begin by observing and characterizing the phenomenon in terms of patterns. A next step might be to simplify the phenomenon by thinking of it as a system and modeling its components and how they interact. In some cases it would be useful to study how energy and matter flow through the system, or to study how structure affects function (or malfunction). These preliminary studies may suggest explanations for the phenomena, which could be checked by predicting patterns that might emerge if the explanation is correct, and matching those predictions with those observed in the real world.

Crosscutting concepts can help students better understand science and engineering practices. Because the crosscutting concepts address the fundamental aspects of nature, they also inform the way humans attempt to understand it. Different crosscutting concepts align with different practices, and when students carry out these practices, they are often addressing one of these crosscutting concepts. For example, when students analyze and interpret data, they are often looking for patterns in observations, mathematical or visual. The practice of planning and carrying out an investigation is often aimed at identifying cause and effect relationships: if you poke or prod something, what will happen? The crosscutting concept of "Systems and System Models" is clearly related to the practice of developing and using models.

Repetition in different contexts will be necessary to build familiarity. Repetition is counter to the guiding principles the writing team used in creating performance expectations to reflect the core ideas in the science disciplines. In order to reduce the total amount of material students are held accountable to learn, repetition was reduced whenever possible. However, crosscutting concepts are repeated within grades at the elementary level and grade-bands at the middle and high school levels so these concepts "become common and familiar touchstones across the disciplines and grade levels." (p. 83)

Crosscutting concepts should grow in complexity and sophistication across the grades. Repetition alone is not sufficient. As students grow in their understanding of the science disciplines, depth of understanding crosscutting concepts should grow as well. The writing team has adapted and added to the ideas expressed in the *Framework* in developing a matrix for use in crafting performance expectations that describe student understanding of the crosscutting concepts. The matrix is found at the end of this section.

Crosscutting concepts can provide a common vocabulary for science and engineering. The practices, disciplinary core ideas, and crosscutting concepts are the same in science and engineering. What is different is how and why they are used—to explain natural phenomena in science, and to solve a problem or accomplish a goal in engineering. Students need both types of experiences to develop a deep and flexible understanding of how these terms are applied in each of these closely allied fields. As crosscutting concepts are encountered repeatedly across academic disciplines, familiar vocabulary can enhance engagement and understanding for English language learners, students with language processing difficulties, and students with limited literacy development.

Crosscutting concepts should not be assessed separately from practices or core ideas. Students should not be assessed on their ability to define "pattern," "system," or any other crosscutting concepts as a separate vocabulary word. To capture the vision in the *Framework,* students should be assessed on the extent to which they have achieved a coherent scientific worldview by recognizing similarities among core ideas in science or engineering that may at first seem very different, but are united through crosscutting concepts.

Performance expectations focus on some but not all capabilities associated with a crosscutting concept. As core ideas grow in complexity and sophistication across the grades it becomes more and more difficult to express them fully in performance expectations. Consequently, most performance expectations reflect only some aspects of a crosscutting concept. These aspects are indicated in the right-hand foundation box in each of the standards. All aspects of each core idea considered by the writing team can be found in the matrix at the end of this section.

Crosscutting concepts are for *all* students. Crosscutting concepts raise the bar for students who have not achieved at high levels in academic subjects and often assigned to classes that emphasize "the basics," which in science may be taken to provide primarily factual information and lower-order thinking skills. Consequently, it is essential that *all students* engage in using crosscutting concepts, which could result in leveling the playing field and promoting deeper understanding for all students.

Inclusion of Nature of Science and Engineering Concepts. Sometimes included in the crosscutting concept foundation boxes are concepts related to materials from the "Nature of Science" or "Science, Technology, Society, and the Environment." These are not to be confused with the "Crosscutting Concepts" but rather represent an organizational structure of the NGSS recognizing concepts from both the Nature of Science and Science, Technology, Society, and the Environment that extend across all of the sciences. Readers should use Appendices H and J for further information on these ideas.

Progression of Crosscutting Concepts Across the Grades

Following is a brief summary of how each crosscutting concept increases in complexity and sophistication across the grades as envisioned in the *Framework*. Examples of performance expectations illustrate how these ideas play out in the NGSS.

1. "Patterns exist everywhere—in regularly occurring shapes or structures and in repeating events and relationships. For example, patterns are discernible in the symmetry of flowers and snowflakes, the cycling of the seasons, and the repeated base pairs of DNA." (p. 85)

While there are many patterns in nature, they are not the norm since there is a tendency for disorder to increase (e.g. it is far more likely for a broken glass to scatter than for scattered bits to assemble themselves into a whole glass). In some cases, order seems to emerge from chaos, as when a plant sprouts, or a tornado appears amidst scattered storm clouds. It is in such examples that patterns exist and the beauty of nature is found. "Noticing patterns is often a first step to organizing phenomena and asking scientific questions about why and how the patterns occur." (p. 85)

"Once patterns and variations have been noted, they lead to questions; scientists seek explanations for observed patterns and for the similarity and diversity within them. Engineers often look for and analyze patterns, too. For example, they may diagnose patterns of failure of a designed system under test in order to improve the design, or they may analyze patterns of daily and seasonal use of power to design a system that can meet the fluctuating needs." (page 85-86)

Patterns figure prominently in the science and engineering practice of "Analyzing and Interpreting Data." Recognizing patterns is a large part of working with data. Students might look at geographical patterns on a map, plot data values on a chart or graph, or visually inspect the appearance of an organism or mineral. The crosscutting concept of patterns is also strongly associated with the practice of "Using Mathematics and Computational Thinking." It is often the case that patterns are identified best using mathematical concepts. As Richard Feynman said, "To those who do not know mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty, of nature. If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks in."

The human brain is remarkably adept at identifying patterns, and students progressively build upon this innate ability throughout their school experiences. The following table lists the guidelines used by the writing team for how this progression plays out across K-12, with examples of performance expectations drawn from the NGSS.

Progression Across the Grades	Performance Expectation from the NGSS
In grades K-2, children recognize that patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.
In grades 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.	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.
In grades 6-8, 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.	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.

In grades 9-12, 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.	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.

2. Cause and effect is often the next step in science, after a discovery of patterns or events that occur together with regularity. A search for the underlying cause of a phenomenon has sparked some of the most compelling and productive scientific investigations. "Any tentative answer, or 'hypothesis,' that A causes B requires a model or mechanism for the chain of interactions that connect A and B. For example, the notion that diseases can be transmitted by a person's touch was initially treated with skepticism by the medical profession for lack of a plausible mechanism. Today infectious diseases are well understood as being transmitted by the passing of microscopic organisms (bacteria or viruses) between an infected person and another. A major activity of science is to uncover such causal connections, often with the hope that understanding the mechanisms will enable predictions and, in the case of infectious diseases, the design of preventive measures, treatments, and cures." (p. 87)

"In engineering, the goal is to design a system to cause a desired effect, so cause-and-effect relationships are as much a part of engineering as of science. Indeed, the process of design is a good place to help students begin to think in terms of cause and effect, because they must understand the underlying causal relationships in order to devise and explain a design that can achieve a specified objective." (p.88)

When students perform the practice of "Planning and Carrying Out Investigations," they often address cause and effect. At early ages, this involves "doing" something to the system of study and then watching to see what happens. At later ages, experiments are set up to test the sensitivity of the parameters involved, and this is accomplished by making a change (cause) to a single component of a system and examining, and often quantifying, the result (effect). Cause and effect is also closely associated with the practice of "Engaging in Argument from Evidence." In scientific practice, deducing the cause of an effect is often difficult, so multiple hypotheses may coexist. For example, though the occurrence (effect) of historical mass extinctions of organisms, such as the dinosaurs, is well established, the reason or reasons for the extinctions (cause) are still debated, and scientists develop and debate their arguments based on different forms of evidence. When students engage in scientific argumentation, it is often centered about identifying the causes of an effect.

Progression Across the Grades	Performance Expectation from the NGSS
In grades 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.	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.
In grades 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.	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.

In grades 6-8, 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.	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.
In grades 9-12, 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.	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.

3. Scale, Proportion and Quantity are important in both science and engineering. These are fundamental assessments of dimension that form the foundation of observations about nature. Before an analysis of function or process can be made (the *how* or *why*), it is necessary to identify the *what*. These concepts are the starting point for scientific understanding, whether it is of a total system or its individual components. Any student who has ever played the game "twenty questions" understands this inherently, asking questions such as, "Is it bigger than a bread box?" in order to first determine the object's size.

An understanding of scale involves not only understanding systems and processes vary in size, time span, and energy, but also different mechanisms operate at different scales. In engineering, "no structure could be conceived, much less constructed, without the engineer's precise sense of scale... At a basic level, in order to identify something as bigger or smaller than something else—and how much bigger or smaller—a student must appreciate the units used to measure it and develop a feel for quantity." (p. 90)

"The ideas of ratio and proportionality as used in science can extend and challenge students' mathematical understanding of these concepts. To appreciate the relative magnitude of some properties or processes, it may be necessary to grasp the relationships among different types of quantities—for example, speed as the ratio of distance traveled to time taken, density as a ratio of mass to volume. This use of ratio is quite different than a ratio of numbers describing fractions of a pie. Recognition of such relationships among different quantities is a key step in forming mathematical models that interpret scientific data." (p. 90)

The crosscutting concept of Scale, Proportion, and Quantity figures prominently in the practices of "Using Mathematics and Computational Thinking" and in "Analyzing and Interpreting Data." This concept addresses taking measurements of structures and phenomena, and these fundamental observations are usually obtained, analyzed, and interpreted quantitatively. This crosscutting concept also figures prominently in the practice of "Developing and Using Models." Scale and proportion are often best understood using models. For example, the relative scales of objects in the solar system or of the components of an atom are difficult to comprehend mathematically (because the numbers involved are either so large or so small), but visual or conceptual models make them much more understandable (e.g., if the solar system were the size of a penny, the Milky Way galaxy would be the size of Texas).

Progression Across the Grades	Performance Expectation from the NGSS
In grades 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.	
In grades 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.	5-ESS1-1. Support an argument that the apparent brightness of the sun and stars is due to their relative distances from Earth.
In grades 6-8, 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.	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.
In grades 9-12, 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).	HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

4. Systems and System Models are useful in science and engineering because the world is complex, so it is helpful to isolate a single system and construct a simplified model of it. "To do this, scientists and engineers imagine an artificial boundary between the system in question and everything else. They then examine the system in detail while treating the effects of things outside the boundary as either forces acting on the system or flows of matter and energy across it—for example, the gravitational force due to Earth on a book lying on a table or the carbon dioxide expelled by an organism. Consideration of flows into and out of the system is a crucial element of system design. In the laboratory or even in field research, the extent to which a system under study can be physically isolated or external conditions controlled is an important element of the design of an investigation and interpretation of results…The properties and behavior of the whole system can be very different from those of any of its parts, and large systems may have emergent properties, such as the shape of a tree, that cannot be predicted in detail from knowledge about the components and their interactions." (p. 92)

"Models can be valuable in predicting a system's behaviors or in diagnosing problems or failures in its functioning, regardless of what type of system is being examined… In a simple mechanical system, interactions among the parts are describable in terms of forces among them that cause changes in motion or physical stresses. In more complex systems, it is not always possible or useful to consider interactions at this detailed mechanical level, yet it is equally important to ask what interactions are occurring (e.g., predator-prey relationships in an ecosystem) and to recognize that they all involve transfers of energy, matter, and (in some cases) information among parts of the system… Any model of a system incorporates assumptions and approximations; the key is to be aware of what they are and how they affect the model's reliability and precision. Predictions may be reliable but not precise or, worse, precise but not reliable; the degree of reliability and precision needed depends on the use to which the model will be put." (p. 93)

Progression Across the Grades	Performance Expectation from the NGSS
In grades 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.	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.
In grades 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.	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.
In grades 6-8, 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.	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.
In grades 9-12, 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.	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.

5. Energy and Matter are essential concepts in all disciplines of science and engineering, often in connection with systems. "The supply of energy and of each needed chemical element restricts a system's operation—for example, without inputs of energy (sunlight) and matter (carbon dioxide and water), a plant cannot grow. Hence, it is very informative to track the transfers of matter and energy within, into, or out of any system under study.

"In many systems there also are cycles of various types. In some cases, the most readily observable cycling may be of matter—for example, water going back and forth between Earth's atmosphere and its surface and subsurface reservoirs. Any such cycle of matter also involves associated energy transfers at each stage, so to fully understand the water cycle, one must model not only how water moves between parts of the system but also the energy transfer mechanisms that are critical for that motion.

"Consideration of energy and matter inputs, outputs, and flows or transfers within a system or process are equally important for engineering. A major goal in design is to maximize certain types of energy output while minimizing others, in order to minimize the energy inputs needed to achieve a desired task." (p. 95)

Progression Across the Grades	Performance Expectation from the NGSS
In grades K-2, students observe objects may break into smaller pieces, be put together into larger pieces, or change shapes.	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.
In grades 3-5, students learn matter is made of particles and energy can be transferred in various ways and between objects. 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.	5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.
In grades 6-8, students learn matter is conserved because atoms are conserved in physical and chemical processes. They 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.	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.
In grades 9-12, students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes 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.	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.

6. Structure and Function are complementary properties. "The shape and stability of structures of natural and designed objects are related to their function(s). The functioning of natural and built systems alike depends on the shapes and relationships of certain key parts as well as on the properties of the materials from which they are made. A sense of scale is necessary in order to know what properties and what aspects of shape or material are relevant at a particular magnitude or in investigating particular phenomena—that is, the selection of an appropriate scale depends on the question being asked. For example, the substructures of molecules are not particularly important in understanding the phenomenon of pressure, but they are relevant to understanding why the ratio between temperature and pressure at constant volume is different for different substances.

"Similarly, understanding how a bicycle works is best addressed by examining the structures and their functions at the scale of, say, the frame, wheels, and pedals. However, building a lighter bicycle may require knowledge of the properties (such as rigidity and hardness) of the materials needed for specific parts of the bicycle. In that way, the builder can seek less dense materials with appropriate properties; this pursuit may lead in turn to an examination of the atomic-scale structure of candidate materials. As a result, new parts with the desired properties, possibly made of new materials, can be designed and fabricated." (p. 96-97)

Progression Across the Grades	Performance Expectation from the NGSS
In grades K-2, students observe the shape and stability of structures of natural and designed objects are related to their function(s).	2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants
In grades 3-5, students learn different materials have different substructures, which can sometimes be observed; and substructures have shapes and parts that serve functions.	
In grades 6-8, 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.	MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
In grades 9-12, 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.	HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

7. Stability and Change are the primary concerns of many, if not most scientific and engineering endeavors. "Stability denotes a condition in which some aspects of a system are unchanging, at least at the scale of observation. Stability means that a small disturbance will fade away—that is, the system will stay in, or return to, the stable condition. Such stability can take different forms, with the simplest being a static equilibrium, such as a ladder leaning on a wall. By contrast, a system with steady inflows and outflows (i.e., constant conditions) is said to be in dynamic equilibrium. For example, a dam may be at a constant level with steady quantities of water coming in and out. . . . A repeating pattern of cyclic change—such as the moon orbiting Earth—can also be seen as a stable situation, even though it is clearly not static.

"An understanding of dynamic equilibrium is crucial to understanding the major issues in any complex system—for example, population dynamics in an ecosystem or the relationship between the level of atmospheric carbon dioxide and Earth's average temperature. Dynamic equilibrium is an equally important concept for understanding the physical forces in matter. Stable matter is a system of atoms in dynamic equilibrium.

"In designing systems for stable operation, the mechanisms of external controls and internal 'feedback' loops are important design elements; feedback is important to understanding natural systems as well. A feedback loop is any mechanism in which a condition triggers some action that causes a change in that same condition, such as the temperature of a room triggering the thermostatic control that turns the room's heater on or off.

"A system can be stable on a small time scale, but on a larger time scale it may be seen to be changing. For example, when looking at a living organism over the course of an hour or a day, it may maintain stability; over longer periods, the organism grows, ages, and eventually dies. For the development of larger systems, such as the variety of living species inhabiting Earth or the formation of a galaxy, the relevant time scales may be very long indeed; such processes occur over millions or even billions of years." (p. 99-100)

Progression Across the Grades	Performance Expectation from the NGSS
In grades K-2, students observe some things stay the same while other things change, and things may change slowly or rapidly.	2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
In grades 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.	
In grades 6-8, 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	MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
In grades 9-12, 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.	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.

How Are the Crosscutting Concepts Connected?

Although each of the seven crosscutting concepts can be used to help students recognize deep connections between seemingly disparate topics, it can sometimes be helpful to think of how they are connected to each other. The connections can be envisioned in many different ways. The following is one way to think about their interconnections.

Patterns

Patterns stand alone because patterns are a pervasive aspect of all fields of science and engineering. When first exploring a new phenomenon, children will notice similarities and differences leading to ideas for how they might be classified. The existence of patterns naturally suggests an underlying cause for the pattern. For example, observing snowflakes are all versions of six-side symmetrical shapes suggests something about how molecules pack together when water freezes; or, when repairing a device a technician would look for a certain pattern of failures suggesting an underlying cause. Patterns are also helpful when interpreting data, which may supply valuable evidence in support of an explanation or a particular solution to a problem.

Causality

Cause and effect lies at the heart of science. Often the objective of a scientific investigation is to find the cause that underlies a phenomenon, first identified by noticing a pattern. Later, the development of theories allows for predictions of new patterns, which then provides evidence in support of the theory. For example, Galileo's observation that a ball rolling down an incline gathers speed at a constant rate eventually led to Newton's Second Law of Motion, which in turn provided predictions about regular patterns of planetary motion, and a means to guide space probes to their destinations.

Structure and function can be thought of as a special case of cause and effect. Whether the structures in question are living tissue or molecules in the atmosphere, understanding their structure is essential to making causal inferences. Engineers make such inferences when examining structures in nature as inspirations for designs to meet people's needs.

Systems

Systems and system models are used by scientists and engineers to investigate natural and designed systems. The purpose of an investigation might be to explore how the system functions, or what may be going wrong. Sometimes investigations are too dangerous or expensive to try out without first experimenting with a model.

Scale, proportion, and quantity are essential considerations when deciding how to model a phenomenon. For example, when testing a scale model of a new airplane wing in a wind tunnel, it is essential to get the proportions right and measure accurately or the results will not be valid. When using a computer simulation of an ecosystem, it is important to use informed estimates of population sizes to make reasonably accurate predictions. Mathematics is essential in both science and engineering.

Energy and matter are basic to any systems model, whether of a natural or a designed system. Systems are described in terms of matter and energy. Often the focus of an investigation is to determine how energy or matter flows through the system, or in the case of engineering to modify the system, so a given energy input results in a more useful energy output.

Stability and change are ways of describing how a system functions. Whether studying ecosystems or engineered systems, the question is often to determine how the system is changing over time, and which factors are causing the system to become unstable.

Conclusion

The purpose of this appendix is to explain the rationale behind integrating crosscutting concepts into the K-12 science curriculum and to illustrate how the seven crosscutting concepts from the *Framework* are integrated into the performance expectations within the NGSS. The crosscutting concepts' utility will be realized when curriculum developers and teachers develop lessons, units, and courses using the crosscutting concepts to tie together the broad diversity of science and engineering core ideas in the curriculum to realize the clear and coherent vision of the *Framework*.

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Performance Expectations Coded to Crosscutting Concepts

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Patterns	*K-LS1-1, K-ESS2-1, 1-LS1-2, 1-LS3-1, 1-ESS1-1, 1-ESS1-2, 2-PS1-1, 2-ESS2-2, 2-ESS2-3*	*3-PS2-2, 3-LS1-1, 3-LS3-1, 3-ESS2-1, 3-ESS2-2, 4-PS4-1, 4-PS4-3, 4-ESS1-1, 4-ESS2-2, 5-ESS1-2*	*MS-PS1-2, MS-PS4-1, MS-LS2-2, MS-LS4-1, MS-LS4-2, MS-LS4-3, MS-ESS1-1, MS-ESS2-3, MS-ESS3-2*	*HS-PS1-1, HS-PS1-2, HS-PS1-3, HS-PS1-5, HS-PS2-4, HS-LS4-1, HS-LS4-3, HS-ESS1-5*
Cause and Effect	*K-PS2-1, K-PS2-2, K-PS3-1, K-PS3-2, K-ESS3-2, K-ESS3-3, 1-PS4-1, 1-PS4-2, 1-PS4-3, 2-PS1-1, 2-LS2-1*	*3-PS2-1, 3-PS2-3, 3-LS2-1, 3-LS3-2, 3-LS4-2, 3-LS4-3, 3-ESS3-1, 4-PS4-2, 4-ESS2-1, 4-ESS3-1, 4-ESS3-2, 5-PS1-4, 5-PS2-1*	*MS-PS1-4, MS-PS2-3, MS-PS2-5, MS-LS1-4, MS-LS1-5, MS-LS2-1, MS-LS3-2, LS4-4, MS-LS4-5, MS-LS4-6, MS-ESS2-5, MS-ESS3-1, MS-ESS3-3, MS-ESS3-4*	*HS-PS2-4, HS-PS3-5, HS-PS4-1, HS-PS4-4, HS-PS4-5, HS-LS2-8, HS-LS3-1, HS-LS3-2, HS-LS4-2, HS-LS4-4, HS-LS4-5, HS-LS4-6, HS-ESS2-4, HS-ESS3-1*
Scale, Proportion, and Quantity		*3-LS4-1, 5-PS1-1, 5-PS2-2, 5-PS1-3, 5-ESS1-1, 5-ESS2-2*	*MS-PS1-1, MS-PS3-1, MS-PS3-4, MS-LS1-1, MS-ESS1-3, MS-ESS1-4, MS-ESS2-2*	*HS-LS2-1, HS-LS2-2, HS-LS3-3, HS-ESS1-1, HS-ESS1-4*
Systems and System Models	*K-ESS3-1, K-ESS2-2*	*3-LS4-4, 4-LS1-1, 5-LS2-1 5-ESS2-1, 5-ESS3-1*	*MS-PS2-1, MS-PS2-4, MS-PS3-2, MS-LS1-3, MS-ESS1-2, MS-ESS2-6*	*HS-PS2-2, HS-PS3-1, HS-PS3-4, HS-PS4-3, HS-LS1-2, HS-LS1-4, HS-LS2-5, HS-ESS3-6*
Energy and Matter	*2-PS1-3*	*4-PS3-1, 4-PS3-2, 4-PS3-3, 4-PS3-4, 5-PS3-1, 5-LS1-1*	*MS-PS1-5, MS-PS1-6, MS-PS3-3, MS-PS3-5, MS-LS1-6, MS-LS1-k, MS-LS1-7, MS-LS2-3, MS-ESS2-4*	*HS-PS1-4, HS-PS1-7, HS-PS1-8, HS-PS3-2, HS-PS3-3, HS-LS1-5, HS-LS1-6, HS-LS1-7, HS-LS2-3, HS-ESS1-2, HS-ESS1-3, HS-ESS2-3, HS-ESS2-6*
Structure and Function	*1-LS1-1, 2-LS2-2, K-2-ETS1-2*		*MS-PS1-5, MS-PS1-6, MS-PS4-a, MS-PS4-2, MS-PS4-3, MS-LS1-6, MS-LS1-7, MS-LS3-1*	*HS-PS2-6, HS-LS1-1, HS-ESS2-5*
Stability and Change	*2-ESS1-1, 2-ESS2-1*		*MS-PS2-2, MS-LS2-4, MS-LS2-5, MS-ESS2-1, MS-ESS3-5*	*HS-PS1-6, HS-PS4-2, HS-LS1-3, HS-LS2-6, HS-LS2-7, HS-ESS1-6, HS-ESS2-1, HS-ESS2-2, HS-ESS2-7, HS-ESS3-3, HS-ESS3-4, HS-ESS3-5*

NGSS Crosscutting Concepts*

Section 2: Crosscutting Concepts Matrix

1. Patterns – Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	▪ Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. ▪ Patterns of change can be used to make predictions. ▪ Patterns can be used as evidence to support an explanation.	▪ Macroscopic patterns are related to the nature of microscopic and atomic-level structure. ▪ Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. ▪ Patterns can be used to identify cause and effect relationships. ▪ Graphs, charts, and images can be used to identify patterns in data.	▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. ▪ Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. ▪ Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system. ▪ Mathematical representations are needed to identify some patterns. ▪ Empirical evidence is needed to identify patterns.

2. Cause and Effect: Mechanism and Prediction – 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.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ Events have causes that generate observable patterns. ▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes.	▪ Cause and effect relationships are routinely identified, tested, and used to explain change. ▪ Events that occur together with regularity might or might not be a cause and effect relationship.	▪ Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. ▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.	▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. ▪ Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. ▪ Systems can be designed to cause a desired effect. ▪ Changes in systems may have various causes that may not have equal effects.

* Adapted from: National Research Council (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academy Press. Chapter 4: Crosscutting Concepts.

NGSS Crosscutting Concepts*

3. Scale, Proportion, and Quantity – In 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.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower). ▪ Standard units are used to measure length.	▪ Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. ▪ Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	▪ Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. ▪ The observed function of natural and designed systems may change with scale. ▪ Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. ▪ Scientific relationships can be represented through the use of algebraic expressions and equations. ▪ Phenomena that can be observed at one scale may not be observable at another scale.	▪ The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. ▪ Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. ▪ Patterns observable at one scale may not be observable or exist at other scales. ▪ Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. ▪ Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

4. Systems and System Models – A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ Objects and organisms can be described in terms of their parts. ▪ Systems in the natural and designed world have parts that work together.	▪ A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. ▪ A system can be described in terms of its components and their interactions.	▪ Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. ▪ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. ▪ Models are limited in that they only represent certain aspects of the system under study.	▪ Systems can be designed to do specific tasks. ▪ When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. ▪ Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. ▪ Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

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NGSS Crosscutting Concepts*

5. Energy and Matter: Flows, Cycles, and Conservation – Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ Objects may break into smaller pieces, be put together into larger pieces, or change shapes.	▪ Matter is made of particles. ▪ Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems. ▪ Energy can be transferred in various ways and between objects.	▪ Matter is conserved because atoms are conserved in physical and chemical processes. ▪ 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.	▪ The total amount of energy and matter in closed systems is conserved. ▪ Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. ▪ Energy cannot be created or destroyed—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.

6. Structure and Function – The way an object is shaped or structured determines many of its properties and functions.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ The shape and stability of structures of natural and designed objects are related to their function(s).	▪ Different materials have different substructures, which can sometimes be observed. ▪ Substructures have shapes and parts that serve functions.	▪ Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. ▪ Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	▪ Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. ▪ The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

7. Stability and Change – For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ Some things stay the same while other things change. ▪ Things may change slowly or rapidly.	▪ Change is measured in terms of differences over time and may occur at different rates. ▪ Some systems appear stable, but over long periods of time will eventually change.	▪ Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. ▪ Small changes in one part of a system might cause large changes in another part. ▪ Stability might be disturbed either by sudden events or gradual changes that accumulate over time. ▪ Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.	▪ Much of science deals with constructing explanations of how things change and how they remain stable. ▪ Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. ▪ Feedback (negative or positive) can stabilize or destabilize a system. ▪ Systems can be designed for greater or lesser stability.

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APPENDIX B: CCSS GRADES 6-8: LITERACY IN SCIENCE AND TECHNICAL SUBJECTS & NGSS CONNECTIONS

APPENDIX M – Connections to the Common Core State Standards for Literacy in Science and Technical Subjects[1]

Literacy skills are critical to building knowledge in science. To ensure the CCSS literacy standards work in tandem with the specific content demands outlined in the NGSS, the NGSS development team worked with the CCSS writing team to identify key literacy connections to the specific content demands outlined in the NGSS. As the CCSS affirms, reading in science requires an appreciation of the norms and conventions of the discipline of science, including understanding the nature of evidence used, an attention to precision and detail, and the capacity to make and assess intricate arguments, synthesize complex information, and follow detailed procedures and accounts of events and concepts. Students also need to be able to gain knowledge from elaborate diagrams and data that convey information and illustrate scientific concepts. Likewise, writing and presenting information orally are key means for students to assert and defend claims in science, demonstrate what they know about a concept, and convey what they have experienced, imagined, thought, and learned.

Every effort has been made to ensure consistency between the CCSS and the NGSS. As is the case with the mathematics standards, NGSS should always be interpreted and implemented in such a way that they do not outpace or misalign to the grade-by-grade standards in the CCSS for literacy (this includes the development of NGSS-aligned instructional materials and assessments). Below are the NGSS Science and Engineering Practices and the corresponding CCSS Literacy Anchor Standards and portions of the Standards for Science and Technical Subjects.

Connections to the English/language arts (ELA) CCSS are included across all disciplines and grade bands in the final version of the NGSS. However, Appendix M focuses on connections to the Standards for Literacy in Science and Technical Subjects, which only cover grades 6–12. Therefore this appendix likewise only lists connections for grades 6–12. The K–12 ELA connections that are currently listed in the NGSS connection boxes will also be added to this appendix in the near future. See the Common Core State Standards website for more information about the Literacy standards: http://www.corestandards.org/ELA-Literacy.

[1] Many thanks to the contributions of Susan Pimentel in the development of this document..

Science and Engineering Practice: Asking Questions and Defining Problems

Students at any grade level should be able to ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from their models or scientific investigations. For engineering, they should ask questions to define the problem to be solved and to elicit ideas that lead to the constraints and specifications for its solution. (NRC *Framework* 2012, p. 56)

Supporting CCSS Literacy Anchor Standards and Relevant Portions of the Corresponding Standards for Science and Technical Subjects	Connection to Science and Engineering Practice
CCR Reading Anchor #1: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. • **RST.6-8.1**: "…support analysis of science and technical texts." • **RST.9-10.1**: "…support analysis of science and technical texts, attending to the precise details of explanations or descriptions." • **RST.11-12.1**: "…support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account."	Evidence plays a critical role in the kinds of questions asked, information gathered, and findings reported in science and technical texts. The notion of close reading in Reading Standard 1 emphasizes the use of asking and refining questions in order to answer them with evidence that is either explicitly stated or implied.
CCR Reading Anchor #7: Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. • **RST.6-8.7**: "Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table)." • **RST.9-10.7**: "Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. • **RST.11-12.7**: "…evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem."	Scientists and engineers present data in a myriad of visual formats in order to reveal meaningful patterns and trends. Reading Standard 7 speaks directly to the importance of asking questions about and evaluating data presented in different formats.
CCR Reading Anchor #8: Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence. • **RST.6-8.8**: "Distinguish among facts, reasoned judgment based on research findings, and speculation..." • **RST.9-10.8**: "Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem." • **RST.11-12.8**: "Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information."	Challenging or clarifying scientific hypotheses, arguments, experiments or conclusions—and the evidence and premises that support them—are key to this practice. Reading Standard 8 emphasizes evaluating the validity of arguments and whether the evidence offered backs up the claims logically.

CCR Writing Anchor #7: Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. • **RST.6-8.7**: "…answer a question (including a self-generated question)…generating additional related, focused questions that allow for multiple avenues of exploration." • **RST.9-12.7**: "…narrow or broaden inquiry when appropriate…"	Generating focused questions and well-honed scientific inquiries are key to conducting investigations and defining problems. The research practices reflected in Writing Standard 7 reflect the skills needed for successful completion of such research-based inquiries.
CCR Speaking & Listening Anchor #1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • **SL.8.1**: "…Pose…specific questions by making comments that contribute to the discussion…" • **SL.9-10.1**: "... posing and responding to questions that relate the current discussion to broader themes or larger ideas…" • **SL.11-12.1**: "…posing and responding to questions that probe reasoning and evidence…"	The ability to pose relevant questions, clarify or elaborate on the ideas of others or request information from others are crucial to learning and conducting investigations in science class. Speaking and Listening Standard 1 speaks directly to the importance of asking and refining questions to clarify ideas that generate solutions and explanations.
CCR Speaking & Listening Anchor #3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. • **SL.8.3**: "…evaluating the soundness of the reasoning and sufficiency of the evidence, and identifying when irrelevant evidence is introduced." • **SL.9-10.3**: "…identifying fallacious reasoning or exaggerated or distorted evidence." • **SL.11-12.3**: "…assessing the stance, premises, links among ideas, word choice, points of emphasis."	Evaluating the soundness of a speaker's reasoning and evidence concerning scientific theories and concepts through a series of inquiries teaches students to be discriminating thinkers. Speaking and Listening Standard 3 directly asserts that students must be able to critique a point of view from the perspective of the evidence provided and reasoning advanced.

Science and Engineering Practice: Planning and Carrying Out Investigations

Students should have opportunities to plan and carry out several different kinds of investigations during their K-12 years. At all levels, they should engage in investigations that range from those structured by the teacher—in order to expose an issue or question that they would be unlikely to explore on their own (e.g., measuring specific properties of materials)—to those that emerge from students' own questions. (NRC *Framework*, 2012, p. 61)

Supporting CCSS Literacy Anchor Standards and Relevant Portions of the Corresponding Standards for Science and Technical Subjects	Connection to Science and Engineering Practice
CCR Reading Anchor #3: Analyze how and why individuals, events, or ideas develop and interact over the course of a text. • **RST.6-8.3**: "Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks." • **RST.9-10.3**: "Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text." • **RST.11-12.3**: "Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text."	Systematic investigations in the field or laboratory lie at the heart of scientific inquiry. Reading Standard 8 emphasizes the importance of accuracy in carrying out such complex experiments and procedures, in following a course of action that will provide the best evidence to support conclusions.
CCR Writing Anchor #7: Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.	Planning and carrying out investigations to test hypotheses or designs is central to scientific and engineering activity. The research practices reflected in Writing Standard 7 reflect the skills needed for successful completion of such research-based inquiries.
CCR Writing Anchor #8: Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. • **WHST.6-8.8**: "... quote or paraphrase the data and conclusions of others..." • **WHST.9-10.8**: "...assess the usefulness of each source in answering the research question..." • **WHST.11-12.8**: "...assess the strengths and limitations of each source in terms of the specific task, purpose, and audience..."	Collecting relevant data across a broad spectrum of sources in a systematic fashion is a key element of this scientific practice. Writing Standard 8 spells out the importance of gathering applicable information from multiple reliable sources to support claims.
CCR Speaking & Listening Anchor #1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • **SL.8.1**: "Come ... having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion...define individual roles as	Carrying out investigations in collaborative settings is crucial to learning in science class and engineering settings. Speaking and Listening

needed." • **SL.9-10.1**: "Come…having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas… make new connections in light of the evidence and reasoning presented." • **SL11-12.1**: "…determine what additional information or research is required to deepen the investigation or complete the task."	Standard 1 speaks directly to the importance of exchanging theories and evidence cooperatively and collaboratively to carrying out investigations.

Science and Engineering Practice: Analyzing and Interpreting Data

Once collected, data must be presented in a form that can reveal any patterns and relationships and that allows results to be communicated to others. Because raw data as such have little meaning, a major practice of scientists is to organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data—and their relevance—so that they may be used as evidence.

Engineers, too, make decisions based on evidence that a given design will work; they rarely rely on trial and error. Engineers often analyze a design by creating a model or prototype and collecting extensive data on how it performs, including under extreme conditions. Analysis of this kind of data not only informs design decisions and enables the prediction or assessment of performance but also helps define or clarify problems, determine economic feasibility, evaluate alternatives, and investigate failures. (NRC *Framework*, 2012, p. 61-62)

Supporting CCSS Literacy Anchor Standards and Relevant Portions of the Corresponding Standards for Science and Technical Subjects	Connection to Science and Engineering Practice
CCR Reading Anchor #7: Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. • **RST.6-8.7**: "Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table)." • **RST.9-10.7**: "Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. • **RST.11-12.7**: "…evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem."	Scientists and engineers present data in a myriad of visual formats in order to reveal meaningful patterns and trends. Reading Standard 7 speaks directly to the importance of understanding and presenting information that has been gathered in various formats to reveal patterns and relationships and allow for deeper explanations and analyses.
CCR Reading Anchor #9: Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. • **RST.6-8.9**: "Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic." • **RST.9-10.9**: "Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts." • **RST.11-12.9**: "Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible."	Scientists and engineers use technology to allow them to draw on multiple sources of information in order to create data sets. Reading Standard 9 identifies the importance of analyzing multiple sources in order to inform design decisions and create a coherent understanding of a process or concept.
CCR Speaking and Listening #2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • **SL.8.2**: "Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally)…"	Central to the practice of scientists and engineers is integrating data drawn from multiple sources in order to create a cohesive vision of what the data means. Speaking and Listening Standard 2

• **SL.9-10.2**: "Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source." • **SL.11-12.2**: "…evaluating the credibility and accuracy of each source and noting any discrepancies among the data."	addresses the importance of such synthesizing activities to building knowledge and defining and clarifying problems. This includes evaluating the credibility and accuracy of data and identifying possible sources of error.
CCR Speaking and Listening #5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. • **SL.8.5**: "Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence..." • **SL.9-12.5**: "Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence…"	Presenting data for the purposes of cross-comparison is essential for identifying the best design solution or scientific explanation. Speaking and Listening Standard 5 stresses the importance of visual displays of data within presentations in order to enhance understanding of the relevance of the evidence. That way others can make critical decisions regarding what is being claimed based on the data.

Science and Engineering Practice: Constructing Explanations and Designing Solutions	
Asking students to demonstrate their own understanding of the implications of a scientific idea by developing their own explanations of phenomena, whether based on observations they have made or models they have developed, engages them in an essential part of the process by which conceptual change can occur. In engineering, the goal is a design rather than an explanation. The process of developing a design is iterative and systematic, as is the process of developing an explanation or a theory in science. Engineers' activities, however, have elements that are distinct from those of scientists. These elements include specifying constraints and criteria for desired qualities of the solution, developing a design plan, producing and testing models or prototypes, selecting among alternative design features to optimize the achievement of design criteria, and refining design ideas based on the performance of a prototype or simulation. (NRC *Framework*, 2012, p. 68-69)	
Supporting CCSS Literacy Anchor Standards and Relevant Portions of the Corresponding Standards for Science and Technical Subjects	**Connection to Science and Engineering Practice**
CCR Reading Anchor #1: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. • **RST.6-8.1**: "…support analysis of science and technical texts." • **RST.9-10.1**: "…support analysis of science and technical texts, attending to the precise details of explanations or descriptions." • **RST.11-12.1**: "…support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account."	Evidence plays a critical role in determining a theory in science and a design solution in engineering. The notion of close reading in Reading Standard 1 emphasizes pursing investigations into well-supported theories and design solutions on the basis of evidence that is either explicitly stated or implied.
CCR Reading Anchor #2: Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. • **RST.6-8.2:** "…provide an accurate summary of the text distinct from prior knowledge or opinions." • **RST.9-10.2:** "…trace the text's explanation or depiction of a complex process, phenomenon, or concept…" • **RST.11-12.2:** "…summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms."	Part of the power of a scientific theory or engineering design is its ability to be cogently explained. That ability to determine and clearly state an idea lies at the heart of Reading Standard 2.
CCR Reading Anchor #8: Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence. • **RST.6-8.8**:"Distinguish among facts, reasoned judgment based on research findings, and speculation..." • **RST.9-10.8**: "Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem." • **RST.11-12.8**: "Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the	Constructing theories and designing solutions both require analysis that is rooted in rational argument and in evidence stemming from an understanding of the world. Reading Standard 8 emphasizes evaluating the validity of arguments and whether the

data when possible and corroborating or challenging conclusions with other sources of information."	evidence offered backs up the claim logically.
CCR Writing Anchor #2: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. • **WHST.6-8.2**: "…Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples…" • **WHST.9-10.2**: "…Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic…" • **WHST.11-12.2**: "…Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic…"	Building a theory or a model that explains the natural world requires close attention to how to weave together evidence from multiple sources. With a focus on clearly communicating complex ideas and information by critically choosing, arranging, and analyzing information, Writing Standard 2 requires students to develop theories with the end goal of explanation in mind.
CCR Writing Anchor #8: Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. • **WHST.6-8.8**: "… quote or paraphrase the data and conclusions of others…" • **WHST.9-10.8**: "…assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas …" • **WHST.11-12.8**: "…assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas …"	Collecting relevant data across a broad spectrum of sources in a systematic fashion is a key element of constructing a theory with explanatory power or a design that meets multiple constraints. Writing Standard 8 spells out the importance of gathering applicable information from multiple reliable sources in order to construct well-honed explanations.
CCR Writing Anchor #9: Draw evidence from literary or informational texts to support analysis, reflection, and research. • **WHST.6-12.9**: "Draw evidence from informational texts to support analysis, reflection, and research."	The route towards constructing a rigorous explanatory account centers on garnering the necessary empirical evidence to support a theory or design. That same focus on generating evidence that can be analyzed is at the heart of Writing Standard 9.
CCR Speaking and Listening Anchor #4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.	A theory in science and a design in engineering is a rational explanatory account of how the world works in light

• **SL.8.4**: "Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning…" • **SL.9-10.4**: "Present information, findings, and supporting evidence clearly, concisely, and logically…" • **SL.11-12.4**: "Present information, findings, and supporting evidence, conveying a clear and distinct perspective… alternative or opposing perspectives are addressed…"	of the evidence. Speaking and Listening Standard 4 stresses how the presentation of findings crucially relies on how the evidence is used to illuminate the line of reasoning embedded in the explanation offered.

Science and Engineering Practice: Engaging in Argument from Evidence

The study of science and engineering should produce a sense of the process of argument necessary for advancing and defending a new idea or an explanation of a phenomenon and the norms for conducting such arguments. In that spirit, students should argue for the explanations they construct, defend their interpretations of the associated data, and advocate for the designs they propose. (NRC *Framework*, 2012, p. 73)

Supporting CCSS Literacy Anchor Standards and Relevant Portions of the Corresponding Standards for Science and Technical Subjects	Connection to Science and Engineering Practice
CCR Reading Anchor #6: Assess how point of view or purpose shapes the content and style of a text. • **RST.6-8.6**: "Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text." • **RST.9-10.6**: "Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address." • **RST.11-12.6**: "Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved."	The central motivation of scientists and engineers is to put forth what they believe is the best explanation for a natural phenomena or design solution, and to verify that representation through well wrought arguments. Understanding the point of view of scientists and engineers and how that point of view shapes the content of the explanation is what Reading Standard 6 asks students to attune to.
CCR Reading Anchor #8: Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence. • **RST.6-8.8**: "Distinguish among facts, reasoned judgment based on research findings, and speculation..." • **RST.9-10.8**: "Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem." • **RST.11-12.8**: "Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information."	Formulating the best explanation or solution to a problem or phenomenon stems from advancing an argument whose premises are rational and supported with evidence. Reading Standard 8 emphasizes evaluating the validity of arguments and whether the evidence offered backs up the claim logically.
CCR Reading Anchor #9: Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. • **RST.6-8.9**: "Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic." • **RST.9-10.9**: "Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts."	Implicit in the practice of identifying the best explanation or design solution is comparing and contrasting competing proposals. Reading Standard 9 identifies the importance of comparing different sources in the process of creating a

• **RST.11-12.9**: "Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible."	coherent understanding of a phenomenon, concept, or design solution.
CCR Writing Anchor #1: Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. • **WHST.6-8.1**: "…Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources…" • **WHST.9-10.1**: "…Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns…" • **WHST.11-12.1**: "…Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases…"	Central to the process of engaging in scientific thought or engineering practices is the notion that what will emerge is backed up by rigorous argument. Writing Standard 1 places argumentation at the heart of the CCSS for science and technology subjects, stressing the importance of logical reasoning, relevant evidence, and credible sources.
CCR Speaking & Listening Anchor #1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • **SL.8.1**: "… Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented." • **SL.9-10.1**: "…actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented." • **Sl.11-12.1**: "…Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task."	Reasoning and argument require critical listening and collaboration skills in order to identify the best explanation for a natural phenomenon or the best solution to a design problem. Speaking and Listening Standard 1 speaks directly to the importance of comparing and evaluating competing ideas through argument to cooperatively and collaboratively identify the best explanation or solution.
CCR Speaking & Listening Anchor #3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. • **SL.8.3**: "…evaluating the soundness of the reasoning and sufficiency of the evidence, and identifying when irrelevant evidence is introduced." • **SL.9-10.3**: "…identifying fallacious reasoning or exaggerated or distorted evidence." • **SL.11-12.3**: "…assessing the stance, premises, links among ideas, word choice, points of emphasis."	Evaluating the reasoning in an argument based on the evidence present is crucial for identifying the best design or scientific explanation. Speaking and Listening Standard 3 directly asserts that students must be able to critique the point of view within an argument presented orally from the perspective of

	the evidence provided and reasoning advanced by others.
CCR Speaking and Listening Anchor #4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. • **SL.8.4**: "Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning…" • **SL.9-10.4**: "Present information, findings, and supporting evidence clearly, concisely, and logically…" • **SL.11-12.4**: "Present information, findings, and supporting evidence, conveying a clear and distinct perspective… alternative or opposing perspectives are addressed…"	The practice of engaging in argument from evidence is a key ingredient in determining the best explanation for a natural phenomenon or the best solution to a design problem. Speaking and Listening Standard 4 stresses how the presentation of findings crucially relies on how the evidence is used to illuminate the line of reasoning embedded in the explanation offered.

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

Any education in science and engineering needs to develop students' ability to read and produce domain-specific text. As such, every science or engineering lesson is in part a language lesson, particularly reading and producing the genres of texts that are intrinsic to science and engineering. (NRC *Framework*, 2012, p. 76)

Supporting CCSS Literacy Anchor Standards and Relevant Portions of the Corresponding Standards for Science and Technical Subjects	Connection to Science and Engineering Practice
CCR Reading Anchor #2: Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. • **RST.6-8.2:** "…provide an accurate summary of the text distinct from prior knowledge or opinions." • **RST.9-10.2:** "…trace the text's explanation or depiction of a complex process, phenomenon, or concept…" • **RST.11-12.2:** "…summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms."	Part of the power of a scientific theory or engineering design is its ability to be cogently explained. That ability to determine and clearly state or summarize a salient scientific concept or phenomena lies at the heart of Reading Standard 2.
CCR Reading Anchor #7: Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. • **RST.6-8.7**: "Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table)." • **RST.9-10.7**: "Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. • **RST.11-12.7**: "…evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem."	A key practice within scientific and engineering communities is communicating about data through the use of tables, diagrams, graphs and models. Reading Standard 7 speaks directly to the importance of understanding information that has been gathered by investigators in visual formats that reveal deeper explanations and analyses.
CCR Reading Anchor #9: Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. • **RST.6-8.9**: "Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic." • **RST.9-10.9**: "Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts." • **RST.11-12.9**: "Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible."	The end goal of these scientific and engineering practices is to position scientists and engineers to be able to evaluate the merit and validity of claims, methods, and designs. Reading Standard 9 identifies the importance of synthesizing information from a range of sources to the process of creating a coherent understanding of a phenomenon or concept.

CCR Reading Anchor #10: Read and comprehend complex literary and informational texts independently and proficiently. • **RST.6-8.10:** "By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently." • **RST.9-10.10:** "By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently." • **RST.11-12.10:** "By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently."	When reading scientific and technical texts, students need to be able to gain knowledge from challenging texts that often make extensive use of elaborate diagrams and data to convey information and illustrate concepts. Reading Standard 10 asks students to read complex informational texts in these fields with independence and confidence.
CCR Writing Anchor #2: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. • **WHST.6-8.2**: "…include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension…Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples…" • **WHST.9-10.2**: "…include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension…Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic…" • **WHST.11-12.2**: "…include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension…Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic…"	The demand for precision in expression is an essential requirement of scientists and engineers, and using the multiple means available to them is a crucial part of that expectation. With a focus on clearly communicating complex ideas and information by critically choosing, arranging, and analyzing information—particularly through the use of visual means—Writing Standard 2 requires students to develop their claims with the end goal of explanation in mind.
CCR Writing Anchor #8: Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. • **WHST.6-8.8**: "…using search terms effectively…quote or paraphrase the data and conclusions of others…" • **WHST.9-10.8**: "…using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas …" • **WHST.11-12.8**: "…using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas …"	Collecting relevant data across a broad spectrum of sources in a systematic fashion is a key element of assessing the validity of claims, methods, and designs. Writing Standard 8 spells out the importance of gathering applicable information from multiple reliable sources so that information can be communicated accurately.
CCR Speaking & Listening Anchor #1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.	Reasoning and argument require critical listening and collaboration skills in order

• **SL.8.1**: "… Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented." • **SL.9-10.1**: "…actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented." • **SL11-12.1**: "…Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task."	to evaluate the merit and validity claims, methods, and designs. Speaking and Listening Standard 1 speaks directly to the importance of comparing and assessing competing ideas through extended discussions grounded in evidence.
CCR Speaking and Listening Anchor #4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. • **SL.8.4**: "Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning…" • **SL.9-10.4**: "Present information, findings, and supporting evidence clearly, concisely, and logically…" • **SL.11-12.4**: "Present information, findings, and supporting evidence, conveying a clear and distinct perspective… alternative or opposing perspectives are addressed…"	Central to the professional activity of scientists and engineers alike is communicating their findings clearly and persuasively. Speaking and Listening Standard 4 stresses how the presentation of findings crucially relies on how the evidence is used to illuminate the line of reasoning embedded in the explanation offered.
CCR Speaking and Listening #5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. • **SL.8.5**: "Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence..." • **SL.9-12.5**: "Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence…"	Presenting data for the purposes of communication is essential for evaluating the merit and validity of claims, methods, and designs. Speaking and Listening Standard 5 stresses the importance of visual or digital displays of data within presentations in order to enhance understanding of the evidence. That way others can make critical decisions regarding what is being claimed based on the data.

APPENDIX C: TECHNOLOGY INTEGRATION

Technology Integration

Hainesport Township School District is a Google Apps for Education (GAfE) district. GAfE is a core suite of productivity applications that Google offers to schools and educational institutions for free. These communication and collaboration apps such as Drive, Docs, and Slides, unlock access to a wide range of other collaborative tools supported by Google such as Classroom and Hangouts. All of these applications exist completely online, meaning that all creations can be accessed from any device with an internet connection. Google allows for enhanced workplace productivity and innovative classroom instruction and learning. Staff and students share and collaborate on documents, create interactive presentations, data spreadsheets, video/audio conferences, information surveys, event scheduling, web design, and much more with ease.

We believe technology should be utilized as a tool to scaffold student learning, facilitate student development of skills and strategies, support problem-solving efforts, and be a catalyst for critical and computational thinking. This must happen across the curriculum in ways that deepen and enhance the learning process. Leveraging technology provides the opportunity for students to become progressively active learners, problem solvers and creative thinkers. In other words, technology is a tool best utilized to assist students reach their learning goals.

Our vision is to build a culture of innovation grounded in trust and empowerment. We strive to create spaces where creativity, innovation and collaboration are fostered and valued, and where technology is used to redefine learning and promote responsible risk taking; therefore maximizing learning and potential. Teachers will empower learners to become creative communicators, empowered learners, computational thinkers, and innovative designers who create new and imaginative solutions using a variety of digital tools. Instruction is then focused on facilitating understanding, raising questions, and designing engaging tasks that encourage learning through a design process. In order for this to occur, we must pioneer instructional technologies but also find balance in a connected world by merging curriculum for digital citizenship with social-emotional learning. As the world accelerates around students, our vision is to ensure their digital well-being. All students need digital citizenship skills to be productive members of their community and make smart choices online.

To that end, the purposeful integration of technology is written into specific lessons and units of instruction throughout various curriculum areas. Attention is given to teaching the responsible use of and integration of technology in context so that students can readily apply technology skills and concepts to their work in various content areas. Further, the district annually purchases licensing for a few key subscriptions that are utilized to enhance learning such as BrainPop & BrainPop, Jr., Gizmos and PearDeck; these are utilized within units of instruction across the curriculum as well.

In the area of Science, technology is infused in units of study through the Engineering Practices as well as through the Connections to Engineering, Technology and Applications of Science (Interdependence of Science, Engineering, and Technology). A specific example in the grade 4 Matter and Energy unit of study, students are tasked with applying scientific ideas to plan, design, test, and refine a device/experiment that converts energy from one form to another. In this culminating task at the end of the unit, students apply their understanding of forms of energy, how it transforms from one type to another and that energy does work or creates change. Students utilize materials from previous investigations such as waterwheels, circuits and marbles to build their model and demonstrate it to the class.

These examples, along with others throughout the various units of instruction in this subject area, enable the following technology standards to be addressed:

21st Century Skills and Technology Integration (Standard 8) Check the appropriate boxes below for which strands (A through F) will be included.

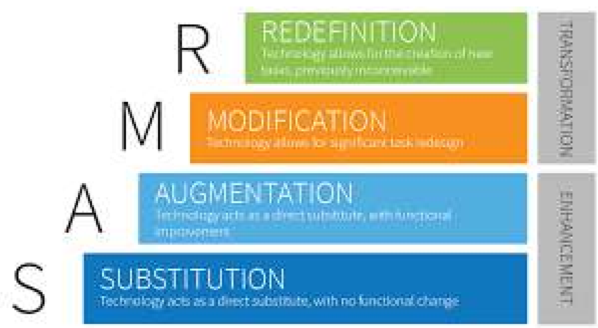
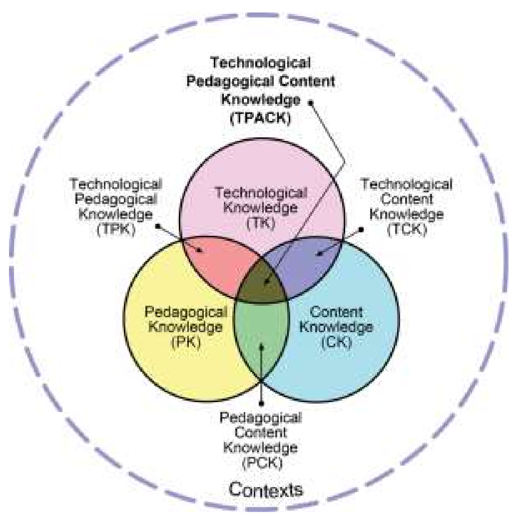
Standard 8.1		**Educational Technology:** *All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.*
X	**Strand A**	**Technology Operations and Concepts:** *Students demonstrate a sound understanding of technology concepts, systems and operations.*
X	**Strand B**	**Creativity and Innovation:** *Students demonstrate creative thinking, construct knowledge and develop innovative products and processes using technology.*
X	**Strand C**	**Communication and Collaboration:** *Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.*
X	**Strand D**	**Digital Citizenship:** *Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.*
X	**Strand E**	**Research and Information Fluency:** *Students apply digital tools to gather, evaluate, and use information.*
X	**Strand F**	**Critical thinking, problem solving, and decision making:** *Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.*
Standard 8.2		**Technology Education, Engineering, Design, and Computational Thinking - Programming:** *All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.*
X	**Strand A**	**The Nature of Technology: Creativity and Innovation:** *Technology systems impact every aspect of the world in which we live.*
X	**Strand B**	**Technology and Society:** *Knowledge and understanding of human, cultural and societal values are fundamental when designing technological systems and products in the global society.*
X	**Strand C**	**Design:** *The design process is a systematic approach to solving problems.*
X	**Strand D**	**Abilities for a Technological World:** *The designed world is the product of a design process that provides the means to convert resources into products and systems.*
X	**Strand E**	**Computational Thinking: Programming:** *Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.*

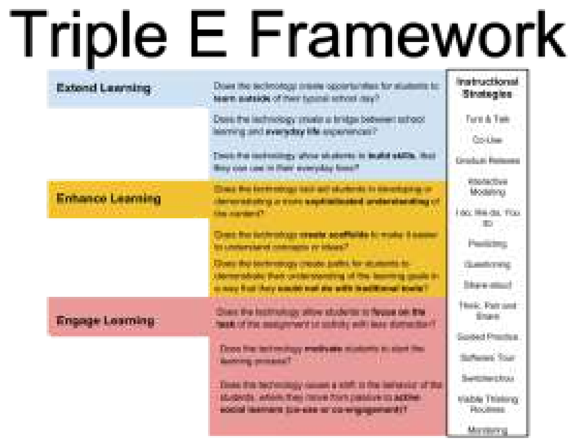
Additionally, ETSD offers technology classes as part of the related arts cycle starting in Kindergarten, taught by a certified teacher. The elementary technology curriculum contains consistent K-5 units of instruction including: Digital Citizenship, Literacy Connections, STEM Connections, Math Connections (Spreadsheets), Game Based Learning and Coding. The middle school curriculum also has consistent units spanning grades 6-8 with the following broad topics, which address the tech standards: Digital Applications, Spreadsheets, Database, Computational Thinking (Coding) and Digital Citizenship. For further elaborations on the technology standards, technology units of instruction, and to view the full [Technology Curriculum document click here and select technology.](#)

Technology Framework Models

Technology integration models remind us to support student use of technology for meaningful, authentic purposes. While each model boasts their version of essential elements of digital literacy, ETSD supports the culminating use of multiple models by teachers to best meet the needs of their students and the curriculum. The ultimate goal is to support teacher and student digital literacy as consumers and creators of technology, increase technology fluency, and promote critical thinking. As with any tool utilized by teachers, the intent is to approach it as a guide to support student learning. Focus is always and ultimately placed on the learning, not the tool. To this end, as students engage with the various technologies in the classroom, teachers are promoting engagement, collaboration, communication, and creativity to intrinsically motivate students.

Each of the models below stress the rethinking and redesign of how technology is used by teachers and students in the classroom. The models move away from productivity tools to more complex thinking and opportunities for personalized learning while also preserving the role of the teacher in education as vital and relevant.

Model	Components	Overview
SAMR	Substitution, Augmentation, Modification, Redefinition	
TPACK	Technological Pedagogical Content Knowledge	

Triple E	Engagement, Enhancement and Extension	

APPENDIX D: 21ST CENTURY LIFE AND CAREERS STANDARDS AND EXPECTATIONS FOR INTEGRATION

21st Century Life and Careers Standards and Expectations for Integration

In today's global economy, students need to be lifelong learners who have the knowledge and skills to adapt to an evolving workplace and world. To address these demands, Standard 9, 21st Century Life and Careers, establishes clear guidelines for what students need to know and be able to do in order to be successful in their future careers and to achieve financial independence.

In Hainesport, 21st century life and career skills focus on enabling students to make informed decisions that will prepare them to engage as active citizens in a dynamic global society and to successfully meet the challenges and opportunities of the 21st century global workplace. Therefore, these life and career skills are integrated across the K-8 curriculum in various subject areas, where appropriate. It is our goal to build a solid foundation for the high school that foster a population that:

- Continually self-reflects and seeks to improve the essential life and career practices that lead to success.
- Uses effective communication and collaboration skills and resources to interact with a global society.
- Is financially literate and financially responsible at home and in the broader community.
- Is knowledgeable about careers and can plan, execute, and alter career goals in response to changing societal and economic conditions.
- Seeks to attain skill and content mastery to achieve success in a chosen career path.

The Standards: Standard 9 is composed of the Career Ready Practices and Standard 9.1 and 9.2 which are outlined below:

- **Career Ready Practices**
  These following practices outline the skills that all individuals need to have to truly be adaptable, reflective, and proactive in life and careers. These are researched practices that are essential to career readiness.

  - CRP1. Act as a responsible and contributing citizen and employee.
  - CRP2. Apply appropriate academic and technical skills.
  - CRP3. Attend to personal health and financial well-being.
  - CRP4. Communicate clearly and effectively and with reason.
  - CRP5. Consider the environmental, social and economic impacts of decisions.
  - CRP6. Demonstrate creativity and innovation.
  - CRP7. Employ valid and reliable research strategies.
  - CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
  - CRP9. Model integrity, ethical leadership and effective management.
  - CRP10. Plan education and career paths aligned to personal goals.
  - CRP11. Use technology to enhance productivity.
  - CRP12. Work productively in teams while using cultural global competence.

- **9.1 Personal Financial Literacy**
  This standard outlines the important fiscal knowledge, habits, and skills that must be mastered in order for students to make informed decisions about personal finance. Financial literacy is an integral component of a student's college and career readiness, enabling students to achieve fulfilling, financially-secure, and successful careers.

- **9.2 Career Awareness, Exploration, and Preparation**
  This standard outlines the importance of being knowledgeable about one's interests and talents, and being well informed about postsecondary and career options, career planning, and career requirements.

The Career Ready Practices at Work:
Science Interdisciplinary Connection

"With ordinary talent and extraordinary perseverance, all things are attainable."
-Thomas Foxwell Buxton

Project-Based Learning Example:

> A science class has agreed to put on a biodiversity exposition. This will be held during class, recorded, and turned into a multimedia presentation. As part of the exposition, each student needs to select two design solutions based on a predetermined rubric. Then, the class will be split into groups of 3-4. The groups will have to select their top design solutions, and each student will have to write a justification saying why that solution is exemplary, using key ideas from the rubric (e.g., constraints could include scientific, economic, and social considerations). This will be done on a shared document. On the actual day of the expo, students will take on different roles, such as MC, audio, visual director, reader, questioner, timer, project director, etc. The final product will be available on the school news channel or on TeacherTube.

Applicable Standards:

Career Ready Practices -

CRP1. Act as a responsible and contributing citizen and employee.
CRP2. Apply appropriate academic and technical skills.
CRP4. Communicate clearly and effectively and with reason.
CRP5. Consider the environmental, social and economic impacts of decisions.
CRP6. Demonstrate creativity and innovation.
CRP7. Employ valid and reliable research strategies.
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Science -

ESS.2.A. Earth Materials and Systems
ESS.3.A. Natural Resources
ESS.3.C. Human Impacts on Earth Systems
ESS.3.D. Global Climate Change
LS.1.B. Growth and Development of Organisms
LS.2.A. Interdependent Relationships in Ecosystems
LS.2.C. Ecosystem Dynamics, Functioning, and Resilience
LS.4.C. Adaptation
LS.4.D. Biodiversity and Humans
PS.2.C. Stability and Instability in Physical Systems

Science and Engineering Practices -

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating and communicating information

Mathematics -

- NJSLS.MATH.PRACTICE.MP1. Make sense of problems and persevere in solving them.
- NJSLS.MATH.PRACTICE.MP2. Reason abstractly and quantitatively.
- NJSLS.MATH.PRACTICE.MP3. Construct viable arguments and critique the reasoning of others.
- NJSLS.MATH.PRACTICE.MP4. Model with mathematics.
- NJSLS.MATH.PRACTICE.MP5. Use appropriate tools strategically.
- NJSLS.MATH.PRACTICE.MP6. Attend to precision.

English Language Arts/Language Arts Literacy -

Anchor Standards for Language

Conventions of Standard English
- NJSLSA.L1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
- NJSLSA.L2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Knowledge of Language
- NJSLSA L3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

Vocabulary Acquisition and Use
- NJSLSA L4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.
- NJSLSA L5. Demonstrate understanding of word relationships and nuances in word meanings.
- NJSLSA L6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

Anchor Standards for Writing

Text Types and Purposes

- NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

Anchor Standards for Speaking and Listening

Comprehension and Collaboration

- NJSLSA.SL1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- NJSLSA.SL2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
- NJSLSA.SL3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

Presentation of Knowledge and Ideas

- NJSLSA.SL4. Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
- NJSLSA.SL5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.
- NJSLSA.SL6. Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

Technology -

- 8.1.8.A.1. Demonstrate knowledge of real world problems with digital tools.
- 8.1.8.A.3. Use and/or develop a simulation that provides an environment to solve a real world problem or theory.

The links below can be accessed by teachers to further elaborate on Standard 9 and identify areas across the curriculum where these concepts and skills are integrated into instruction.

CPIs to reach by grade 4

CPIs to reach by grade 8

APPENDIX E: RESOURCES

- *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*
- *Ready, Set, SCIENCE! Putting Research to Work in K-8 Science Classrooms*
- Educational Leadership. *Teaching the Value of Science* (Dec. 2014/Jan. 2015)
- Educational Leadership. *Reading About Real Scientists* (Dec. 2014/Jan. 2015)
- Educational Leadership. *In Step with the New Science Standards* (Dec. 2014/Jan. 2015)
- Science Scope. *EQuIP-ped for Success* (Jan. 2015)
- Educational Leadership: *Disciplinary Literacy: Just the FAQs* (Feb. 2017)