K-2 Sciences Curriculum Committee

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# 9-12 Communication Arts Curriculum

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District Mission

The City of St. Charles School District will REACH, TEACH, and EMPOWER all students by providing a challenging, diverse, and innovative education.

District Vision

The City of St. Charles School District will be an educational leader recognized for high performance and academic excellence that prepares students to succeed in an ever-changing global society.

District Values

We, the City of St. Charles School District community of students, parents, staff, and patrons, value:

- High quality education for all students which includes:
  - Lifelong learning from early childhood through adult education
  - Rigorous learning experiences that challenge all students
  - Instruction that meets the needs of a diverse community
  - Respect for all
  - Real world, critical thinking and problem-solving skills to prepare students for the 21st Century
  - Developing caring, productive, and responsible citizens
  - Strong engagement of family and community
  - A safe, secure, and nurturing school environment

- Achievement through:
  - Celebration of individual success
  - Collaboration with parents and community stakeholders
  - Exploration, Innovation, and creativity

- High quality staff by:
  - Hiring and retaining highly qualified and invested employees
  - Providing professional development and collaboration focused on increasing student achievement
  - Empowering staff to use innovative resources and practices

- Informed decisions that are:
  - Student-centered
  - Focused on student achievement
  - Data Driven
  - Considerate of all points of view
  - Fiscally responsible
District Goals

For planning purposes, five overarching goals have been developed. These goals are statements of the key functions of the school district.

1. **Student Performance**
   - Develop and enhance the quality educational/instructional programs to improve student performance and enable students to meet their personal, academic, and career goals.

2. **Highly qualified staff**
   - Recruit, attract, develop, and retain highly qualified staff to carry out the District’s mission, vision, goals, and objectives.

3. **Facilities, Support, and Instructional Resource**
   - Provide and maintain appropriate instructional resources, support services, and functional and safe facilities.

4. **Parent and Community Involvement**
   - Promote, facilitate and enhance parent, student, and community involvement in district educational programs.

5. **Governance**
   - Govern the district in an efficient and effective manner providing leadership and representation to benefit the students, staff, and patrons of the district.
School District Philosophical Foundations

Teachers in the School District of the City of St. Charles share in and ascribe to a philosophy that places children at the heart of the educational process. We feel that it is our professional responsibility to strive to be our best at all times and to maximize our efforts by ensuring that the following factors are present in our classrooms and our schools.

1. Learning is developed within the personal, physical, social, and intellectual contexts of the learner.
2. A strong educational program should provide developmental continuity.
3. The successful learner is motivated, strategic, knowledgeable, and interactive.
4. Children learn best when they have real purposes and can make connections to real life.
5. Effective learning is a combination of student exploration and teacher and mentor modeling.
6. Assessment is an ongoing and multidimensional process that is an integral part of instruction.
7. Making reading and writing connections across multiple sources and curricula facilitates meaning.
8. Literacy for the future means literacy in multiple technologies.
9. Education must respond to society’s diverse population and serve all children.
10. Interactions among students, teachers, parents, and community form the network that supports learning.
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K-12 Science Overview

Following the vision of Next Generation Science Standards’, A Framework for K-12 Science Education and the Missouri Learning Standards, the City of St. Charles Science Curriculum is intended to increase coherence in our K-12 science education and embed a STEM/STEAM connected approach through an inquiry based model. The following excerpt from the Framework explains this methodology 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, 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 allowing more time for teachers and students to explore each idea in greater depth. This gives time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented. Stating clearly 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 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.” – excerpted from NRC Framework for K-12 Science Education, 1-3
### Strand 5: Earth Systems & Strand 6: Universe Enduring Understandings Progression

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<td>The universe and its stars</td>
<td>Patterns of movement of the sun, moon, and stars as seen from Earth can be observed, described, and predicted</td>
<td>Stars range greatly in size and distance from Earth and this can explain their relative brightness</td>
<td>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</td>
<td>N/A</td>
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<tr>
<td>Earth and the solar system</td>
<td>N/A</td>
<td>The Earth’s orbit and rotation, and the orbit of the moon around the Earth cause observable patterns.</td>
<td>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. Observatories and space probes provide evidence for explanations of solar system formation and great distances in space.</td>
<td>N/A</td>
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<tr>
<td>The history of planet Earth</td>
<td>Some events on Earth occur very quickly; others can occur very slowly.</td>
<td>Certain features on Earth can be used to order events that have occurred in a landscape.</td>
<td>Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth’s early history.</td>
<td>N/A</td>
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<td>Earth materials and systems</td>
<td>Wind and water change the shape of the land.</td>
<td>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.</td>
<td>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.</td>
<td>N/A</td>
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<tr>
<td>Plate tectonics and large-scale system interactions</td>
<td>Maps show where things are located. One can map the shapes and kinds of land and water in any area.</td>
<td>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.</td>
<td>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.</td>
<td>N/A</td>
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<td><strong>The roles of water in Earth’s surface processes</strong></td>
<td><strong>Most of Earth’s water is in the ocean and much of the Earth’s fresh water is in glaciers or underground.</strong></td>
<td><strong>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.</strong></td>
<td><strong>The planet’s dynamics are greatly influenced by water’s unique chemical and physical properties.</strong></td>
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<td><strong>Weather and climate</strong></td>
<td><strong>Climate describes patterns of typical weather conditions over different scales and variations. Historical weather patterns can be analyzed.</strong></td>
<td><strong>Complex interactions determine local weather patterns and influence climate, including the role of the ocean.</strong></td>
<td><strong>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.</strong></td>
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<td><strong>Natural resources</strong></td>
<td><strong>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.</strong></td>
<td><strong>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.</strong></td>
<td><strong>Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.</strong></td>
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<td><strong>Natural hazards</strong></td>
<td><strong>A variety of hazards result from natural processes; humans cannot eliminate hazards but can reduce their impacts.</strong></td>
<td><strong>Mapping the history of natural hazards in a region and understanding related geological forces.</strong></td>
<td><strong>Natural hazards and other geological events have shaped the course of human history at local, regional, and global scales.</strong></td>
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<td><strong>Human impacts on Earth systems</strong></td>
<td><strong>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.</strong></td>
<td><strong>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.</strong></td>
<td><strong>Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies.</strong></td>
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<td><strong>Global climate change</strong></td>
<td><strong>N/A</strong></td>
<td><strong>Human activities affect global warming. Decisions to reduce the impact of global warming depend on understanding climate science, engineering capabilities, and social dynamics.</strong></td>
<td><strong>Global climate models used to predict changes continue to be improved, although discoveries about the global climate system are ongoing and continually needed.</strong></td>
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<td>Structure and function</td>
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<tr>
<td>All organisms have external parts that they use to perform everyday functions.</td>
<td>Organisms have both internal and external macroscopic structures that allow for growth, survival, behavior, and reproduction.</td>
<td>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.</td>
<td>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.</td>
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<tr>
<td>Growth and development of organisms</td>
<td>Parents and offspring often engage in behaviors that help the offspring survive.</td>
<td>Reproduction is essential to every kind of organism. Organisms have unique and diverse life cycles.</td>
<td>Animals engage in behaviors that increase the odds of reproduction. An organism’s growth is affected by both genetic and environmental factors.</td>
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<td>Organization for matter and energy flow in organisms</td>
<td>Animals obtain food they need from plants or other animals. Plants need water and light.</td>
<td>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.</td>
<td>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.</td>
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<td>Information Processing</td>
<td>Animals sense and communicate information and respond to inputs with behaviors that help them grow and survive.</td>
<td>Different sense receptors are specialized for particular kinds of information; Animals use their perceptions and memories to guide their actions.</td>
<td>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.</td>
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<td>Interdependent relationships in ecosystems</td>
<td>Plants depend on water and light to grow, and also depend on animals for pollination or to move their seeds around.</td>
<td>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.</td>
<td>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.</td>
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<td>Cycles of matter and energy transfer in ecosystems</td>
<td>N/A</td>
<td>Matter cycles between the air and soil and among organisms as they live and die.</td>
<td>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.</td>
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<td>Strand 3: Living Organisms &amp; Strand 4: Ecology Enduring Understandings Progression</td>
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INCREASING SOPHISTICATION OF STUDENT THINKING
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<td>N/A</td>
<td>When the environment changes some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die.</td>
<td>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.</td>
<td>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.</td>
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<td>Inheritance of traits</td>
<td>Young organisms are very much, but not exactly, like their parents and also resemble other organisms of the same kind.</td>
<td>Genes chiefly regulate a specific protein, which affect an individual’s traits.</td>
<td>DNA carries instructions for forming species’ characteristics. Each cell in an organism has the same genetic content, but genes expressed by cells can differ</td>
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<td>Variation of traits</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
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<td>Evidence of common ancestry and diversity</td>
<td>Some living organisms resemble organisms that once lived on Earth. Fossils provide evidence about the types of organisms and environments that existed long ago.</td>
<td>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.</td>
<td>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.</td>
<td></td>
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<tr>
<td>Natural selection</td>
<td>Differences in characteristics between individuals of the same species provide advantages in surviving and reproducing.</td>
<td>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.</td>
<td>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.</td>
<td></td>
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<td>Adaptation</td>
<td>Particular organisms can only survive in particular environments.</td>
<td>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.</td>
<td>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.</td>
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<td>Biodiversity and humans</td>
<td>A range of different organisms lives in different places.</td>
<td>Populations of organisms live in a variety of habitats. Change in those habitats affects the organisms living there.</td>
<td>Changes in biodiversity can influence humans’ resources and ecosystem services they rely on.</td>
<td>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.</td>
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**Strand 1: Matter and Energy & Strand 2: Force and Motion Enduring Understandings Progression**

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<th>Definitions of energy</th>
<th>Conservation of energy and energy transfer</th>
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<tr>
<td>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.</td>
<td>Heating and cooling substances cause changes that are sometimes reversible and sometimes not.</td>
<td>Pushes and pulls can have different strengths and directions, and can change the speed or direction of its motion or start or stop it.</td>
<td>Pushes and pulls can have different strengths and directions, and can change the speed or direction of its motion or start or stop it.</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>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.</td>
<td>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.</td>
<td>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.</td>
<td>Forces that act at a distance involve fields that can be mapped by their relative strength and effect on an object.</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>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.</td>
<td>Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>Relationship between energy and forces</td>
<td>Bigger pushes and pulls cause bigger changes in an object’s motion or shape.</td>
<td>When objects collide, contact forces transfer energy so as to change the objects’ motions.</td>
<td>When two objects interact, each one exerts a force on the other, and these forces can transfer energy between them.</td>
<td>Fields contain energy that depends on the arrangement of the objects in the field.</td>
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<tr>
<td>Energy in chemical processes and everyday life</td>
<td>Sunlight warms Earth’s surface.</td>
<td>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.</td>
<td>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.</td>
<td>Photosynthesis is the primary biological means of capturing radiation from the sun; energy cannot be destroyed, it can be converted to less useful forms.</td>
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</tr>
<tr>
<td>Wave properties</td>
<td>Sound can make matter vibrate, and vibrating matter can make sound.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Electromagnetic radiation</td>
<td>Objects can be seen only when light is available to illuminate them.</td>
<td>Object can be seen when light reflected from their surface enters our eyes. Patterns can encode, send, receive and decode information.</td>
<td>The construct of a wave is used to model how light interacts with objects.</td>
<td>Both an electromagnetic wave model and a photon model explain features of electromagnetic radiation broadly and describe common applications of electromagnetic radiation.</td>
<td></td>
</tr>
<tr>
<td>Information technologies and instrumentation</td>
<td>People use devices to send and receive information.</td>
<td>Waves can be used to transmit digital information. Digitized information is comprised of a pattern of 1s and 0s.</td>
<td>Large amounts of information can be stored and shipped around as a result of being digitized.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Adapted from The Next Generation Science Standards and The Missouri Learning Standards*
Kindergarten Curriculum
UNIT TITLE: Changes in Ecosystems and Interactions of Organisms with their Environments

CONTENT AREA: Physical Science

COURSE: Kindergarten Science

UNIT DURATION: 2 weeks

MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:
- Nonfiction Text on the different seasons
- Pictures cards of weather and seasons
- Discovery Science Techbook: Cycles in Nature Unit
- Access to Brainpop Jr.
- Thermometer

BIG IDEA(S):
- Organisms are interdependent with one another and their environment.

ENDURING UNDERSTANDINGS:
- All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem.

ESSENTIAL QUESTIONS:
- How do people and animals behave during each season?
- How do plants change in different seasons?

WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit.</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1.A.a</td>
<td>Describe how the seasons affect the behavior of plants and animals.</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>4.1.A.b</td>
<td>Describe how the seasons affect the everyday life of humans (e.g., clothing, activities)</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>5.2.F.a</td>
<td>Observe and describe daily weather: precipitation (e.g., snow, rain, sleet, fog), wind (i.e., light breezes to strong wind), cloud cover, temperature</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>5.2.F.b</td>
<td>Observe and describe the general weather conditions that occur during each season</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>6.2.C.a</td>
<td>Observe and describe the characteristics of the four seasons as they cycle through the year (summer, fall, winter, spring)</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>7.1.A.a</td>
<td>Pose questions about objects, materials, organisms and events in the environment</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>7.1.B.a</td>
<td>Make qualitative observations using the five senses</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>7.1.C.c</td>
<td>Compare explanations with prior knowledge</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>7.1.C.d</td>
<td>Communicate observations using words, pictures, and numbers</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>7.1.D.a</td>
<td>Communicate observations using words, pictures, and number</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

OBJECTIVE # 1

REFERENCES/STANDARDS
- 4.1.A.a, 4.1.A.b, 5.2.F.a, 5.2.F.b, 6.2.C.a, 7.1.A.a, 7.1.B.a, 7.1.C.a, 7.1.C.c, 7.1.C.d

WHAT SHOULD STUDENTS KNOW?
- Facts, Names, Dates, Places, Information

ACADEMIC VOCABULARY
- seasons (summer, fall, winter, spring)
- plants

WHAT SHOULD STUDENTS UNDERSTAND?
- Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.

- All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem.

WHAT SHOULD STUDENTS BE ABLE TO DO?
- Skills; Products

- Describe how the seasons affect the behavior of plants and animals.
<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Such as: Teacher will... (provide possible examples of teacher involvement)</td>
<td>Such as: Students will... (provide possible examples)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
<tr>
<td>- The teacher will use the lesson: <em>Four Seasons</em> (Cycles in Nature) from Discovery Education Science Techbook to teach concepts</td>
<td>- Students will read books about the four seasons.</td>
<td>DOK 1 and 2</td>
</tr>
<tr>
<td>- The teacher will read nonfiction text about each season.</td>
<td>- Students will discuss how animals and plants respond to changing seasons.</td>
<td></td>
</tr>
<tr>
<td>- The teacher will describe how animals and plants respond to changing seasons.</td>
<td>- Students will review the life cycle of plants</td>
<td></td>
</tr>
<tr>
<td>- The teacher will explain how plants and animals adapt to each season.</td>
<td>- Students will interact with Brainpop Jr. activities to learn about the four seasons</td>
<td></td>
</tr>
<tr>
<td>- The teacher will review the life cycle of a plant.</td>
<td>- Students will sort seasonal pictures into the appropriate season.</td>
<td></td>
</tr>
<tr>
<td>- The teacher will provide opportunities for students to sort pictures of each season.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The teacher could use Brainpop Jr. as a resource to teach the four seasons.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The teacher could bring in examples of clothing for each season and have students sort the clothing into the correct season.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The teacher could review the season during calendar and weather.</td>
<td>- Students will review seasons during calendar and weather</td>
<td></td>
</tr>
</tbody>
</table>

**INTERDISCIPLINARY CONNECTION**
- Shared Reading
- Read Alouds
- Social Studies
- Math (Calendar/Weather)

**PRIOR KNOWLEDGE CONNECTIONS**
- Weather changes
- What should students already know coming in?

**CONNECTIONS TO STRANDS 7 &/OR 8**
- Communicate observations using words, pictures, and numbers
- Pose questions about objects, materials, organisms and events in the environment
- Make qualitative observations using the 5 senses.
- Compare explanations with prior knowledge
- Use observations as support for reasonable explanations

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

**ASSESSMENT DESCRIPTION**
- The teacher will observe students knowledge of each season during Calendar and Weather.
- The teacher will have students sort seasonal pictures into the correct season (i.e. trees from season to season, swimming suits, winter coats, hibernating animals).

**ASSESSMENT TYPE?**
(i.e. formative, summative, obtrusive, unobtrusive, etc.)

- Formative, Unobtrusive Assessment
- Summative, obtrusive assessment

**DOK TARGET**
(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK Level 1
- DOK Level 2

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

**TEACHER INSTRUCTIONAL ACTIVITY**
- The teacher could provide opportunities for students to look at pictures of

**STUDENT LEARNING TASK**
- The students could look at pictures of each season and match the weather to the

**DOK TARGET**
(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK Level 1
- The teacher can use the interactive glossary from Discovery Techbook to teach students difficult concepts.
- The teacher could provide opportunities for students to discuss different activities they do in each season.

The students could discuss different activities they do in each season and draw pictures of the activities.

<table>
<thead>
<tr>
<th>HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Possible Extensions/Enrichments</strong></td>
</tr>
<tr>
<td><strong>INSTRUCTIONAL ACTIVITY/METHOD</strong></td>
</tr>
<tr>
<td>The teacher could have students compare and contrast each season and how plants and animals are affected by the seasons.</td>
</tr>
<tr>
<td><strong>STUDENT LEARNING TASK</strong></td>
</tr>
<tr>
<td>The student could use a venn diagram to compare and contrast one season to another and how plants and animals are affected by the seasons</td>
</tr>
<tr>
<td><strong>DOK TARGET</strong> (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
<tr>
<td>DOK Level 3</td>
</tr>
</tbody>
</table>

DOK Level 1
**MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:**
- Nonfiction texts about the Earth, Sun, Moon and other celestial bodies
- Posters, picture cards, and/or models of the Earth, Sun, and Moon.
- Discovery Science Techbook: Cycles in Nature Unit
- Oreos

**BIG IDEA(S):**
- The universe has observable properties and structure
- Regular and predictable motions of objects in the universe can be described and explained as the result of gravitational forces

**ENDURING UNDERSTANDINGS:**
- The Earth, Sun, and Moon are part of a larger system that includes other planets and smaller celestial bodies
- The apparent position of the Sun and other stars, as seen from Earth, change in observable patterns
- The apparent position of the moon, as seen from Earth, and its actual position relative to Earth change in observable patterns
- The regular and predictable motions of the Earth and Moon relative to the Sun explain natural phenomena on Earth, such as day, month, year, shadows, moon phases, eclipses, tides, and seasons

**ESSENTIAL QUESTIONS:**
- How does the position of the sun and other stars change when seen from Earth?
- How does the moon's position change when seen from Earth?
- How do motions of the Earth, Moon and Sun explain the natural phenomena on Earth, such as day, month, year, shadows, moon phases, eclipses, tides and seasons.

**WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?**

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit.</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.e. GLE/CLE/MLS/NGSS</td>
<td>Be sure to include connections to strands 7 &amp; 8 as supporting standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1.A.a</td>
<td>Observe and describe the presence of the Sun, Moon, and stars in the sky</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1.A.b</td>
<td>Observe there are more stars in the sky than anyone can count and that they are scattered unevenly and vary in brightness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2.A.a</td>
<td>Describe the Sun as only being seen in the daytime and appears to move across the sky from morning to night</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2.B.a</td>
<td>Observe the Moon can be seen sometimes at night and sometimes during the daytime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2.C.a</td>
<td>Observe that the Moon appears to change shape over the course of a month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.A.b</td>
<td>Conduct a simple investigation (fair test) to answer a question</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.B.b</td>
<td>Make observations using simple tools and equipment (e.g., magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.C.b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.C.c</td>
<td>Compare explanations with prior knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.C.d</td>
<td>Communicate observations using words, pictures, and numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1.B.a</td>
<td>Describe how tools have helped scientists make better observations (i.e., magnifiers)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OBJECTIVE #1**
- The universe has observable properties and structure

**REFERENCES/STANDARDS**
- 6.1.A.a, 6.1.A.b, 6.2.A.a, 6.2.B.a, 6.2.C.a, 7.1.A.a, 7.1.B.a, 7.1.C.a, 7.1.C.c, 7.1.C.d
### WHAT SHOULD STUDENTS KNOW?

**Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY**

- sun
- moon
- stars
- sky

### UNDERSTAND?

**Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.**

- The Earth, Sun, and Moon are part of a larger system that includes other planets and smaller celestial bodies

### BE ABLE TO DO?

**Skills; Products**

- Students will be able to explain that the Earth, Sun, and Moon are part of a larger system that includes other planets and smaller celestial bodies

### FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Such as: Teacher will...(provide possible examples of teacher involvement)</td>
<td>Such as: Students will...(provide possible examples)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
<tr>
<td>Teacher will use the Lesson: Day and Night Cycle (Cycles in Nature) from Discovery Science Techbook to teach the concepts.</td>
<td>Students will listen to and read nonfiction books about the solar system.</td>
<td>DOK: 1, 2 and 3</td>
</tr>
<tr>
<td>Teacher will read nonfiction books about the solar system.</td>
<td>Students will partake in discussion about the Sun and Moon.</td>
<td></td>
</tr>
<tr>
<td>Teacher will use KWL charts to lead discussions on the Sun and Moon.</td>
<td>Students will draw pictures of different objects that appear in the Day and Night sky.</td>
<td></td>
</tr>
<tr>
<td>Teacher will provide examples of objects that appear in the Day and Night sky.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher will show examples of the different phases of the moon.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher could provide opportunities for students to watch Branipop Jr. videos on the Sun and Moon.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Students could use Oreos to show the different phases of the moon.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**3-2-1 Blast Off**

(Primary Science That To Learn About The Solar System)
Students could watch Brainpop Jr. videos on the Sun and Moon.

**INTERDISCIPLINARY CONNECTION**
- Shared Reading
- Read Alouds
- Social Studies
- Math (Calendar/Weather)

**PRIOR KNOWLEDGE CONNECTIONS**
(What should students already know coming in?)
- It is light during the day and dark at night.

**CONNECTIONS TO STRANDS 7 &/OR 8**
- Communicate observations using words, pictures, and numbers
- Compare explanations with prior knowledge
- Use observations as support for reasonable explanations
- Use observations to describe relationships and patterns and to make predictions to be tested

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

**ASSESSMENT DESCRIPTION**
- The teacher will observe students knowledge of each season during Calendar and Weather.
- The teacher will have students sort pictures of the sun, moon, stars, rainbow, planets, etc. into either Day time sky, Night time sky or both

**ASSESSMENT TYPE?**
(i.e. formative, summative, obtrusive, unobtrusive, etc.)
- Formative, Unobtrusive Assessment
- Summative, obtrusive assessment

**DOK TARGET**
(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)
- DOK Level 1
- DOK Level 2
## HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?

**Possible Interventions**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher will use games, songs and books to teach the concept of Sun and Moon</td>
<td>Students will play games, sing songs and read books about the Sun and Moon.</td>
<td>DOK Level 1</td>
</tr>
</tbody>
</table>

## HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?

**Possible Extensions/Enrichments**

<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher will explain how the objects in the sky create seasons on Earth. The Earth revolves around the sun, the seasons change in a predictable pattern. Teacher could have children chart moon observations every night for 5 days and share finding with the class</td>
<td>Students will create a four column chart and label the columns: Fall, Winter, Spring, Summer. Students will list changes that happen in each season where they live. Student will chart moon observations every night for 5 days and share findings with the class.</td>
<td>DOK Level 3 DOK Level 4</td>
</tr>
</tbody>
</table>
UNIT TITLE: Properties and Principles of Matter and Energy

CONTENT AREA: Physical Science

COURSE: Kindergarten Science

MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:
- Attribute blocks
- Pan Balance
- Everyday Mathematics Book
- Discovery Science Techbook: Physical Properties of Matter Unit
- Five Senses Books

BIG IDEA(S):
- Changes in properties and states of matter provide evidence of the atomic theory of matter.
- Energy has a source, can be stored, and can be transferred but is conserved within a system.

ENDURING UNDERSTANDINGS:
- Objects, and the materials they are made of, have properties that can be used to describe and classify them.
- Forms of energy have a source, a means transfer (work and heat), and a receiver.

ESSENTIAL QUESTIONS:
- How can we classify and describe objects and materials according to their properties?
- How can you describe energy as a receiver, a mean of transfer or a source of heat?

WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

<p>| STANDARDS: Content specific standards that will be addressed in this unit. |</p>
<table>
<thead>
<tr>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe physical properties of objects (i.e., size, shape, color, mass) by using the senses, simple tools (e.g., magnifiers, equal arm balances), and/or nonstandard measures (e.g., bigger/smaller; more/less)</td>
<td></td>
</tr>
<tr>
<td>1.1.A.a</td>
<td></td>
</tr>
<tr>
<td>Identify materials (e.g., cloth, paper, wood, rock, metal) that make up an object and some of the physical properties of the materials (e.g., color, texture, shiny/dull, odor, sound, taste, flexibility)</td>
<td></td>
</tr>
<tr>
<td>1.1.A.c</td>
<td></td>
</tr>
<tr>
<td>Identify the sounds and their source of vibrations in everyday life (e.g., alarms, car horns, animals, machines, musical instruments)</td>
<td></td>
</tr>
<tr>
<td>1.2.A.a</td>
<td></td>
</tr>
<tr>
<td>Compare different sounds (i.e., loudness, pitch, rhythm)</td>
<td></td>
</tr>
<tr>
<td>1.2.A.b</td>
<td></td>
</tr>
<tr>
<td>Identify the ear as a receiver of vibrations that produce sound</td>
<td></td>
</tr>
<tr>
<td>1.2.A.c</td>
<td></td>
</tr>
<tr>
<td>Pose questions about objects, materials, organisms and events in the environment</td>
<td></td>
</tr>
<tr>
<td>7.1.A.a</td>
<td></td>
</tr>
<tr>
<td>Conduct a simple investigation (fair test) to answer a question</td>
<td></td>
</tr>
<tr>
<td>7.1.A.b</td>
<td></td>
</tr>
<tr>
<td>Make qualitative observations using the five senses</td>
<td></td>
</tr>
<tr>
<td>7.1.B.a</td>
<td></td>
</tr>
<tr>
<td>Make observations using simple tools and equipment (e.g., magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
<td></td>
</tr>
<tr>
<td>7.1.B.b</td>
<td></td>
</tr>
<tr>
<td>Measure length and mass using non-standard units</td>
<td></td>
</tr>
<tr>
<td>7.1.B.c</td>
<td></td>
</tr>
<tr>
<td>Compare amounts/measurements</td>
<td></td>
</tr>
<tr>
<td>7.1.C.a</td>
<td></td>
</tr>
<tr>
<td>Use observations as support for reasonable explanations</td>
<td></td>
</tr>
<tr>
<td>7.1.C.b</td>
<td></td>
</tr>
<tr>
<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
<td></td>
</tr>
<tr>
<td>7.1.C.c</td>
<td></td>
</tr>
<tr>
<td>Communicate observations using words, pictures, and numbers</td>
<td></td>
</tr>
<tr>
<td>7.1.C.d</td>
<td></td>
</tr>
<tr>
<td>Observe and identify that some objects occur in nature (natural objects); others have been designed and made by people</td>
<td></td>
</tr>
<tr>
<td>7.1.A.a</td>
<td></td>
</tr>
<tr>
<td>Describe how tools have helped scientists make better observations (i.e., magnifiers)</td>
<td></td>
</tr>
<tr>
<td>8.1.B.a</td>
<td></td>
</tr>
</tbody>
</table>
## OBJECTIVE # 1

Changes in properties and states of matter provide evidence of the atomic theory of matter


## WHAT SHOULD STUDENTS KNOW?

**Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY**

- size, shape, color, mass, bigger/smaller, more/less

## WHAT SHOULD STUDENTS UNDERSTAND?

**Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.**

- Objects, and the materials they are made of, have properties that can be used to describe and classify them.

## BE ABLE TO DO?

**Skills; Products**

- Describe physical properties of objects (i.e., size, shape, color, mass) by using the senses, simple tools (e.g., magnifiers, equal arm balances), and/or nonstandard measures (e.g., bigger/smaller; more/less)
- Sort objects based on observable physical properties (e.g., size, material, color, shape, mass)

### FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>SUCH AS: Teacher will...(provide possible examples of teacher involvement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher will use Sorting Object (Physical Properties of Matter) lesson from Discovery Science Techbook.</td>
<td></td>
</tr>
<tr>
<td>Teacher will provide objects for students to sort based on observable physical properties (e.g., size, shape, material, color, shape, mass).</td>
<td></td>
</tr>
<tr>
<td>Teacher will have students go on a nature walk.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STUDENT LEARNING TASK</th>
<th>SUCH AS: Students will...(provide possible examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will sort objects according to observable physical properties (attributes).</td>
<td></td>
</tr>
<tr>
<td>Students will sort collections of objects they find in nature</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOK TARGET</th>
<th>1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOK 2</td>
<td></td>
</tr>
<tr>
<td>INTERDISCIPLINARY CONNECTION</td>
<td>PRIOR KNOWLEDGE CONNECTIONS (What should students already know coming in?)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| ● Everyday Math (Kindergarten):  
  Lesson 4-1: Attribute Blocks  
  Lesson 7-6: Pan Balance:  
  Leveling  
  Lesson 9-8: Uniform Weights on a Pan Balance  
  Attribute Blocks  
  Shapes  
  Bigger and Smaller | ● Colors  
  ● Shapes  
  ● Bigger and Smaller | ● Tools like the arm balance are used to make observations and drive thinking throughout experiments.  
  ● Forms of standard and nonstandard measurement can be used to describe physical properties of objects |

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

<table>
<thead>
<tr>
<th>ASSESSMENT DESCRIPTION</th>
<th>ASSESSMENT TYPE? (i.e. formative, summative, obtrusive, unobtrusive, etc.)</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Observation</td>
<td>● Formative unobtrusive</td>
<td>● DOK Level 2</td>
</tr>
</tbody>
</table>

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

**Teacher Instructional Activity**  
● Teacher will provide opportunities for students to use outstretched arms to show heavier and lighter objects.

**Student Learning Task**  
● Children discuss the pan balance and use outstretched arms to show heavier and lighter objects.

**DOK Target**  
● DOK Level 2

**HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?**

**Possible Extensions/Enrichments**

<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
</table>
| ● Teacher will provide opportunities for students to balance objects using nonstandard units | ● Student will sort objects by two attributes and explain their thinking  
  ● Children balance objects using nonstandard units | ● DOK Level 2                                             |
**OBJECTIVE # 2**

Changes in properties and states of matter provide evidence of the atomic theory of matter

**REFERENCES/STANDARDS**

i.e. GLE/CLE/MLS/NGSS


**WHAT SHOULD STUDENTS KNOW?**

Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY

- size, shape, color, mass, rigid, flexible

**UNDERSTAND?**

Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.

- Objects, and the materials they are made of, have properties that can be used to describe and classify them.
- Identify materials (e.g., cloth, paper, wood, rock, metal) that make up an object and some of the physical properties of the materials (e.g., color, texture, shiny/dull, odor, sound, taste, flexibility)
- Sort objects based on observable physical properties (e.g., size, material, color, shape, mass)

**BE ABLE TO DO?**

Skills; Products

- Identify materials (e.g., cloth, paper, wood, rock, metal) that make up an object and some of the physical properties of the materials (e.g., color, texture, shiny/dull, odor, sound, taste, flexibility)
- Sort objects based on observable physical properties (e.g., size, material, color, shape, mass)

**FACILITATING ACTIVITIES — STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

**TEACHER INSTRUCTIONAL ACTIVITY**

Such as: Teacher will... (provide possible examples)

- Teacher will use *Flexibility and Rigidity (Physical Properties of Matter)* Lesson from *Discovery Science Techbook*.

**STUDENT LEARNING TASK**

Such as: Students will... (provide possible examples)

- Students will sort flexible and rigid objects

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK Level 2

**INTERDISCIPLINARY CONNECTION**

Prior Knowledge Connections (What should students already know coming in?)

- Everyday Math

**PRIOR KNOWLEDGE CONNECTIONS**

Students communicate observation of other students work (i.e. sorting mats).

- 7.1.A.a Pose questions about each others sorting mats.

**CONNECTIONS TO STRANDS 7 &/OR 8**

- Everyday Math

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

**ASSESSMENT DESCRIPTION**

(i.e. formative, summative, obtrusive, unobtrusive, etc.)

- Observations of sorting mats

**ASSESSMENT TYPE?**

- formative

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK Level 2

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

Possible Interventions

**TEACHER INSTRUCTIONAL ACTIVITY**

- Teacher will review attributes (i.e., shapes, colors)
- Teacher will provide students with opportunities to sort objects by color or shape.

**STUDENT LEARNING TASK**

- Students will review colors and shapes through books and/or music.
- Students will sort objects according to color or shape.

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK Level 1

**HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?**

Possible Extensions/Enrichments

**INSTRUCTIONAL ACTIVITY/METHOD**

- Teacher will provide opportunity for students to sort more than one attribute and explain their thinking.

**STUDENT LEARNING TASK**

- Student will sort objects by more than one attribute (i.e. shape and color) and explain their thinking.

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK Level 2
**OBJECTIVE # 3**

Energy has a source, can be stored, and can be transferred but is conserved within a system.

**REFERENCES/STANDARDS**

i.e. GLE/CLE/MLS/NGSS

- 1.2.A.a, 1.2.A.b, 1.2.A.c, 7.1.A.a, 7.1.A.b, 7.1.B.a, 7.1.B.b, 7.1.B.c, 7.1.B.d, 7.1.C.a, 7.1.C.b, 7.1.C.c, 7.1.D.a, 8.1.A.a, 8.1.B.a,

**WHAT SHOULD STUDENTS...**

<table>
<thead>
<tr>
<th>KNOW?</th>
<th>UNDERSTAND?</th>
<th>BE ABLE TO DO?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY</td>
<td>Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.</td>
<td>Skills; Products</td>
</tr>
<tr>
<td>● compare, identify, investigate</td>
<td>● Forms of energy have a source, a means of transfer (work and heat), and a receiver</td>
<td>● Identify the sounds and their source of vibrations in everyday life (e.g., alarms, car horns, animals, machines, musical instruments)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Compare different sounds (i.e., loudness, pitch, rhythm)</td>
</tr>
</tbody>
</table>

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Such as: Teacher will... (provide possible examples)</td>
<td>Such as: Students will... (provide possible examples)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
<tr>
<td>● Teacher will provide examples of different sounds and their source (i.e., animals, machines, musical instruments)</td>
<td>● Students will play sound BINGO <a href="http://mattgomez.com/sound-bingo/">http://mattgomez.com/sound-bingo/</a></td>
<td>● DOK Level 2</td>
</tr>
<tr>
<td>● Teacher will provide activities for students to learn about the sense of hearing.</td>
<td>● Students will create individual 5 senses labeling chart</td>
<td></td>
</tr>
<tr>
<td>● Teacher will create a 5 senses labeling anchor chart with class</td>
<td>● Students will make 5 senses book</td>
<td></td>
</tr>
</tbody>
</table>

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

- **Teacher Instructional Activity**
  - Teacher will provide examples of different sounds and their source (i.e., animals, machines, musical instruments)
  - Teacher will provide activities for students to learn about the sense of hearing.
  - Teacher will create a 5 senses labeling anchor chart with class

- **Student Learning Task**
  - Students will play sound BINGO [http://mattgomez.com/sound-bingo/](http://mattgomez.com/sound-bingo/)
  - Students will create individual 5 senses labeling chart
  - Students will make 5 senses book

**DOK Target**

- 1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking
Students will complete 5 senses labeling activity

<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
<th>PRIOR KNOWLEDGE CONNECTIONS (What should students already know coming in?)</th>
<th>CONNECTIONS TO STRANDS 7 &amp;/OR 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Studies (5 senses)</td>
<td>n/a</td>
<td>7.1.A.a Pose questions about where sound originates</td>
</tr>
</tbody>
</table>
### HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?

<table>
<thead>
<tr>
<th>ASSESSMENT DESCRIPTION</th>
<th>ASSESSMENT TYPE? (i.e. formative, summative, obtrusive, unobtrusive, etc.)</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Observations of students playing sound BINGO</td>
<td>• formative unobtrusive</td>
<td>DOK Level 2</td>
</tr>
<tr>
<td>• 5 senses labeling activity</td>
<td>• summative obtrusive</td>
<td></td>
</tr>
</tbody>
</table>

### HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Teacher will provide opportunities for students to play with various objects that produce sounds (i.e., bells, buzzers, whistles)</td>
<td>• Student will experiment with various objects that produce sound (i.e. bells, buzzers, whistles)</td>
<td>DOK Level 1</td>
</tr>
</tbody>
</table>

### HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?

<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Teacher will provide opportunities for students to investigate ways to change the loudness of a sound.</td>
<td>• Student will investigate ways in which to change the loudness of a sound and explain their thinking (i.e. cover a buzzer to decrease the loudness)</td>
<td>DOK Level 3</td>
</tr>
</tbody>
</table>
MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:

- Fiction and Nonfiction texts on plants and animals
- Animal Matching Cards
- Plant labeling anchor chart and worksheet
- Discovery Science Techbook: Living Organisms Unit

BIG IDEA(S):

- There is a fundamental unity underlying the diversity of all living organisms.
- There is a genetic basis for the transfer of biological characteristics from one generation to the next through productive processes

ENDURING UNDERSTANDINGS:

- Plants and animals have different structures that serve similar functions necessary for the survival of the organism
- There is heritable variation within every species of organism

ESSENTIAL QUESTIONS:

- How do plants and animals structures differ and how are their functions necessary for the survival of the organism?
- Why is there a heritable variation within every species of organism?

WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit. Be sure to include connections to strands 7 &amp; 8 as supporting standards</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.D.a</td>
<td>Observe and compare the structures and behaviors of different kinds of plants and animals</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.3.D.a</td>
<td>Identify that living things have offspring based on the organisms' physical similarities and differences</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.A.a</td>
<td>Pose questions about objects, materials, organisms and events in the environment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.B.a</td>
<td>Make qualitative observations using the five senses</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.C.b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.D.a</td>
<td>Communicate observations using words, pictures, and numbers</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>8.1.B.a</td>
<td>Describe how tools have helped scientists make better observations (i.e., magnifiers)</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
### OBJECTIVE # 1
There is a fundamental unity underlying the diversity of all living organisms

**REFERENCES/STANDARDS**
i.e. GLE/CLE/MLS/NGSS

### WHAT SHOULD STUDENTS...

<table>
<thead>
<tr>
<th>KNOW?</th>
<th>UNDERSTAND?</th>
<th>BE ABLE TO DO?</th>
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</thead>
<tbody>
<tr>
<td>Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY</td>
<td>Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.</td>
<td>Skills; Products</td>
</tr>
</tbody>
</table>

- observe
- compare
- identify
- similarities
- differences
- Plants and animals have different structures that serve similar functions necessary for the survival of the organism
- There is a heritable variation within every species of organism
- Students will be able to observe and compare the structures and behaviors of different kinds of plants and animals
- Students will be able to identify that living things have offsprings based on the organisms’ physical similarities and differences

### FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Such as: Teacher will... (provide possible examples of teacher involvement)</td>
<td>Such as: Students will... (provide possible examples)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
</tbody>
</table>

- The teacher will read fiction and nonfiction text during shared reading with topics on plants and animals.
- Teacher will provide opportunities for students to match pictures animals to their offsprings.
- Teacher will provide opportunities for students to label parts of a plant and body parts of animals.
- Teacher will use the *Living Organism Unit* from Discovery Science Techbook to teach the concept.
- Students will match animals and their offsprings through the use of pictures and games.
- Students will label parts of a plant and body parts of animals.
- Students will compare animals and discuss their physical similarities and differences.
- DOK Level 1
- DOK Level 2
| INTERDISCIPLINARY CONNECTION | PRIOR KNOWLEDGE CONNECTIONS  
(What should students already know coming in?) | CONNECTIONS TO STRANDS 7 &/OR 8 |
|-----------------------------|-------------------------------------------------|
| • shared reading            | • Communicate observations using words, pictures, and numbers  
• Pose questions about objects, materials, organisms and events in the environment |

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

| ASSESSMENT DESCRIPTION | ASSESSMENT TYPE?  
(i.e. formative, summative, obtrusive, unobtrusive, etc.) | DOK TARGET  
(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking) |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Teacher observations</td>
<td>formative/unobtrusive</td>
</tr>
<tr>
<td>• Animal/offspring picture matching</td>
<td>summative/obtrusive</td>
</tr>
<tr>
<td>• plant labeling</td>
<td></td>
</tr>
</tbody>
</table>

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

| TEACHER INSTRUCTIONAL ACTIVITY | STUDENT LEARNING TASK  
(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking) |
|------------------------------|---------------------------------------------------------------------|
| • Teacher will provide additional opportunities for students to name animal characteristics.  
• Teacher will provide additional opportunities for students to match animals and their offsprings, with a fewer number of animals to match.  
• Teacher will provide additional opportunities for students to name and label parts of a plant, with a fewer amount of parts to label. | • Students will match a fewer number of animal to their offsprings.  
• Students will label parts of a plant, pumpkin, apple, and animal they are very familiar with. |
| • Teacher will provide additional opportunities for student to label parts of plant and animals without providing the parts of the plant/animal.  
• Teacher will provide opportunities for student to tell similarities and differences between an animal and their offspring. | • Student will label parts of plant and animal without any labels provided to them.  
• Student will compare different plants and animals and tell their similarities and differences. |

**HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?**

| INSTRUCTIONAL ACTIVITY/METHOD | STUDENT LEARNING TASK  
(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking) |
|-----------------------------|---------------------------------------------------------------------|
| • Teacher will provide additional opportunities for student to label parts of plant and animals without providing the parts of the plant/animal.  
• Teacher will provide opportunities for student to tell similarities and differences between an animal and their offspring. | • Student will label parts of plant and animal without any labels provided to them.  
• Student will compare different plants and animals and tell their similarities and differences. |
**CONTENT AREA:** Earth Science

**COURSE:** Kindergarten Science

---

**MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:**
- Monthly calendar
- Class weather graph
- Months of the year displayed
- Thermometer
- Discovery Science Techbook: Air and Weather Unit

**BIG IDEA(S):**
- Earth’s systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures
- Earth’s systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes

**ENDURING UNDERSTANDINGS:**
- Climate is a description of average weather conditions in a given area due to the transfer of energy and matter through Earth’s systems

**ESSENTIAL QUESTIONS:**
- What observations can be made about wind as moving air that is felt?
- How is daily weather described?

---

**WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?**

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>5.1.C.a</td>
<td>Observe wind as moving air that is felt</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5.1.F.a</td>
<td>Observe and describe daily weather: precipitation (e.g., snow, rain, sleet, fog), wind (i.e., light breezes to strong wind), cloud cover, temperature</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5.1.F.b</td>
<td>Observe and describe the general weather conditions that occur during each season</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.B.d</td>
<td>Compare amounts/measurements</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1.D.a</td>
<td>Communicate observations using words, pictures, and numbers</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>8.3.A.b</td>
<td>Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member (Assess Locally)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**OBJECTIVE # 1**

Changes in properties and states of matter provide evidence of the atomic theory of matter

**REFERENCES/STANDARDS**

i.e. GLE/CLE/MLS/NGSS

- 5.1.C.a
- 5.1.F.a
- 5.1.F.b
- 7.1.B.d
- 7.1.C.a
- 7.1.D.a
- 8.3.A.b

**WHAT SHOULD STUDENTS KNOW?**

Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY

- weather, seasons, precipitation, temperature, thermometer, graph, wind, cloud, cloud cover

**UNDERSTAND?**

Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.

- Understand that the weather is constantly changing

**BE ABLE TO DO?**

Skills; Products

- Recognize different examples of weather conditions.
- Students will collect, organize, and analyze weather and temperature data over time.
- Students will discuss and record weather observations. Students will read the outdoor thermometer (or gather temperature data from another source), show the temperature using the class thermometer.
- Students will count and compare the number of days of each type of weather.

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

**TEACHER INSTRUCTIONAL ACTIVITY**

Such as: Teacher will... (provide possible examples of teacher involvement)

- Teacher will use the Unit: Air and Weather from Discovery Science Techbook to teach the concepts.
- Teacher will provide opportunities for students to discuss and record weather observations. Teacher will read outdoor thermometer with students. Once a month teacher will provide opportunities for students to compile data and describe the months weather and temperature trends.
- Teacher will ask questions such as: How many sunny days were there this month?
- Were there more sunny days or cloudy day?

**STUDENT LEARNING TASK**

Such as: Students will... (provide possible examples)

- Students will discuss and record weather observations.
- Students will compile weather data

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK 1 and DOK 2

**INTERDISCIPLINARY CONNECTION**

- Everyday Math Calendar and Weather Routines

**PRIOR KNOWLEDGE CONNECTIONS**

(What should students already know coming in?)

- hot, cold, rain, snow

**CONNECTIONS TO STRANDS 7 &/OR 8**

- Communicate observations using words, pictures, and numbers
- Forms of standard and nonstandard measurement can be used to describe physical properties of objects

**ASSESSMENT DESCRIPTION**

**ASSESSMENT TYPE?**

(i.e. formative, summative, obtrusive, unobtrusive, etc.)

- Observations during Calendar and Weather routines

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK 1 and DOK 2

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

Possible Interventions

- Teacher will provide opportunities for students to to draw the weather conditions daily.
- Teacher will continue modeling daily weather graph and ask questions related to current weather.

**TEACHER INSTRUCTIONAL ACTIVITY**

Such as: Teacher will... (provide possible examples of teacher involvement)

- Teacher will provide opportunities for students to to draw the weather conditions daily.
- Teacher will continue modeling daily weather graph and ask questions related to current weather.

**STUDENT LEARNING TASK**

Such as: Students will... (provide possible examples)

- Students will draw the weather conditions daily and add it to the calendar and weather graph.
- Students will associate appropriate clothing for weather conditions.

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK Level 2
<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Teacher will provide opportunities for students to apply knowledge to study the effect of weather on human and animal activity and plant growth.</td>
<td>● Students will apply knowledge and skills learned from weather observation and investigations to study the effect on human and animal activity and plant growth.</td>
<td>● DOK Level 2</td>
</tr>
</tbody>
</table>
Grade 1 Curriculum
### Science Curriculum Units of Study

**CONTENT AREA:** Science  
**COURSE:** Grade 1  
**UNIT TITLE:** Living Organisms  
**UNIT DURATION:**

#### MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:
- Items that we get from plants: fabric, cotton balls, sugar, paper, etc. **optional activity**
- Note cards - (to write vocabulary words on and practice with a partner)
- Books - *The Tree Farmer* by Chuck Leavell, *The Fruits we Eat* by Gail Gibbons,
- Use of reading-a-z.com (membership required) for guided readers and shared reading projectable books.

#### BIG IDEA(S):
- Organisms are interdependent with one another and with their environment

#### ENDURING UNDERSTANDINGS:
- All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem

#### ESSENTIAL QUESTIONS:
- How can we use plants for food? Clothing? Shelter?  
- How can we use animals for food? Clothing? Shelter?

#### WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit. Be sure to include connections to strands 7 &amp; 8 as supporting standards</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1.A.a</td>
<td>Identify ways man depends on plants and animals for food, clothing, and shelter</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>7.1.A.a</td>
<td>Pose questions about objects, materials, organisms, and events in the environment</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>7.1.C.b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>7.1.C.c</td>
<td>Compare explanations with prior knowledge</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>7.1.D.a</td>
<td>Communicate simple procedures and results of investigations and explanations through: oral presentations drawings and maps data tables graphs (bar, pictograph) writings</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

**OBJECTIVE # 1**  
Organisms are interdependent with one another and with their environment

**REFERENCES/STANDARDS**  
*i.e. GLE/CLE/MLS/NGSS*  
- 4.1.A.a, 7.1.A.a, 7.1.C.a, 7.1.C.b, 7.1.C.c, 7.1.C.d

**KNOW?**  
Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY

- **Vocabulary:** depend, food, clothing, shelter, needs, wants

**UNDERSTAND?**  
Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.

- All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem

**BE ABLE TO DO?**  
Skills; Products

- Students will identify ways man depends on plants and animals for food, clothing, and shelter.  
- EX. Student will be able to describe and compare the physical properties of objects.  
- Student will be able to classify objects as “one kind of material”
### Facilitating Activities – Strategies and Methods for Teaching and Learning

<table>
<thead>
<tr>
<th>Teacher Instructional Activity</th>
<th>Student Learning Task</th>
<th>DOK Target</th>
</tr>
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<tbody>
<tr>
<td>Teacher will ask students to think about different things that come from plants. Brainstorming ideas like the wood on a desk comes from a tree. Teacher can hand out items like cotton balls, vegetables, fabric, maple syrup, sugar packet, paper, perfumed vegetable soap, flowers, etc. asking students to think about how we use these plant items.</td>
<td>Students will write down how many things they can find around the classroom that are made from plants. Students will group items as categories of shelter, food, clothing, or other.</td>
<td>DOK level 2</td>
</tr>
</tbody>
</table>

**- More lesson plan ideas listed here**
- [http://pbskids.org/eekoworld//parentteachers/lessons3_2.html-food chain activity](http://pbskids.org/eekoworld//parentteachers/lessons3_2.html-food chain activity)

### Interdisciplinary Connection

<table>
<thead>
<tr>
<th>Prior Knowledge Connections</th>
<th>Connections to Strands 7 &amp;/or 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needs and wants is also taught through the social studies curriculum. For interactive read aloud, read the book <em>The Tree Farmer</em> by Chuck Leavell-Challenged by his grandson as to how he can grow beautiful trees only to cut them down, the tree farmer shares his knowledge and understanding of trees as a renewable resource. For interactive read aloud, read the book <em>The Fruits we Eat</em> by Gail Gibbons. Shared reading book “Needs and Wants” on Readinga-z.com (Level F). This book could also be printed and multiple copies used for guided reading groups. Shared reading book “Where animals live” on readinga-z.com (level E). This book could also be printed and multiple copies used for guided reading groups. Shared reading book “The Food We eat” on readinga-z.com (level G). This book could also be printed and multiple copies used for guided reading groups.</td>
<td>In Kindergarten, students should have learned how the seasons affect the behavior of plants and animals. Humans, plants, and animals have needs in order to survive.</td>
</tr>
</tbody>
</table>

### How Do We Know What Students Have Learned?

<table>
<thead>
<tr>
<th>Assessment Description</th>
<th>Assessment Type?</th>
<th>DOK Target</th>
</tr>
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<tbody>
<tr>
<td>Teacher will observe the student’s understanding. And give a grade based off observations. The students are only supposed to “identify” ways people use plants and animals, so it doesn’t have to be a lengthy assessment.</td>
<td>unobtrusive</td>
<td>DOK 2</td>
</tr>
</tbody>
</table>

### How Will We Respond If Students Have Not Learned?

<table>
<thead>
<tr>
<th>Teacher Instructional Activity</th>
<th>Student Learning Task</th>
<th>DOK Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher could facilitate a new discussion on needs of humans and how we use plants and animals to meet those needs. Teacher could chart out what humans need and have students come up with things and sort them into categories. During a reading group, the teacher could find a set of books relating to this topic.</td>
<td>Students could participate in a new discussion on needs of humans and how they relate to plants/animals. Students could practice teaching each other the vocabulary and words through cooperative learning groups and cards for quizzing.</td>
<td>DOK 2</td>
</tr>
<tr>
<td>INSTRUCTIONAL ACTIVITY/METHOD</td>
<td>STUDENT LEARNING TASK</td>
<td>DOK TARGET</td>
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<tr>
<td>-------------------------------</td>
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<tr>
<td>Teacher could facilitate a discussion about other ways that organisms interact with the environment such as pollination, seed dispersal, camouflage, and migration. Teacher could read books or start a discussion about different types of ecosystems such as forests, ponds, and prairies.</td>
<td>Students could read about and discuss other ways that organisms interact with the environment such as pollination, seed dispersal, camouflage, and migration. Students could read or watch a video about different types of ecosystems such as forests, ponds, and prairies. They could learn about the animals of these ecosystems and how they work.</td>
<td>DOK 2</td>
</tr>
</tbody>
</table>
## Course: Science

### Grade: 1

### Content Area: Force and Motion

<table>
<thead>
<tr>
<th>MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:</th>
<th>BIG IDEA(S):</th>
</tr>
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<tbody>
<tr>
<td>● hot wheel cars</td>
<td>● The motion of an object is described by its change in position relative to another object or point.</td>
</tr>
<tr>
<td>● marbles</td>
<td>● Forces affect motion.</td>
</tr>
<tr>
<td>● paint</td>
<td></td>
</tr>
<tr>
<td>● variety of objects for dropping experiment</td>
<td></td>
</tr>
<tr>
<td>● rubberbands</td>
<td></td>
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<tr>
<td>● straws</td>
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<tr>
<td>● ramping materials-pool noodles, cardboard, pipe, wooden blocks</td>
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</tr>
<tr>
<td>● Books - Moving Fast and Slow (on discovery ed.), Roller Coaster! By: Marla Frazee, Move It! by Adrienne Mason, Forces Make Things Move by Kimberly Bradley</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENDURING UNDERSTANDINGS:</th>
<th>ESSENTIAL QUESTIONS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● The motion of an object is described as a change in position, direction, and speed relative to another object.</td>
<td>● How do different forces affect an object’s motion?</td>
</tr>
<tr>
<td>● Forces are classified as either contact (pushes, pulls and friction) or non-contact forces that can be described in terms of direction and magnitude.</td>
<td>● Why is a force classified as a push and pull?</td>
</tr>
<tr>
<td>● Newton’s Laws of Motion explain the interaction of mass and forces, and are used to predict changes in motion.</td>
<td>● How can motions be altered?</td>
</tr>
<tr>
<td></td>
<td>● How can objects move faster/slower?</td>
</tr>
</tbody>
</table>
### WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

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<tr>
<th>REFERENCE/STANDARD</th>
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<tr>
<td>i.e. GLE/CLE/MLS/NGSS</td>
<td>Be sure to include connections to strands 7 &amp; 8 as supporting standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.A.a</td>
<td>Compare the position of an object relative to another object (e.g., left of or right of)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.1.A.b</td>
<td>Describe an object’s motion as straight, circular, vibrating (back and forth), zigzag, stopping, starting, or falling</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.1.A.c</td>
<td>Compare the speeds (faster vs. slower) of two moving objects</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2.A.a</td>
<td>Identify the force (i.e., push or pull) required to do work (move an object)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2.D.a</td>
<td>Describe ways to change the motion of an object (i.e., how to cause an object to go slower, go faster, go farther, change direction, stop)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.A.a</td>
<td>Pose questions about objects, materials, organisms, and events in the environment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.A.b</td>
<td>Plan and conduct a simple investigation (fair test) to answer a question</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.B.a</td>
<td>Make qualitative observations using the five senses.</td>
<td>X</td>
<td></td>
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<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations</td>
<td>X</td>
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<td>7.1.C.b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested.</td>
<td>X</td>
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<td>7.1.D.a</td>
<td>Communicate simple procedures and results of investigations and explanations through: oral presentations, drawings and maps, data tables, graphs (bar, pictograph), writings</td>
<td>X</td>
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<tr>
<td>8.3.A.b</td>
<td>Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member</td>
<td>X</td>
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**OBJECTIVE # 1**
The motion of an object is described by its change in position relative to another object or point.

**REFERENCES/STANDARDS**
- GLE/CLE/MLS/NGSS

**WHAT SHOULD STUDENTS...**

<table>
<thead>
<tr>
<th>KNOW?</th>
<th>UNDERSTAND?</th>
<th>BE ABLE TO DO?</th>
</tr>
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</table>
| **Facts, Names, Dates, Places, Information,**
  **ACADEMIC VOCABULARY**

  Vocabulary: straight, circular, vibrating, zigzag, positional words (left of or right of), force, push, pull

  * The motion of an object is described as a change in position, direction, and speed relative to another object (frame of reference)

  * Concept; essential truths that give meaning to the topic; ideas that transfer across situations.

  - Students will be able to compare the position of an object relative to another object (e.g., left of or right of).
  - Students will be able to describe an object’s motion as straight, circular, vibrating (back and forth), zigzag, stopping, starting, or falling.
  - Students will be able to compare the speeds (faster vs. slower) of two moving objects.

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
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</thead>
<tbody>
<tr>
<td><strong>Such as: Teacher will...(provide possible examples of teacher involvement)</strong></td>
<td><strong>Such as: Students will...(provide possible examples)</strong></td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
</tbody>
</table>
| ● Teacher will take the class outside or in a large open area. Then the teacher will have the students copy the motion they do (Ex. walk in a straight line, walk in zigzag line, walk fast, walk slow) The teacher can have the students sing the Motion song to the tune of “Are You Sleeping” | ● Students will move objects according to directions given by the teacher. (ex. place the pencil to the left of the page, place the pencil under the page, place the pencil to the right of the page etc) ● Students will play a game of “Simon Says” with motion words in a small group.
  ● Students will experiment with marbles to describe an object’s motion. Students will do this by rolling large marbles fast and slow, side to side, back and forth, around and around, and in a zig zag. | ● DOK 2 |

- DOK 2
Teacher will discuss different types of motion. The students will help make an anchor chart with each type of motion they come up with.

The teacher will read a variety of books discussing speeds, position and motion of objects.

Teacher will do a demonstration that shows how objects can move fast and slow. Drop a marble. Drop a feather etc. Discuss which moved faster? Why?

- Moving Fast and Slow (on discovery ed.)
- Roller Coaster! By: Marla Frazee
- Move It! By: Adrienne Mason
- Forces Make Things Move By: Kimberly Bradley

Youtube videos:

Students will compare the speeds of two moving objects.

Students will investigate with how to make objects move fast or slow when given a variety of different materials. (sand paper, cardboard, aluminum foil etc.)

Students will predict what materials will make the object go faster or slower and then prove which material impacts the car to go the fastest.

Students will be given materials to create two different ramps. Students will then test the two ramps to see which ramp will cause their car to go faster or slower. Students will record their findings and share their findings with their peers.


Students will investigate with a variety of objects (feather, ball, pencil, crayon, balloon) to test which ones will drop faster or slower.
Positional Words:  

https://youtu.be/8F0NYBBKcrM

Motion:

https://youtu.be/xKmhS4qLj_s

Slow. Students will make predictions of why an object may move faster or slower and then participate in a discussion with their peers explaining what they observed.

- DOK 2/ DOK 3

<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
<th>PRIOR KNOWLEDGE CONNECTIONS</th>
<th>CONNECTIONS TO STRANDS 7 &amp;/OR 8</th>
</tr>
</thead>
</table>
| ● Math: Students can measure length that car traveled in experiment using nonstandard units of measurement (yarn, unit blocks, paper clips, etc.)  
  ● Math: Students work with geoboards and rubber bands or yarn to create lines that are curvy, straight,  
  ● Art: following and researching Jackson Pollock’s work and comparing it with their own marble art-motions of the marble with paint  
  ● For interactive read aloud, read Moving Fast and Slow (on discovery ed, Roller Coaster! by Marla Frazee, Move It! by Adrienne Mason, Forces Make Things Move by Kimberly Bradley. |
| ● Students should know that people and objects can move in a variety of ways.  
  ● Terms: (above, below, in front of, behind) should be familiar |
| ● 7.1.A.a: Pose questions about objects, materials, organisms, and events in the environment.  
  ● 7.1.A.b: Plan and Conduct a simple investigation to answer a question.  
  ● 7.1.B.a: Make qualitative observations using the five senses.  
  ● 7.1.C.a: Use observations as support for reasonable explanations.  
  ● 7.1.C.b: Use observations to describe relationships and patterns and to make predictions to be tested.  
  ● 7.1.D.a: Communicate simple procedures and results of investigations through: oral |
presentations, drawings and maps, data tables, graphs (bar, pictograph), writings

- 8.3.A.b: Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member

### HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?

<table>
<thead>
<tr>
<th>ASSESSMENT DESCRIPTION</th>
<th>ASSESSMENT TYPE? (i.e. formative, summative, obstrusive, unobtrusive, etc.)</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
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</table>
| ● Asking students to move in certain ways-zig zag, fast, move to the left of your desk, etc.  
● Students will pair up and student one will move a certain way, student 2 will compare movements and distinguish which way they are moving  
● Draw lines following directions with zig zag, curvy, straight, etc.  
● Teacher will observe/ask questions while students are comparing speeds of cars. During this time the teacher will use a checklist to keep track of student learning. | ● unobtrusive/observational  
● unobtrusive/observational  
● obtrusive  
● obtrusive | ● DOK 1  
● DOK 2  
● DOK 1  
● DOK 3 |

### HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?

_Possible Interventions_

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
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</table>
- Teacher will read *Rosie’s Walk* and review positional words.

- Teacher will work with small groups using two different materials and cars to discuss why one car might go faster on one surface rather than another surface.

- Students will play a new version of “Simon Says”. Each child will have a small object, such as a cube, and the children will then place the object in different places around their bodies. Ex. Simon says put the cube above your head.

<table>
<thead>
<tr>
<th>HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?</th>
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<tbody>
<tr>
<td><em>Possible Extensions/Enrichments</em></td>
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<tr>
<td>Teacher set out different materials such as play dough, yarn, clay, rubber bands, straws, etc. to create different movements for students to explore</td>
<td>Students explore independently with various materials. They can determine which materials are easy to move and harder-could hypothesize why material moves one way but not another.</td>
<td>DOK 2</td>
</tr>
<tr>
<td>with-have motion words written on board</td>
<td>Teacher can use multi step directions for positional arrangements that create thinking and trial and error-for instance</td>
<td></td>
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<tr>
<td>Students will test out problem solving based on the problems dealing with position words.</td>
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- I see 5 cubes. The yellow cube is in front of the red cube. The green cube is behind the red cube. The orange cube is in between the green cube and the blue cube.

- DOK 3
<table>
<thead>
<tr>
<th>OBJECTIVE # 2</th>
<th>Forces affect motion</th>
</tr>
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<tbody>
<tr>
<td>REFERENCES/STANDARDS</td>
<td>● 2.2.A.a, 2.2.D.a, 7.1.A.a, 7.1.A.b, 7.1.B.a, 7.1.C.a, 7.1.C.b, 7.1.D.a, 8.3.A.b</td>
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<td>i.e. GLE/CLE/MLS/NGSS</td>
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**WHAT SHOULD STUDENTS…**

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<tr>
<td>Facts, Names, Dates, Places, Information, Academic Vocabulary</td>
<td>Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.</td>
<td>Skills; Products</td>
</tr>
<tr>
<td>● push, pull, force</td>
<td>● Forces are classified as either contact (pushes, pulls, friction, buoyancy) or non-contact forces (gravity, magnetism), that can be described in terms of direction and</td>
<td>● Students will be able to identify the force (i.e., push or pull) required to do work (move an object) ● Students will be able to describe ways to change the motion of an object (i.e., how to cause an object to go slower, go faster, go farther, change direction, stop)</td>
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**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

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<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
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<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
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<tr>
<td>Such as: Teacher will…(provide possible examples)</td>
<td>Such as: Students will…(provide possible examples)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
<tr>
<td>● Teacher will introduce the word force and and make an anchor chart with the students on what a force is.</td>
<td>● Students will place various objects in the wagon one at at time. Students will then pull the wagon with heavy objects then light. Students will have a discussion after they pull each object and discuss whether it was easy or hard to push. ● Students will choose two items (small objects with wheels, small balls, blocks etc.) to push. The students will then make a prediction of which object will move the farthest when pushed. Students will start on a marked line and then push the objects to see which one moved farther. After students have completed their experiment, have the students lead a discussion about why some objects move farther. (round objects, objects with</td>
<td>● DOK 2</td>
</tr>
<tr>
<td>● Teacher will conduct a penny activity with students. Place a stack of pennies on a small strip of paper on a flat surface. Quickly pull the paper out from underneath the pennies. The pennies will stay</td>
<td></td>
<td>● DOK 2/DOK 3</td>
</tr>
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</table>
stacked. Have students conduct the same activity in small groups and discuss why the pennies didn’t move. Then, lead a whole class discussion about why the pennies didn’t move. The pennies didn’t move because there wasn’t anything that pushed or pulled them. Explain that all things that move must have some type of force making them move.

- Teacher will take students on a “scavenger hunt” around the school to look for objects that push or pull.
- Youtube Videos:
  - https://youtu.be/XZlqs0tixo
  - https://youtu.be/7Olow619AeU
- Books:
  - And Everyone Shouted, “Pull!”
  - Newton and Me

Students will experiment with the penny activity and record their predictions and findings.

- Students will draw pictures or write the names of the objects they see around the school that they can push or pull.

- DOK 2
- DOK 2
| INTERDISCIPLINARY CONNECTION | PRIOR KNOWLEDGE CONNECTIONS  
(What should students already know coming in?) | CONNECTIONS TO STRANDS 7 &/OR 8 |
|------------------------------|-----------------------------------------------|-------------------------------|
| ● Math: Students can measure the distance of how far their object moved with unifix cubes or paperclips.  
● Writing: Students could write a “How To Book” in the Lucy Calkins unit on “How to move an object”  
● Reading:                                                            | ● Should be familiar with terms push and pull.                                                                 | ● 7.1.A.a: Pose questions about objects, materials, organisms, and events in the environment.  
● 7.1.A.b: Plan and Conduct a simple investigation to answer a question.  
● 7.1.B.a: Make qualitative observations using the five senses.  
● 7.1.C.a: Use observations as support for reasonable explanations.  
● 7.1.C.b: Use observations to describe relationships and patterns and to make predictions to be tested.  
● 7.1.D.a: Communicate simple procedures and results of investigations through: oral presentations, drawings and maps, data tables, graphs (bar, pictograph), writings  
● 8.3.A.b: Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member |
<table>
<thead>
<tr>
<th>HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?</th>
<th>ASSESSMENT DESCRIPTION</th>
<th>ASSESSMENT TYPE?</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASSESSMENT DESCRIPTION</strong></td>
<td>(i.e. formative, summative, obtrusive, unobtrusive, etc.)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
<td></td>
</tr>
<tr>
<td>I Can Identify <strong>PUSH</strong> and <strong>PULL</strong> forces:</td>
<td>● obtrusive</td>
<td>● DOK 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● <a href="https://www.pinterest.com/pin/106256872430237031/">https://www.pinterest.com/pin/106256872430237031/</a></td>
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<tr>
<td></td>
<td>● Teacher will observe students participating in activities listed above while engaging them into higher level conversations</td>
<td></td>
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<tr>
<td></td>
<td>● Unobtrusive</td>
<td>● DOK 2/ DOK 3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?</th>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Possible Interventions</strong></td>
<td>● Teacher will revisit what a push and a pull is. The teacher will make an anchor chart with the students</td>
<td>● Students will go around the classroom exploring different things they can find that you can push and pull</td>
<td>● DOK 1/ DOK 2</td>
</tr>
</tbody>
</table>
discussing things you have to do to push or pull ex. pulling a door shut, pushing a stroller etc.

<table>
<thead>
<tr>
<th>HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Extensions/Enrichments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teacher will give students bag of materials along with stone and ask the students to move the stone without using their hands.</strong></td>
<td></td>
<td><strong>DOK 3/ DOK 4</strong></td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td><strong><a href="http://joysofateacher.blogspot.com/2015/01/push-and-pull-stem-activity.html">http://joysofateacher.blogspot.com/2015/01/push-and-pull-stem-activity.html</a></strong></td>
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<tr>
<td><strong>Students will design a plan to move the rock by selecting materials to apply a force.</strong></td>
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</table>
**Curriculum Unit of Study**
**Grade: 1**
**Content Area: Living Organisms**

**MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:**
- body covering examples (fur, feathers)
- seeds
- dixie cups/zip lock bag
- celery

**BIG IDEA(S):**
- There is a fundamental unity underlying the diversity of all living organisms.

**ENDURING UNDERSTANDINGS:**
- Organisms have basic needs for survival
- Plants and animals have different structures that serve similar functions necessary for the survival of the organism
- Biological classifications are based on how organisms are related

**ESSENTIAL QUESTIONS:**
- How do plants and animals structures differ and how are their functions necessary for the survival of the organism?
- How do the basic needs of plants and animals affect their survival?

**WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?**

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD i.e. GLE/CLE/MLS/NGSS</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit. Be sure to include connections to strands 7 &amp; 8 as supporting standards</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.A.a</td>
<td>Identify the basic needs of most animals (i.e., air, water, food, shelter)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.1.A.b</td>
<td>Identify the basic needs of most plants (i.e., air, water, light)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.1.A.c</td>
<td>Predict and investigate the growth of plants when</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3.1.D.a</td>
<td>Identify and compare the physical structures of a variety of plants (e.g., stem, leaves, flowers, seeds, roots)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.1.D.b</td>
<td>Identify and compare the physical structures of a variety of animals (e.g., sensory organs, beaks, appendages, body covering) (Do NOT assess terms: sensory organs, appendages)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.1.D.c</td>
<td>Identify the relationships between the physical structures of plants and the function of those structures (e.g., absorption of water, absorption of light energy, support, reproduction)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.1.D.d</td>
<td>Identify the relationships between the physical structures of animals and the function of those structures (e.g., taking in water, support, movement, obtaining food, reproduction)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.1.E.a</td>
<td>Distinguish between plants and animals based on observable structures and behaviors</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.A.a</td>
<td>Pose questions about objects, materials, organisms, and events in the environment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations</td>
<td>X</td>
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<tr>
<td>7.1.C.b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.C.c</td>
<td>Compare explanations with prior knowledge</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.D.a</td>
<td>Communicate simple procedures and results of investigations and explanations through: oral presentations, drawings and maps, data tables, graphs (bar, pictograph), writings</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>REFERENCES/STANDARDS</td>
<td>There is a fundamental unity underlying the diversity of all living organisms</td>
<td></td>
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<tr>
<td>----------------------</td>
<td>--------------------------------------------------------------------------</td>
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<td></td>
</tr>
</tbody>
</table>

### KNOW?  
**Facts, Names, Dates, Places, Information,**  
**ACADEMIC VOCABULARY**  
Vocabulary: shelter, needs, stem, seeds, leaves, flowers, roots, absorption, body covering, sensory organs (beaks, appendages, reproduction)

### UNDERSTAND?  
**Concepts: essential truths that give meaning to the topic; ideas that transfer across situations.**
- Organisms have basic needs for survival  
- Plants and animals have different structures that serve similar functions necessary for the survival of the organism.  
- Biological classifications are based on how organisms are related

### BE ABLE TO DO?  
**Skills; Products**
- Students will be able to identify the basic needs of animals (i.e., air, food, water, shelter)  
- Students will be able to identify the basic needs of plants (i.e. air, water, light)  
- Students will be able to predict and investigate the growth of plants when growing conditions are altered (e.g., dark vs. light, water vs. no water)  
- Students will be able to compare the physical structures of a variety of plants (e.g., stem, leaves, flowers, seeds, roots)  
- Students will be able to identify and compare the physical structures of a variety of animals (e.g. sensory organs, beaks, appendages, body covering)  
- Students will be able to identify the relationships between physical structures of plants and the function of those structures (e.g. absorption of water, absorption of light energy, support, reproduction)  
- Students will be able to identify the relationships between physical structures of animals and the structures of animal and the function of those structures (e.g. taking in water, support, movement, obtaining food, reproduction)  
- Students will be able to distinguish between plants and animals based on observable structures and behaviors.

### FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>SUCH AS: Teacher will... (provide possible examples of teacher involvement)</th>
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<tbody>
<tr>
<td>Such as:</td>
<td>The teacher will read fiction and nonfiction text during interactive read aloud and shared reading with topics on plants and animals. Before reading, have the class generate a list of the schema they already have about plants and animals. Then add their new learning to the anchor chart throughout the unit.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STUDENT LEARNING TASK</th>
<th>SUCH AS: Students will... (provide possible examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Such as:</td>
<td>Students will label parts of a plant and animal.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOK TARGET</th>
<th>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
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<tbody>
<tr>
<td>DOK 1</td>
<td></td>
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</table>
- Possible website lessons-
  - www.brainpop jr.com (parts of a plant or plant life cycle)
  - http://kids.nationalgeographic.com/kids
  - YOUTUBE Videos: https://youtu.be/dUbJQ1fTRL
    https://youtu.be/5XnHff2Kjc
- Teacher will provide opportunities for students to label parts of a plant and body parts of animals.
- Teacher will make an anchor chart having students come up and fill in the parts of the plant.

- Students will be able to recall and explain the basic needs for plants and animals and explain why the basic needs are imperative for the animals and plants growth and survival.

- DOK 2/3
- DOK 3/ DOK 4
- DOK 2
- The teacher with the children will be able to generate the needs of plants and animals on an anchor chart after reading non-fiction text.

- The teacher will have the students predict and investigate the growth of plants when growing conditions are altered. Teacher will have students generate ideas of how they could alter the seeds growing conditions. (ex. dark vs. light, water vs. no water)

- Students will experiment with growing seeds into a flower, grass etc. under controlled and altered conditions. Students will generate the idea of the altered condition and then track the plant growth through observations and tracking it in a journal.

- Students will experiment with celery sticks and food coloring to see how the water from the soil travels up through the roots, to the stem up to the leaves. Students will make predictions before the experiment and keeps track of their findings with a graphic organizer.

<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
<th>PRIOR KNOWLEDGE CONNECTIONS</th>
<th>CONNECTIONS TO STRANDS 7 &amp;/OR 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>• During interactive read aloud or shared reading, read:</td>
<td>• dark vs. light</td>
<td>7.1.A.a: Pose questions about objects, materials, organisms, and events in the environment</td>
</tr>
</tbody>
</table>
- A Seed Grows - Reading AtoZ - Level G
- What comes from Plants - Reading AtoZ - Level J (could be used for enrichment.
- Tops and Bottoms by Janet Stevens
- From Seed to Plant by Gail Gibbons
- Oh Say you can Seed? All about flowering plants by Bonnie Worth
- The Vegetables we eat by Gail Gibbons
- The Magic School bus plants seeds by Joanna Cole
- The Carrot Seed by Ruth Krauss
- What Living Organisms need - https://www.istorybooks.co/

- Writers Workshop: Lucy Caulkins: Non-fiction, Informational and alternate unit of study "How to books" also "All About" books.
- Students could write an all about book on an animal or plant of their choice.
- Social Studies: Needs Unit

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

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</table>
| Teacher observations and conversations with students during the experiments throughout the unit | - Unobtrusive | - DOK 2 / DOK 3
| plant labeling          | - Obtrusive                 | - DOK 1
| Students compare the needs of plants and animals.     |                                           | - DOK 2 |

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

**Possible Interventions**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
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<tbody>
<tr>
<td>Teacher will provide additional opportunities for students to name and label parts of a plant, with a fewer amount of parts to label.</td>
<td>Students will make a flipbook with the parts of the plants.</td>
<td>- DOK 2</td>
</tr>
</tbody>
</table>
### HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?

**Possible Extensions/Enrichments**

<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
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<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
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</thead>
<tbody>
<tr>
<td>Teacher will provide opportunities for students to create a new animal or plant.</td>
<td>Students will have the opportunity to create a new plant or animal and then describe how their physical structures help them survive.</td>
<td>DOK 3/ DOK 4</td>
</tr>
</tbody>
</table>
### Science Curriculum Units of Study
#### Course: Grade 1 Science
#### Content Area: Matter and Energy

**MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:**
- Equal arm balance (should be with math materials)
- Class set of thermometers
- Everyday math big thermometer to display
- Class weather chart
- Popcorn kernels
- Plastic tubs
- Small cups
- Unifix cubes
- Use of readingz.com (membership required) for guided readers and shared reading projectable books.

**BIG IDEA(S):**
- Changes in properties and states of matter provide evidence of the atomic theory of matter
- Energy has a source, can be stored, and can be transferred but is conserved within a system

**ENDURING UNDERSTANDINGS:**
- Objects, and the materials they are made of, have properties that can be used to describe and classify them
- Forms of energy have a source, a means of transfer (work and heat), and a receiver
- Electromagnetic energy from the Sun (solar radiation) is a major source of energy on Earth

**ESSENTIAL QUESTIONS:**
- How can we classify and describe objects and materials according to their properties?
- How can you describe energy as a receiver, a mean of transfer, or a source of heat?
- How is electromagnetic energy from the sun a source of energy on the Earth?

**WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?**

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</tr>
</thead>
<tbody>
<tr>
<td>1.1.A.a</td>
<td>Given an equal-arm balance and various objects, illustrate arrangements in which the beam is balanced</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1.1.A.b</td>
<td>Measure and compare the mass of objects (more/less)</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1.1.A.c</td>
<td>Order objects according to mass</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1.2.A.a</td>
<td>Identify the source of energy that causes an increase in the temperature of an object (e.g., Sun, stove, flame, light bulb)</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1.2.A.b</td>
<td>Compare the temperature of hot and cold objects using a simple thermometer</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1.2.A.c</td>
<td>Describe the change in temperature of an object as warmer or cooler</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1.2.C.a</td>
<td>Identify light from the Sun as a basic need of most plants</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>7.1.A.a</td>
<td>Pose questions about objects, materials, organisms, and events in the</td>
<td>x</td>
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<tr>
<td>Objective</td>
<td>Description</td>
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<td></td>
</tr>
<tr>
<td>7.1.A.b</td>
<td>Plan and conduct a simple investigation (fair test) to answer a question</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.B.b</td>
<td>Make observations using simple tools and equipment (e.g., magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.B.c</td>
<td>Measure length, mass, and temperature using standard and nonstandard units</td>
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<td></td>
</tr>
<tr>
<td>7.1.B.d</td>
<td>Compare amounts/measurements</td>
<td></td>
<td></td>
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<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations</td>
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<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
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<td>7.1.C.c</td>
<td>Communicate simple procedures and results of investigations and explanations through: oral presentations, drawings and maps, graphs (bar, pictograph), writings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1.B.a</td>
<td>Describe how tools have helped scientists make better observations (e.g., magnifiers, balances, thermometers)</td>
<td></td>
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</tr>
</tbody>
</table>

**Objectives # 1**

Changes in properties and states of matter provide evidence of the atomic theory of matter

**References/Standards**

i.e. GLE/CLE/MLS/NGSS


**What Should Students...**

**Know?**

Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY

- Objects, and the materials they are made of, have properties that can be used to describe and classify them

**Understand?**

Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.

**Be Able to Do?**

Skills; Products

- Given an equal-arm balance and various objects, illustrate arrangements in which the beam is balanced
- Measure and compare the mass of objects (more/less)
- Order objects according to mass
- Pose questions about objects, materials, organisms, and events in the environment
- Plan and conduct a simple investigation (fair test) to answer a question
- Make observations using simple tools and equipment (e.g., magnifiers/hand lenses, magnets, equal arm balances, thermometers)
- Measure length, mass, and temperature using standard and nonstandard units
- Compare amounts/measurements
- Use observations as support for reasonable explanations
- Use observations to describe relationships and patterns and to make predictions to be tested
- Compare explanations with prior knowledge
- Communicate simple procedures and results of investigations and explanations through: oral presentations, drawings and maps, graphs (bar, pictograph), writings

**Vocabulary:** Mass, measure, compare, weight, balance
### FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY Such as: Teacher will…(provide possible examples of teacher involvement)</th>
<th>STUDENT LEARNING TASK Such as: Students will…(provide possible examples)</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
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</thead>
</table>
| • Teacher will provide classroom items to use and model an equal-arm balance and guide a discussion regarding it.  
• Teacher will provide materials for an experiment where students test whether certain objects will sink or float in a tub of water. Then guide a discussion about what the students found out through the experiment.  
• Teacher will facilitate a group study on apples (in the fall) and collect apples for them to predict weights, classify, and compare mass. (The study of apples and their parts also ties into the “living organisms” strand: 3.1.D.a, 3.1.D.c,)  
• Teacher will facilitate a group study on pumpkins (in the fall) and collect pumpkins of all sizes for them to predict weights, classify, and compare mass. (The study of pumpkins and their parts also ties into the “living organisms” strand: 3.1.D.a, 3.1.D.c,)  
• Teacher will facilitate a discussion about scientists and the tools they use. | • Students will use equal-arm balance to compare the mass of objects as being more, less, or the same  
• Students will predict which objects will be heavier and then test out their predictions. They will then discuss why their predictions were correct or not. Samples below: | DOK level 1 and 2 |
- Students will compare the weight of objects to unifix cubes and predict how many unifix cubes it will take to equal the weight of classroom objects.

- Students could study apples and their parts. They could predict which apple has the most mass and why. Then students could test the mass of two apples by using an equal-arm balance. Students should have a conversation about why one apple has more mass than the other.

- Students could study pumpkins and their parts. They could predict which pumpkin has the most mass and why. Then students could test the mass of two (smaller) pumpkins by using an equal-arm balance. Students should have a conversation about why one pumpkin has more mass that the other. Students could even dig inside the pumpkin to make a connection between the amount of seeds and the mass of the pumpkin. They could test to see if more mass equals more seeds.

- Students will predict whether they think objects will sink or float in a tub of water. They will need to explain their predictions to one another. Then they will test whether objects will sink or float and discuss why they did or did not float.

**INTERDISCIPLINARY CONNECTION**

**PRIOR KNOWLEDGE CONNECTIONS**
*(What should students already know coming in?)*

**CONNECTIONS TO STRANDS 7 &/OR 8**

- Shared reading book “Does it Sink or Float?” on Readinga-z.com (Level F). This book could also be printed and multiple copies used for guided reading groups.

- Writing prompt explaining why one object is heavier than other. (teacher could provide pictures of classroom items for student use in prompt. eg: erasers, Heavier things weigh more than lighter things

- In the instructional activities, the students are posing questions about objects (7.1.A.a) Planning and conducting a simple investigation (7.1.A.b) Making observations using simple tools (7.1.B.b)
• Math: Students will compare corn kernels with popped corn (and also other classroom manipulatives) on the equal arm balance. Will the same amount of kernels weigh more or less once popped? Why?

• As referenced in the teacher/student learning activities, the science GLES: 3.1.D.a, 3.1.D.c -
  o Studying apples and pumpkins could go along with the “Living Organisms” strand of science.

• For interactive read aloud, read the book *The Snowy Day* by Ezra Jack Keats. This book goes into the states of matter when the snowball melts, turning into water.

• For interactive read aloud, read the book *What is the World Made of? All About Solids, Liquids and Gasses* by Kathleen Weidner Zoehfeld.

• For interactive read aloud, read the
**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

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<tbody>
<tr>
<td>Teacher will observe with a checklist to track students using a pan balance and whether they are sorting objects correctly or not. Teachers should also note if a student can explain “What is mass?” Teacher could have students do a picture sort on their desks. Sort them into two groups. Items with “More mass” and “Less mass”</td>
<td>unobstrusive assessment unobstrusive assessment</td>
<td>DOK level 2</td>
</tr>
</tbody>
</table>

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

**Possible Interventions**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher could facilitate a new discussion on comparing weights. Teacher could sort out things that are lighter or heavier. See below:</td>
<td>Students could sort things into two categories of “Less mass” and “More mass”. Give them pictures of things that they could put into two groups at their desks. They could sort independently or with a partner. (This activity could possibly be used as an assessment tool)</td>
<td>DOK 1 and 2</td>
</tr>
</tbody>
</table>
Teacher could reinforce the idea of mass and weight by showing the video “The Elephant Mass Song” or “Mathematics: Learn the basics of mass” both found on youtube.com.

### HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?

<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
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</thead>
<tbody>
<tr>
<td>Teacher could pull a small enrichment group (or a higher level reading group) and begin introducing the concept that mass means how much “matter” is in an object. Have a discussion about matter (solid, liquid, gas) and what that means. Use a guided reader about matter. Discuss volume and what it means when an object has a lot or a little volume. Facilitate an experiment using popcorn kernels and actual popped popcorn. Ask them which container holds more volume.</td>
<td>Students could participate in a group discussion about mass/matter. Students could learn the properties of matter (solid, liquid, gas) and touch or talk about things that could be examples of solids, liquids, and gasses. Students participate in a group discussion about volume and what it means when an object has more volume than another. They could test out this theory by looking at popcorn kernels vs. actual popped popcorn and asking with container holds more volume than the other. Students could generate and test a hypothesis relating to mass and weight. Let them use objects from the room and a pan balance to test out their hypothesis.</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking) DOK level 2 and 3</td>
</tr>
<tr>
<td>KNOW?</td>
<td>UNDERSTAND?</td>
<td>BE ABLE TO DO?</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>WHAT SHOULD STUDENTS...</strong></td>
<td><strong>CONCEPTS; ESSENTIAL TRUTHS THAT GIVE MEANING TO THE TOPIC; IDEAS THAT TRANSFER ACROSS SITUATIONS.</strong></td>
<td><strong>SKILLS; PRODUCTS</strong></td>
</tr>
<tr>
<td><strong>FACTS, NAMES, DATES, PLACES, INFORMATION, ACADEMIC VOCABULARY</strong></td>
<td>Forms of energy have a source, a means of transfer (work and heat), and a receiver</td>
<td>Identify the source of energy that causes an increase in the temperature of an object (e.g., Sun, stove, flame, light bulb)</td>
</tr>
<tr>
<td>Vocabulary: heat, energy, temperature, thermometer, hot, cold, compare, change, Fahrenheit</td>
<td>Electromagnetic energy from the Sun (solar radiation) is a major source of energy on Earth</td>
<td>Compare the temperature of hot and cold objects using a simple thermometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Describe the change in temperature of an object as warmer or cooler</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identify light from the Sun as a basic need of most plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plan and conduct a simple investigation (fair test) to answer a question</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make observations using simple tools and equipment (e.g., magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measure length, mass, and temperature using standard and nonstandard units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compare amounts/measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use observations as support for reasonable explanations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use observations to describe relationships and patterns and to make predictions to be</td>
</tr>
</tbody>
</table>

**OBJECTIVE #2**

Energy has a source, can be stored, and can be transferred but is conserved within a system

**REFERENCES/STANDARDS**

i.e. GLE/CLE/MLS/NGSS

- 1.2.A.a, 1.2.A.b, 1.2.A.c, 1.2.C.a, 7.1.A.b, 7.1.B.b, 7.1.B.c, 7.1.B.d, 7.1.C.a, 7.1.C.b, 7.1.C.c, 8.1.B.a
<table>
<thead>
<tr>
<th>FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING</th>
</tr>
</thead>
</table>
| **TEACHER INSTRUCTIONAL ACTIVITY**
*Such as: Teacher will...*(provide possible examples) | **STUDENT LEARNING TASK**
*Such as: Students will...*(provide possible examples) | **DOK TARGET**
(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking) |
| • The teacher will do daily math routines as outlined in Everyday Math in order for students to practice and maintain background knowledge about temperatures, seasons, and weather. This includes displaying a calendar, weather chart, and large thermometer in the room. The teacher should encourage students to observe the weather each day and then record it. *(Routine 4 - Weather Routine)* | • The student will participate in daily math routines as required by the Everyday Math curriculum. This means the student will observe and record the weather every day. It can be a tally chart or just simply circling the weather for the day on paper. The student will also predict and confirm their predictions for the weather and temperature on some days. | |
| • The teacher will guide students to conduct an experiment where they will measure the temperature of something (possibly water) after sitting in the sun for a given period. | • The student will conduct an experiment where they measure the temperature of water after sitting in the sun for a given period. | |
| • The teacher will integrate these topics during nonfiction read alouds and shared reading lessons. Teacher will have students turn and talk or jot about their findings during the book. Then the teacher will ask if they can think of any experiments they could conduct after reading the book. | • Students will discuss what makes things change temperature (heat or cold) | |
| • Teacher could facilitate a discussion about scientists and the tools they use (thermometers) | • Students will come up with experiments that they would like to try regarding weather and temperature | |

<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
</tr>
</thead>
</table>
| **PRIOR KNOWLEDGE CONNECTIONS**
*(What should students already know coming in?)* |
| **CONNECTIONS TO STRANDS 7 &/OR 8** |
| • Great read alouds on the topic:
  - Weather Words and What They Mean - by Gail Gibbons
  - The Reasons for Seasons - by Gail Gibbons
  - The Story of Snow - by Mark Cassino
  - Clouds - by Anne Rockwell
Great books to use for shared reading:
  - Changing Seasons (level F) on reading a-z.com
  - The Four Seasons (level E) on reading a-z.com
Lessons through Everyday Math that go along with this objective:
  - All Everyday Math calendar | • Weather, hot, cold, sun, |
| Tools like the thermometer are used to make observations and drive thinking throughout experiments. | | | |
### ASSESSMENT DESCRIPTION
- Teacher will observe with a checklist to track students using thermometers correctly or incorrectly.
- Teacher facilitates discussion on why the temperature increases or decreases according to methods tried. (adding ice, putting closer to lamp, etc.)

### ASSESSMENT TYPE?
- Unobtrusive

### DOK TARGET
- 1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking

### HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?
#### TEACHER INSTRUCTIONAL ACTIVITY
- Teacher will pull small groups and review thermometers with them and possibly show videos “The Thermometer song” by Harry Kindergarten Music or “What is Temperature?” by makemegenius.com. (Found on Youtube)
- Teacher could reteach thermometers and how to read them with class thermometers or math masters of the class thermometer (from EveryDay Math)
- Teacher could spend more time each day during the math routines discussing the temperatures of objects and how we can tell if something is warmer or cooler (along with weather)
- Teacher could pull a small group during reader’s workshop and pick a book referring to temperature. The kids could then talk more in detail about the thermometers and how they are used.

#### STUDENT LEARNING TASK
- Students will participate in a small group to discuss thermometers and temperatures.
- Students could watch “The Thermometer song” by Harry Kindergarten Music or “What is Temperature?” by makemegenius.com. (Found on Youtube) for a deeper understanding or a visual way to remember what it means.
- Students could take part in more experiments in order to further practice their skills of temperature and warm/cool.
- Students could spend more time each day during their math routines discussing temperature and thermometers. Students should compare the weather over a period of time.

### HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?
#### INSTRUCTIONAL ACTIVITY/METHOD
- □

#### STUDENT LEARNING TASK
- □

#### DOK TARGET
- 1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking
Course: Science Grade 1
Content Area: Processes and Interactions of the Earth's Systems

MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:
- Class weather graph
- Months of the year displayed
- Thermometer
- Rain gauge
- Wind socks
- Cotton balls—cloud building

BIG IDEA(S):
- Earth’s systems interact with one another as they change by common processes.
- Human activity is dependent upon and affects Earth’s resources and systems

ENDURING UNDERSTANDINGS:
- Earth’s materials are limited natural resource’s affected by human activity.
- Climate is a description of average weather conditions in a given area due to the transfer of energy and matter through Earth’s systems.

ESSENTIAL QUESTIONS:
- Why are Earth’s materials limited?
- How does having limited natural resources affect humans and their activities?
- How does the temperature affect our weather and climate?
- How can we influence states of matter?

WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit. Be sure to include connections to strands 7 &amp; 8 as supporting standards</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2.F.a</td>
<td>Observe, measure, record weather data throughout the year (i.e., cloud cover, temperature, precipitation, wind speed) by using thermometers, rain gauges, wind socks</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5.2.F.b</td>
<td>Compare temperatures in different locations (e.g., inside, outside, in the sun, in the shade)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5.2.F.c</td>
<td>Compare weather data observed at different times throughout the year (e.g., hot vs. cold, cloudy vs. clear, types of precipitation, windy vs. calm)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5.2.F.d</td>
<td>Identify patterns indicating relationships between observed weather data and weather phenomena (e.g., temperature and types of participation, clouds and amounts of precipitation)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5.3.A.a</td>
<td>Observe and describe ways water, both as a solid and liquid, is used in everyday activities at different times of the year (e.g., bathe, drink, make ice cubes, build snowmen, cook, swim)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.A.a</td>
<td>Pose questions about objects, materials, organisms, and events in the environment.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.A.b</td>
<td>Plan and Conduct a simple investigation to answer a question.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.B.a</td>
<td>Make qualitative observations using the five senses.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.C.a</td>
<td>Use observations as support for reasonable explanations.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.C.b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1.D.a</td>
<td>Communicate simple procedures and results of investigations through: oral presentations, drawings and maps, data tables, graphs (bar, pictograph), writings</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
**OBJECTIVE # 1**

Earth's systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes.

**REFERENCES/STANDARDS**

i.e. GLE/CLE/MLS/NGSS

- 5.2.F.a, 5.2.F.b, 5.2.F.c, 5.2.F.d, 7.1.A.a, 7.1.A.b, 7.1.B.a, 7.1.C.a, 7.1.C.b, 7.1.D.a

<table>
<thead>
<tr>
<th>KNOW? Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary: wind speed, temperature, precipitation, rain gauges, windsocks, thermometers, sun, shade, cloud cover</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNDERSTAND? Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate is a description of average weather conditions in a given area due to the transfer of energy and matter through Earth's systems.</td>
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</table>

<table>
<thead>
<tr>
<th>WHAT SHOULD STUDENTS...</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE ABLE TO DO? Skills; Products</td>
</tr>
<tr>
<td>Students will be able to observe, measure and record weather data throughout the year (cloud cover, temperature, precipitation, wind speed) by using thermometers, rain gauges and windsocks.</td>
</tr>
<tr>
<td>Students will be able to compare temperatures in different locations (inside, outside, in the sun, in the shade)</td>
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<td>Students will be able to compare weather data observed at different times throughout the year (e.g., hot vs. cold, cloudy vs. clear, types of precipitation, windy vs. calm)</td>
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<td>Students will be able to identify patterns indicating relationships between observed weather data and weather phenomena (e.g., temperature and types of precipitation, clouds and amounts of precipitation)</td>
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</table>

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

| TEACHER INSTRUCTIONAL ACTIVITY | SUCH AS: Teacher will...(provide possible examples of teacher involvement) |
|---|
| - Teacher will provide opportunities for students to discuss and record weather observations. |
| - Teacher will read outdoor thermometer with students and compare that temperature with the indoor temperature. |
| - Teacher will read a variety of non-fiction text about weather and weather tools. |
| - The teacher will will compose a weather anchor chart that describes the different types of weather tools. |

| STUDENT LEARNING TASK | SUCH AS: Students will...(provide possible examples) |
|---|
| - Students will compare temperatures in different locations. Have the students come up with the locations they want to test/compare. |
| - Students will make predictions and explain which location will be warmer/cooler based on prior knowledge and then revisit their predictions to see if they were correct. If their predictions were wrong students will then explain why their predictions were incorrect. |
| - Students will act as "meteorologist" to observe and measure weather throughout the year. Students will keep track of their findings and observations on a class chart or individual chart/weather journal. |
| - Students will use weather tools (rain gauges, windsocks and thermometers) to measure the weather. |
| - Students could create their own individual winds socks. |

<table>
<thead>
<tr>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- DOK 2</td>
</tr>
<tr>
<td>- DOK 2/ DOK 3</td>
</tr>
</tbody>
</table>
- Websites:
  http://www.weather.com/
  http://www.weatherwizkids.com/
  http://www.brainpopjr.com/

Teacher can allow children to observe the clouds and give cotton balls to explore how to create different clouds.

- Students will use data collected throughout the year to compare the weather from different months.

(Students could compare from weekly observation sheets collected throughout the year or seasons)
- Students can create cloud books showing variation by manipulating cotton balls.

- DOK 2
- DOK 2
- DOK 3/ DOK 4
- DOK 2
- DOK 3/ DOK 4
<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
<th>PRIOR KNOWLEDGE CONNECTIONS</th>
<th>CONNECTIONS TO STRANDS 7 &amp;/OR 8</th>
</tr>
</thead>
</table>
| - Everyday Math morning routines  
  - Math-Graphing the weather from day to day/month to month  
  - Social Studies-Could question and determine why weather is different in varying places-geography  
  - Writing-All About Weather-nonfiction  
  - Book List:  
    - The Reasons For Seasons by Gail Gibbons  
    - Oh See Can You See What’s The Weather Today? by Tish Rabe  
    - The Cloud Book by Tomie de Paola  
    - Little Cloud by Eric Carle  
    - A Drop Around The World by Barbara McKinney  
    - National Geographic Kids Everything Weather | - Weather occurs differently throughout the seasons  
  - Weather words-sleet, precipitation (e.g., snow, rain, sleet, fog), wind (i.e., light breezes to strong wind), cloud cover, temperature. | - 7.1.A.a: Pose questions about objects, materials, organisms, and events in the environment.  
  - 7.1.A.b: Plan and Conduct a simple investigation to answer a question.  
  - 7.1.B.a: Make qualitative observations using the five senses.  
  - 7.1.C.a: Use observations as support for reasonable explanations.  
  - 7.1.C.b: Use observations to describe relationships and patterns and to make predictions to be tested.  
  - 7.1.D.a: Communicate simple procedures and results of investigations through: oral presentations, drawings and maps, data tables, graphs (bar, pictograph), writings |

| HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED? |
|---|---|---|
| ASSESSMENT DESCRIPTION | ASSESSMENT TYPE?  
(i.e. formative, summative, obstrusive, unobtrusive, etc.) | DOK TARGET  
(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking) |
Weather tracking with thermometer:
http://www.homeschoolcreations.net/2011/01/weekly-temperature-tracking-printable/

Prediction on what objects will be moved by wind (fan)
http://kindergartenkel.blogspot.com/2012/04/day-one-of-weather-unit-fun.html

Predicting what the weather will be like when certain clouds are in the sky.
<table>
<thead>
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<th>DOK TARGET</th>
</tr>
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<tbody>
<tr>
<td>Teacher could pull a small group and read about the four seasons. Engage students in a conversation about the different types of weather that occurs in the seasons.</td>
<td>Students can then talk about the different types of weather that occurs in each season and work together to make an anchor chart.</td>
<td>DOK 1/ DOK 2</td>
</tr>
<tr>
<td>Review instructional videos on weather topics <a href="https://jr.brainpop.com/science/weather/">https://jr.brainpop.com/science/weather/</a></td>
<td></td>
<td></td>
</tr>
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**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

*Possible Interventions*

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<td></td>
</tr>
</tbody>
</table>
- Teacher can do small group introductory lesson on the water cycle. How water changes forms throughout the cycle.

- Students will complete the weather cycle based on new learning.

- DOK 2
**OBJECTIVE # 2**

Human activity is dependent upon and affects Earth’s resources and systems

**REFERENCES/STANDARDS**

i.e. GLE/CLE/MLS/NGSS

- 5.3.A.a, 7.1.A.a, 7.1.A.b, 7.1.B.a, 7.1.C.a, 7.1.C.b,

**WHAT SHOULD STUDENTS...**

<table>
<thead>
<tr>
<th>KNOW?</th>
<th>UNDERSTAND?</th>
<th>BE ABLE TO DO?</th>
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<tr>
<td>Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY</td>
<td>Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.</td>
<td>Students will be able to observe and describe ways water, both as a solid and liquid, is used in everyday activities at different times of the year (e.g., bathe, drink, make ice cubes, build snowmen, cook, swim)</td>
</tr>
</tbody>
</table>

- solid, liquid.
- Earth’s materials are limited natural resource’s affected by human activity

**ACADEMIC VOCABULARY UNDERSTAND?**

- Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.

**BE ABLE TO DO?**

- Skills; Products

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

**TEACHER INSTRUCTIONAL ACTIVITY**

Such as: Teacher will... (provide possible examples)

- Teacher can gather snow and mark in a clear container where the snow measures to, allow time to pass to observe changes.

Can have two examples of this, one under a lamp one not to see if the heat changes

**STUDENT LEARNING TASK**

Such as: Students will... (provide possible examples)

- Students will predict how much water is in snow by drawing a prediction of what will happen as time passes.

- Students can compare with a contrast lamp and not lamp experiments.

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK 2/DOK 3

**INTERDISCIPLINARY CONNECTION**

**PRIOR KNOWLEDGE CONNECTIONS**

(What should students already know coming in?)

- This is mainly introductory
- May know terminology from prior experiences.

**CONNECTIONS TO STRANDS 7 &/OR 8**

- 7.1.A.a: Pose questions about objects, materials, organisms, and events in the environment.
- 7.1.A.b: Plan and Conduct a simple investigation to answer a question.
- 7.1.B.a: Make qualitative observations using the five senses.
- 7.1.C.a: Use observations as support for reasonable explanations.
- 7.1.C.b: Use observations to describe relationships and patterns and to make predictions to be tested.
### How Do We Know What Students Have Learned?

<table>
<thead>
<tr>
<th>Assessment Description</th>
<th>Assessment Type? (i.e. formative, summative, obtrusive, unobtrusive, etc.)</th>
<th>DOK Target (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
</table>
| Teacher will observe students making predictions in the snow melting activity. Teacher will use a checklist and have students explain how they can change a solid into a liquid. | • unobtrusive  
• unobtrusive  
• obtrusive | • DOK 2  
• DOK 2  
• DOK 1 |

### How Will We Respond If Students Have Not Learned?

<table>
<thead>
<tr>
<th>Teacher Instructional Activity</th>
<th>Possible Interventions</th>
<th>Student Learning Task</th>
<th>DOK Target (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
</table>
Small group discussion-direct teaching for sort. |  
||| • DOK 1  
<p>| | | | Solid and liquid sort <a href="https://www.teacherspayteachers.com/Product/Matter-Sort-by-JSimmons-217115">https://www.teacherspayteachers.com/Product/Matter-Sort-by-JSimmons-217115</a> |</p>
<table>
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<tr>
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<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher will explain the third state of matter which is a “gas”.</td>
<td>Students will experiment with making a root beer float and draw conclusions on what part of the root beer float is a solid, liquid or gas.</td>
<td>DOK 3</td>
</tr>
</tbody>
</table>
Grade 2 Curriculum
MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:
- A variety of rocks (or photos and descriptions)
- Different types of soils (or photos and description)
- Nonfiction texts to support the content (rocks & soil)
- Discoveryeducation.com (TechBook); unit: Earth Materials and unit: Soil and unit: Earth's Changing Surface
- Additional websites about rocks and soil (including BrainPop, Jr.)

BIG IDEA(S):
- Earth’s systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures
- Earth’s systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes
- Human activity is dependent upon and affects Earth’s resources and systems

ENDURING UNDERSTANDINGS:
- The Earth’s crust is composed of various materials, including soil, minerals, and rocks, with characteristic properties
- The Earth’s materials and surface features are changed through a variety of external processes
- Earth’s materials are limited natural resources affected by human activity

ESSENTIAL QUESTIONS:
- What are rocks made of?
- What are some of the properties of rocks?
- What materials are found in different soils?
- What are natural resources?
- How does Earth’s surface and materials through weathering, erosion, and human activity?
- How can people help protect Earth and its natural resources?
- What can we learn from fossils?

WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit. Be sure to include connections to strands 7 &amp; 8 as supporting standards</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1A.2a</td>
<td>Observe and describe the physical properties (e.g., odor, color, shape, and appearance, relative grain size, texture, absorption of water) and different components (i.e., sand, clay, humus) of soils</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>5.1A.2b</td>
<td>Observe and describe the physical properties of rocks (i.e., size, shape, color, presence of fossils)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>5.2A.2a</td>
<td>Observe and identify examples of slow changes in the Earth’s surface and surface materials (e.g., rock, soil layers) due to processes such as decay (rotting), freezing, thawing, breaking, or wearing away by running water or wind</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>5.3A.2a</td>
<td>Observe and describe ways humans use Earth’s materials (e.g., soil, rocks) in daily life</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1A.2a</td>
<td>Pose questions about objects, materials, organisms, and events in the environment</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1B.2a</td>
<td>Make qualitative observations using the five senses</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1B.2b</td>
<td>Make observations using simple tools and equipment (i.e., magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1C.2a</td>
<td>Use observations as support for reasonable explanations</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1C.2i</td>
<td>Communicate simple procedures and results of investigations and explanations through: oral presentations, drawings and maps, data tables, graphs (bar, pictograph) and writings</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>8.3A.2a</td>
<td>Identify a question that was asked, or could be asked, or a problem that needed to be solved when given a brief scenario (fiction or nonfiction of individuals solving everyday problems or learning through discovery)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>8.3A.2b</td>
<td>Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member (Assess Locally)</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
**OBJECTIVE # 1**
Earth’s systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures

**REFERENCES/STANDARDS**
i.e. GLE/CLE/MLS/NGSS
- 5.1A.2a
- 5.1A.2b

**WHAT SHOULD STUDENTS KNOW?**
- Facts, Names, Dates, Places, Information,
- ACADEMIC VOCABULARY

**WHAT SHOULD STUDENTS UNDERSTAND?**
- Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.

**BE ABLE TO DO?**
- Skills; Products

- boulder - a large rock
- fossil - any remains, impression, or trace of a living thing of a former geologic age
- humus - the dark organic material in soils, produced by the decomposition of vegetable or animal matter
- luster - the state or quality of shining by reflecting light
- mineral - nonliving solid that comes from Earth
- natural resource - something that people use that comes from the Earth and is not made by man
- property - something about an object that can be observed with the senses
- sand - tiny pieces of rock
- texture - the visual and especially tactile quality of a surface

- The Earth’s crust is composed of various materials, including soil, minerals, and rocks, with characteristic properties

- Students will be able to observe and describe the physical properties and different components of soils.
- Students will be able to observe and describe the physical properties of rocks.

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Such as:</strong> Teacher will...(provide possible examples of teacher involvement)</td>
<td><strong>Such as:</strong> Students will...(provide possible examples)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
<tr>
<td>• Teacher will provide students with opportunities to observe a variety of rocks.</td>
<td>• Students will observe rocks and describe their various properties using a science notebook (log) or a teacher-provided table or recording sheet.</td>
<td>• DOK 1&amp;2</td>
</tr>
<tr>
<td>• Teacher will provide students with opportunities to observe a variety of soils.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Teacher will present texts and information about rocks and soils.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Teacher will present lessons in the Discovery Education TechBook.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Teacher will visit other websites and show videos to illustrate and explain the topic.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Students will observe different soils and describe their various properties using a science notebook (log) or a teacher-provided table or recording sheet.

![Soil Sample Observation Sheet](image)

- DOK 1 & 2

**INTERDISCIPLINARY CONNECTION**

- Connect to Communication Arts: Teacher and students will read texts about the topic.

**PRIOR KNOWLEDGE CONNECTIONS**

(What should students already know coming in?)

- Students need to know what rocks are?

**CONNECTIONS TO STRANDS 7 &/OR 8**

- Make qualitative observations using the five senses (7.1B.2a)
- Connect to Communication Arts: Students will write about their observations and conclusions in a science notebook.

- Students need to know what soil is?

- Make observations using simple tools and equipment (i.e., magnifiers/hand lenses, magnets, equal arm balances, thermometers) (7.1B.2b)
- Use observations as support for reasonable explanations (7.1C.2a)
- Compare explanations with prior knowledge (7.1C.2c)
- Communicate simple procedures and results of investigations and explanations through: oral presentations, drawings and maps, data tables, graphs (bar, pictograph) and writings (7.1D.2a)

---

### HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?

<table>
<thead>
<tr>
<th>ASSESSMENT DESCRIPTION</th>
<th>ASSESSMENT TYPE? (i.e. formative, summative, obtrusive, unobtrusive, etc.)</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Observations (unobtrusive, formative)</td>
<td>unobtrusive</td>
<td>teacher generated: Indicate DOK target number for assessments</td>
</tr>
<tr>
<td>Student Journal Entries (unobtrusive, formative)</td>
<td>unobtrusive</td>
<td></td>
</tr>
<tr>
<td>Unit Common Assessment (obtrusive, summative)</td>
<td>summative</td>
<td></td>
</tr>
</tbody>
</table>

### HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?

**Possible Interventions**

**TEACHER INSTRUCTIONAL ACTIVITY**

- Teacher will show additional examples of rocks and/or soils to students and help them identify properties.
- Teacher will provide additional texts and photographs of rocks and/or soils for students to explore.

**-Helpful Websites:** kidsloverocks.com and soils.org/digdeeper

**STUDENT LEARNING TASK**

- Students will observe additional examples and read additional texts about rocks and soil.
- Students will sort rocks and/or soils according to observable characteristics.

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK 1&2
- DOK 1&2

### HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?

**Possible Extensions/Enrichments**

**INSTRUCTIONAL ACTIVITY/METHOD**

- Teacher will provide opportunities for students to explore websites about rocks and/or soil to research additional questions about the topics.
- Teacher will provide opportunities for students to teach their classmates about new knowledge on the topic or related topics.

**STUDENT LEARNING TASK**

- Students will pose new/additional questions that they have. Then, students will research to find answers to questions on websites, such as rockhoundskids.com, rocksandminerals4u.com, rocksforkids.com, and soils.org/digdeeper. Students will create posters or research papers to teach their classmates additional knowledge about rocks and soils.

**DOK TARGET**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

- DOK 1,2,3&4
**OBJECTIVE # 2**

Earth’s systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes and human activity is dependent upon and affects Earth’s resources and systems.

**REFERENCES/STANDARDS**

i.e. GLE/CLE/MLS/NGSS

- 5.2A.2a
- 5.3A.3a

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**WHAT SHOULD STUDENTS...**

<table>
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<tr>
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<th>BE ABLE TO DO?</th>
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<td>Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY</td>
<td>Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.</td>
<td>Skills; Products</td>
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</table>

- **WHAT SHOULD STUDENTS KNOW?**
  - decay - to rot
  - erosion - an external process by which rocks and soil are moved from one place to another
  - natural resource - something that people use that comes from the Earth and is not made by man
  - pollution - anything harmful added to land, air, or water
  - recycle - to change something so that it can be used again
  - sand - tiny pieces of rock
  - weathering - the breaking apart and changing of rocks as an external process

- **WHAT SHOULD STUDENTS UNDERSTAND?**
  - The Earth’s materials and surface features are changed through a variety of external processes
  - Earth’s materials are limited natural resources affected by human activity

- **WHAT SHOULD STUDENTS BE ABLE TO DO?**
  - Students will be able to observe and identify examples of slow changes in the Earth’s surface and surface materials due to processes such as decay, freezing, thawing, breaking or wearing away by running water or wind.
  - Students will be able to observe and describe ways humans use Earth’s materials in daily life.

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**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

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<td>Such as: Teacher will... (provide possible examples)</td>
<td>Such as: Students will... (provide possible examples)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
</tbody>
</table>

- **TEACHER INSTRUCTIONAL ACTIVITY**
  - Teacher will provide many visual examples of erosion and weathering through DiscoveryEd (TechBook) lesson resources and other texts/videos.
  - Teacher will provide students will opportunities to write about and illustrate examples of ways the Earth can change through erosion and weathering.
  - Teacher will make (with students) and display a chart of natural resources as a class resource.

- **STUDENT LEARNING TASK**
  - Students will draw pictures to illustrate land and Earth’s surface materials before and after weathering or to show erosion.
  - Students will record main ideas and details of their learning.
  - Students will identify natural resources.

- **DOK TARGET**
  - DOK 2
  - DOK 2&3
  - DOK 1
- Teacher will lead students in exploration on how to protect Earth and how to use natural resources responsibly.
- Students will write persuasive letters about the importance of using natural resources in a responsible way (i.e., conservation, recycling, non-wasteful practices).

**INTERDISCIPLINARY CONNECTION**

- Connect to Communication Arts: Teacher and students will read texts about the topic.
- Connect to Communication Arts: Students will write about their predictions, discoveries, and conclusions in a science notebook.
- Connect to Social Studies: Students will explore how science needs affect laws and how laws can have an impact on science.

**PRIOR KNOWLEDGE CONNECTIONS**

(What should students already know coming in?)

- Students should know about weather phenomena, such as wind.
- Students should know about landforms (i.e., flowing rivers).

**CONNECTIONS TO STRANDS 7 &/OR 8**

- Pose questions about objects, materials, organisms, and events in the environment (7.1A.2a)
- Make qualitative observations using the five senses (7.1B.2a)
- Compare explanations with prior knowledge (7.1C.c)
- Compare amounts/measurements (7.1D.2a)
- Identify a question that was asked, or could be asked, or a problem that needed to be solved when given a brief scenario (fiction or nonfiction of individuals solving everyday problems or learning through discovery) (8.3A.2a)
- Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member (Assess Locally) (8.3A.2b)

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

**ASSESSMENT DESCRIPTION**

(i.e. formative, summative, obtrusive, unobtrusive, etc.)

**ASSESSMENT TYPE?**

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)

**DOK TARGET**

- Teacher Observations (unobtrusive, formative)
- Journal Entries (unobtrusive, formative)
- Unit Common Assessments (obtrusive, summative)

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

**TEACHER INSTRUCTIONAL ACTIVITY**

**STUDENT LEARNING TASK**

**DOK TARGET**

- Teacher will revisit charts and materials to illustrate natural and humanistic effects on Earth’s surface
- Students will read and view materials to show examples of weathering, erosion, and human activities that impact Earth and its surface.
- Students will answer questions about vocabulary and processes of erosion/weathering/pollution/consumption.

**Possible Interventions**

- DOK 1
- DOK 1&2

**HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?**

**Possible Extensions/Enrichments**

**INSTRUCTIONAL ACTIVITY/METHOD**

**STUDENT LEARNING TASK**

**DOK TARGET**

- Teacher will provide students will opportunities to explore the topic further through texts and online resources.
- Students will pose additional questions to teach their classmates further and then research their questions.
- Students will create a poster to show the difference between inexhaustible, renewable, and nonrenewable natural resources.

**Possible Extensions/Enrichments**

- DOK 2&3
- DOK 4
Students will write letters to persuade others to take particular actions to prevent or slow down certain effects on Earth about which they learned.

DOK 3&4
MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:
- Nonfiction texts to support force, motion, gravity, magnets
- Access to youtube.com and/or brainpopjr.com
- Science Techbook force and motion unit

BIG IDEA(S):
- The motion of an object is described by its change in position relative to another object or point
- Forces affect motion

ENDURING UNDERSTANDINGS:
- An object that is accelerating is speeding up, slowing down, or changing direction
- Forces are classified as either contact (pushes, pulls, friction, buoyancy) or non-contact forces (gravity, magnetism), that can be described in terms of direction and magnitude
- Every object exerts gravitational force on every other object
- Newton’s Laws of Motion explain the interaction of mass and forces, and are used to predict changes in motion
- Work transfers energy into and out of a mechanical system

ESSENTIAL QUESTIONS:
- What is a force?
- How do forces affect the motion of objects?
- What is magnetism?
- What is gravity?
- Who is Isaac Newton?
- How can motion be prediction using Newton’s Laws of Motion?
- How can simple machines make work easier?

WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>2.1B.2a</td>
<td>Describe Earth’s gravity as a force that pulls objects on or near the Earth toward the Earth without touching the object</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2A.2a</td>
<td>Identify magnets attract and repel each other and certain materials</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2A.2b</td>
<td>Describe magnetism as a force that can push or pull other objects without touching them</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2A.2c</td>
<td>Measure (using non-standard units) and compare the force (i.e. push or pull) required to overcome friction and move an object over different surfaces (i.e. rough, smooth)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2B.2a</td>
<td>Describe Earth’s gravity as a force that pulls objects on or near the Earth toward the Earth without touching the object</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2D.2a</td>
<td>Describe the direction and amount of force (i.e. direction of push or pull, strong/weak push or pull) needed to change an object’s motion (i.e. faster/slower, change in direction)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2D.2b</td>
<td>Describe and compare the distances traveled by heavier/lighter objects after applying the same amount of force (i.e. push or pull) in the same direction</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2D.2c</td>
<td>Describe and compare the distances traveled by objects with the same mass after applying different amounts of force (i.e. push or pull) in the same direction</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2F.2a</td>
<td>Compare and describe the amount of force (i.e. more, less, or same push or pull) needed to raise an object to a given height, with or without using inclined planes (ramps) of different slopes</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>2.2F.2b</td>
<td>Compare and describe the amount of force (i.e. more, less, or same push or pull) needed to raise an object to a given height, with or without using levers</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2F.2c</td>
<td>Apply the use of an inclined plane (ramp) and/or lever to different real life situations in which objects are raised</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1A.2b</td>
<td>Plan and conduct a simple investigation (fair test) to answer a question</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1B.2a</td>
<td>Make qualitative observations using the five senses</td>
<td>X</td>
<td></td>
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<td>7.1B.2b</td>
<td>Make observations using simple tools and equipment (e.g. magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1B.2c</td>
<td>Measure length, mass, and temperature using standard and non-standard units</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1C.2a</td>
<td>Use observations as support for reasonable explanations</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1C.2b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1C.2c</td>
<td>Compare explanations with prior knowledge</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1D.2a</td>
<td>Communicate observations using words, pictures, and numbers</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
### OBJECTIVE # 1
Forces affect motion

### REFERENCES/STANDARDS
*i.e. GLE/CLE/MLS/NGSS*
- 2.2A.2a,b,c
- 2.2D.2a,b,c
- 2.2F.2a,b,c

### WHAT SHOULD STUDENTS...

<table>
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<tr>
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<td>Skills; Products</td>
</tr>
<tr>
<td>• attract</td>
<td>• Forces are classified as either contact (pushes, pulls, friction, buoyancy) or non-contact forces (gravity, magnetism), that can be described in terms of direction and magnitude</td>
<td>• Recognize magnets attract and repel each other and certain materials</td>
</tr>
<tr>
<td>• buoyancy</td>
<td>• Every object exerts gravitational force on every other object</td>
<td>• Describe magnetism as a forces that can push or pull other objects without touching them</td>
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<tr>
<td>• force</td>
<td>• Newton’s Laws of Motion explain the interaction of mass and forces, and are used to predict changes in motion</td>
<td>• Measure (using non-standard units) and compare the force (i.e. push or pull) required to overcome friction and move an object over different surfaces (i.e. rough, smooth)</td>
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<tr>
<td>• friction</td>
<td>• Work transfers energy into and out of a mechanical system</td>
<td>• Describe Earth’s gravity as a force that pulls objects on or near the Earth toward the Earth without touching the object</td>
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<td>• gravity</td>
<td></td>
<td>• Describe the direction and amount of force (i.e. direction of push or pull, strong/weak push or pull) needed to change an object’s motion (i.e. faster/slower, change in direction)</td>
</tr>
<tr>
<td>• inclined plane</td>
<td></td>
<td>• Describe and compare the distances traveled by heavier/lighter objects after applying the same amount of force (i.e. push or pull) in the same direction</td>
</tr>
<tr>
<td>• lever</td>
<td></td>
<td>• Describe and compare the distances traveled by objects with the same mass after applying different amounts of force (i.e. push or pull) in the same direction</td>
</tr>
<tr>
<td>• magnetism</td>
<td></td>
<td>• Compare and describe the amount of force (i.e. more, less, or same push or pull) needed to raise an object to a given height, with or without using inclined planes (ramps) of different slopes</td>
</tr>
<tr>
<td>• mass</td>
<td></td>
<td>• Compare and describe the amount of force</td>
</tr>
<tr>
<td>• motion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• pulley</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• repel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• simple machine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• wheel and axle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• work</td>
<td></td>
<td></td>
</tr>
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<td>-------------------------------</td>
<td>-----------------------</td>
<td>------------</td>
</tr>
<tr>
<td>• Create a KWL or graffiti poster to find out students’ prior knowledge.</td>
<td>• Students will use magnets to investigate which items will and will not be attracted and sort the items into two groups to conclude what types of materials are magnetic.</td>
<td>• DOK 2</td>
</tr>
<tr>
<td>• Provide students with magnetic and non-magnetic materials as well as magnets to determine commonalities (i.e. wood and plastic are not magnetic while steel and</td>
<td>• Students will discover and experiment to determine differences in the amount of force needed to move a ball a given distance through grass and the same distance on concrete.</td>
<td>• DOK 3</td>
</tr>
<tr>
<td>discuss vocabulary of unit and create flash cards or booklet which includes the word, definition, a drawing, and the word used in a sentence.</td>
<td>• Students will drop several objects of varying weights from a given height to observe which items fall faster than others (i.e. a rubber ball vs. a feather).</td>
<td>• DOK 3</td>
</tr>
<tr>
<td>• Search youtube.com or brainpopjr.com (where available) for introductory videos of force and motion, gravity, and/or magnetism</td>
<td>• Students will pull one book and then two books using a rubber band and observe the changing effects on the rubber band to determine the change in the amount of force needed to pull more weight.</td>
<td>• DOK 3</td>
</tr>
<tr>
<td>• Create anchor chart to introduce how things move.</td>
<td>• Students will construct two or three inclined planes with different slopes and use them to determine the amount of force needed to push a dictionary up each one of them.</td>
<td>• DOK 2</td>
</tr>
<tr>
<td></td>
<td>• Students will illustrate a person or an animal using a “lever” to more easily lift an object.</td>
<td>• DOK 3</td>
</tr>
<tr>
<td></td>
<td>• Students will maintain and add entries to</td>
<td></td>
</tr>
</tbody>
</table>
- Using a toy car, ramp, carpet surface, and tile surface, facilitate discussion on whether the car with travel further on the carpet or the tile (can be integrated into Lucy Calkins’s 2nd Grade Unit 2, Lab Reports).
- Provide students with toy cars and ramps to have them investigate other ways to create an experiment with force, motion, gravity, and friction.
- Using a red plastic cup, balloon, 1 pom pom, cut the end off the balloon, stretch over the bottom of the cup. Then cut out the bottom of the cup. Demonstrate amounts of force effect distance by pulling back on the balloon just a little with a small force, then pulling back a lot with a big force.

<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
<th>PRIOR KNOWLEDGE CONNECTIONS</th>
<th>INQUIRY CONNECTIONS</th>
</tr>
</thead>
</table>
| Lucy Calkins, 2nd Grade, Unit 2, Lab Reports  
Read non-fiction text to introduce or elaborate on big ideas such as force and motion, gravity, and magnetism | A force is a push or a pull  
Motion can be changed (i.e. faster, slower, change direction, etc.) | Plan and conduct a simple investigation (fair test) to answer a question (7.1A.2b)  
Make qualitative observations using the five senses (7.1B.2a)  
Make observations using simple tools and equipment (e.g. magnifiers/hand lenses, magnets, equal arm balances, thermometers) (7.1B.2b)  
Measure length, mass, and temperature using standard and non-standard units (7.1B.2c)  
Use observations as support for reasonable explanations (7.1C.2a)  
Use observations to describe relationships and patterns and to make predictions to be tested (7.1C.2b)  
Compare explanations with prior knowledge (7.1C.2c)  
Communicate observations using words, pictures, and numbers (7.1D.2a) |
<table>
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<tr>
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<th>ASSESSMENT DESCRIPTION</th>
<th>FORMATIVE OR SUMMATIVE?</th>
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<tr>
<th>HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?</th>
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</thead>
<tbody>
<tr>
<td>Possible Interventions</td>
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</tbody>
</table>

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<tr>
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<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
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| •                            | •                     |                                                                            |
MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:
- Nonfiction texts to support animal life cycles and offspring
- Access to youtube.com and/or brainpopjr.com
- Items such as construction paper, scissors, glue, etc. to allow students to create animal life cycles
- Science Techbook life cycles unit

BIG IDEA(S):
- There is a fundamental unity underlying the diversity of all living organisms
- There is a genetic basis for the transfer of biological characteristics from one generation to the next through productive processes

ENDURING UNDERSTANDINGS:
- Organisms progress through life cycles unique to different types of organisms
- There is heritable variation within every species of organism

ESSENTIAL QUESTIONS:
- What is a life cycle?
- How animals grow and change?
- How are young animals alike and different from their parents?

WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit.</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.e. GLE/CLE/MLS/NGSS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1B.2a</td>
<td>Characteristics and Interactions of Living Organisms</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.1B.2b</td>
<td>Characteristics and Interactions of Living Organisms</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1A.2a</td>
<td>Pose questions about objects, materials, organisms and events in the environment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1B.2a</td>
<td>Make qualitative observations using the five senses</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1C.2b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1C.2c</td>
<td>Compare explanations with prior knowledge</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1D.2a</td>
<td>Communicate observations using words, pictures, and numbers</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

REFERENCE/STANDARD:
i.e. GLE/CLE/MLS/NGSS

STANDARDS: Content specific standards that will be addressed in this unit.

MAJOR STANDARD

SUPPORTING STANDARD
**OBJECTIVE # 1**
Identify, sequence, and observe life cycles (birth, growth and development, reproduction and death) of different animals (butterfly, dog, frog, chicken, sea turtle)

**REFERENCES/STANDARDS**
ie. GLE/CLE/MLS/NGSS
- 3.1B.2a
- 3.1B.2b

**WHAT SHOULD STUDENTS...**

<table>
<thead>
<tr>
<th>KNOW?</th>
<th>UNDERSTAND?</th>
<th>BE ABLE TO DO?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facts, Names, Dates, Places, Information, ACADEMIC VOCABULARY</td>
<td>Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.</td>
<td></td>
</tr>
<tr>
<td>- life cycle</td>
<td>- Organisms progress through life cycles unique to different types of organisms</td>
<td>- Recognize that animals progress through life cycles of birth, growth and development, reproduction, and death</td>
</tr>
<tr>
<td>- nymph</td>
<td>- There is heritable variation within every species of organisms</td>
<td>- Identify life cycles of different animals (butterfly, dog, frog, chicken, sea turtle)</td>
</tr>
<tr>
<td>- pupa</td>
<td></td>
<td>- Sequence the stages in the life cycle of different animals (butterfly, dog, frog, chicken, sea turtle)</td>
</tr>
<tr>
<td>- larvae</td>
<td></td>
<td>- Record observations of life cycles of different animals (butterfly, dog, frog, chicken, sea turtle)</td>
</tr>
<tr>
<td>- reproduce</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Search youtube.com or brainpopjr.com (where available) for life cycles of different animals such as butterfly, frog, or chicken</td>
<td>- Students will match the different stages of life cycles to the correct animals (butterfly, chicken, frog, horse) and then sequence them correctly</td>
<td>- DOK 1</td>
</tr>
<tr>
<td>- Complete a vocabulary booklet using the applicable vocabulary from above</td>
<td></td>
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</tr>
<tr>
<td>- Observe a living animal life cycle such as a butterfly and record observations (use the Teachers Pay Teachers resource below)</td>
<td>- Record observations of a living animal life cycle</td>
<td>- DOK 2</td>
</tr>
<tr>
<td><a href="https://www.teacherspayteachers.com/Product/Butterfly-Life-Cycle-Observation-Booklet-232703">https://www.teacherspayteachers.com/Product/Butterfly-Life-Cycle-Observation-Booklet-232703</a></td>
<td>- Create a flow chart of the life cycle of an animal such as a butterfly and label the steps of growth to adulthood</td>
<td>- DOK 3</td>
</tr>
<tr>
<td>- Illustrate how different types of animals might have different life cycles. (i.e. insects have different life cycles than mammals)</td>
<td></td>
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</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
<th>PRIOR KNOWLEDGE CONNECTIONS</th>
<th>INQUIRY CONNECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td></td>
<td>• Pose questions about objects, materials, organisms and events in the environment (7.1A.2a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Make qualitative observations using the five senses (7.1B.2a)</td>
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<td></td>
<td></td>
<td>• Use observations to describe relationships and patterns and to make predictions to be tested (7.1C.2b)</td>
</tr>
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<td></td>
<td></td>
<td>• Compare explanations with prior knowledge (7.1C.2c)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Communicate observations using words, pictures, and numbers (7.1D.2a)</td>
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</table>

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

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<thead>
<tr>
<th>ASSESSMENT DESCRIPTION</th>
<th>FORMATIVE OR SUMMATIVE?</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Arrange and describe the stages of animal life cycles</td>
<td>Summative</td>
<td>DOK 1, 2, &amp; 3</td>
</tr>
</tbody>
</table>

**HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?**

*Possible Interventions*
<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher will provide students opportunities to research life cycles using nonfiction texts and the internet.</td>
<td>Conduct research and compile a report about the similarities and differences of the life cycles of two different types of animals (i.e. life cycle of a mammal vs. life cycle of an amphibian)</td>
<td>DOK 4</td>
</tr>
</tbody>
</table>

**HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?**

*Possible Extensions/Enrichments*

<table>
<thead>
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<tr>
<td>Teacher will provide students opportunities to research life cycles using nonfiction texts and the internet.</td>
<td>Conduct research and compile a report about the similarities and differences of the life cycles of two different types of animals (i.e. life cycle of a mammal vs. life cycle of an amphibian)</td>
<td>DOK 4</td>
</tr>
</tbody>
</table>
**OBJECTIVE # 2**
Identify and relate the similarities and differences among animal parents and their offspring or multiple offspring

**REFERENCES/STANDARDS**
i.e. GLE/CLE/MLS/NGSS
- 3.3D.2a

<table>
<thead>
<tr>
<th>WHAT SHOULD STUDENTS...</th>
<th>KNOW?</th>
<th>UNDERSTAND?</th>
<th>BE ABLE TO DO?</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Facts, Names, Dates, Places, Information, <strong>ACADEMIC VOCABULARY</strong></td>
<td>Concepts; essential truths that give meaning to the topic; ideas that transfer across situations.</td>
<td><strong>Skills; Products</strong></td>
</tr>
</tbody>
</table>

- Offspring
- Reproduce
- There is heritable variation within every species of organisms.
- Identify similarities and differences between animal parents and their offspring
- Recognize similarities and differences among multiple offspring of an animal parent

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Read various texts showing adult animals and their offspring while describing their likenesses and differences.</td>
<td>Draw a picture of an adult animal and its young and explain their likenesses and differences.</td>
<td>DOK 1/2/2</td>
</tr>
<tr>
<td></td>
<td>Students will use a Venn diagram to compare and contrast young animals with their parents.</td>
<td></td>
</tr>
</tbody>
</table>

**INTERDISCIPLINARY CONNECTION**

- Living things have offspring based on physical similarities and differences

**HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?**

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<tr>
<td></td>
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<tr>
<td></td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
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<tbody>
<tr>
<td>Teacher will guide students to choose physical characteristics of adults and their offspring.</td>
<td>Students will use picture cards to match adult animals to their offspring, then describe their physical similarities and differences.</td>
<td>DOK 1</td>
</tr>
<tr>
<td>INSTRUCTIONAL ACTIVITY/METHOD</td>
<td>STUDENT LEARNING TASK</td>
<td>DOK TARGET</td>
</tr>
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<td>------------------------------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
</tbody>
</table>
**MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:**
- Materials for a mixture (M&M's, trail mix, Kool Aid, water)
- Nonfiction texts to support properties of matter and mixtures

**BIG IDEA(S):**
- Changes in properties and states of matter provide evidence of the atomic theory of matter

**ENDURING UNDERSTANDINGS:**
- Objects, and the materials they are made of, have properties that can be used to describe and classify them
- Properties of mixtures depend upon the concentrations, properties, and interactions of particles

**ESSENTIAL QUESTIONS:**
- What is matter?
- What are the three states of matter and the properties of each state?
- How can matter be changed?
- How can heating and cooling affect matter?
- What are mixtures?

**WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?**

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit. Be sure to include connections to strands 7 &amp; 8 as supporting standards</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1A.2a</td>
<td>Describe and compare the physical properties of objects by using simple tools (i.e. thermometer, magnifier, centimeter ruler, balance, magnet)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.1A.2b</td>
<td>Classify objects/substances as &quot;one kind of material&quot; or a mixture (i.e. M&amp;M's vs. trail mix, water vs. Kool Aid)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.1B.2a</td>
<td>Observe and describe how mixtures are made by combining solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1B.2b</td>
<td>Describe ways to separate the components of a mixture by their physical properties (i.e. sorting, magnets, screening)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1A.2a</td>
<td>Pose questions about objects, materials, organisms, and events in the environment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1A.2b</td>
<td>Plan and conduct a simple investigation (fair test) to answer a question</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1B.2a</td>
<td>Make qualitative observations using the five senses</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1B.2b</td>
<td>Make observations using simple tools and equipment (i.e. magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1B.2c</td>
<td>Measure length, mass, and temperature using standard and nonstandard units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1B.2d</td>
<td>Compare amounts/measurements</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1C.2a</td>
<td>Use observations as support for reasonable explanations</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1C.2b</td>
<td>Use observations as support for reasonable explanations</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1C.2c</td>
<td>Compare explanations with prior knowledge</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7.1D.2a</td>
<td>Communicate simple procedures and results of investigations and explanations through; oral presentations, drawings and maps, data tables, graphs (bar, pictograph), writings</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>8.1A.2b</td>
<td>Describe how tools have helped scientists make better observations, measurements, or equipment for investigations (i.e. magnifiers, balances, stethoscopes, thermometers)</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
## OBJECTIVE # 1
Changes in properties and states of matter provide evidence of the atomic theory of matter

### REFERENCES/STANDARDS
i.e. GLE/CLE/MLS/NGSS
- 1.1A.2a
- 1.1A.2b

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<td>Skills; Products</td>
</tr>
<tr>
<td>- gas</td>
<td></td>
<td>Student will be able to describe and compare the physical properties of objects by using simple tools (i.e. thermometer, magnifier, centimeter ruler, balance, magnet)</td>
</tr>
<tr>
<td>- liquid</td>
<td></td>
<td>Student will be able to classify objects as “one kind of material” or a mixture (i.e. M&amp;M’s vs. trail mix, water vs. Kool Aid)</td>
</tr>
<tr>
<td>- mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- matter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- mixture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- property</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- solid</td>
<td></td>
<td></td>
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<tr>
<td>- states of matter</td>
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</tr>
</tbody>
</table>

### FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING

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<th>DOK TARGET</th>
</tr>
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<tbody>
<tr>
<td>Such as: Teacher will... (provide possible examples of teacher involvement)</td>
<td>Such as: Students will... (provide possible examples)</td>
<td>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</td>
</tr>
<tr>
<td>- Teacher will provide tools such as a thermometer, magnifier, ruler, balance, magnet, and objects to sort by physical properties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Teacher will provide “one kind of material” items and mixtures to illustrate the difference between the two</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Teacher will provide opportunities to separate components of a mixture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Teacher will show videos (i.e. Brain Pop, YouTube, Discovery Ed) to introduce or enhance topic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students will describe and compare the physical properties of objects by using simple tools (i.e. thermometer, magnifier, centimeter ruler, balance, magnet)</td>
<td>DOK 2</td>
</tr>
</tbody>
</table>

DOK 2
Students will classify objects as “one kind of material” or a mixture
Students will observe and describe how mixtures are made by combining solids
Students will describe ways to separate the components of a mixture by their physical properties (i.e. sorting, magnets, screening)

<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
<th>PRIOR KNOWLEDGE CONNECTIONS (What should students already know coming in?)</th>
<th>CONNECTIONS TO STRANDS 7 &amp;/OR 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nonfiction text features</td>
<td>• Use their 5 senses to describe physical properties of matter</td>
<td>• Pose questions about objects, materials, organisms, and events in the environment (7.1.A.2a)</td>
</tr>
<tr>
<td>• Interactive Read Aloud</td>
<td>• Use simple tools (i.e. balance, magnet)</td>
<td>• Plan and conduct a simple investigation (fair test) to answer a question (7.1.A.2b)</td>
</tr>
<tr>
<td>• Writing Lab Reports</td>
<td></td>
<td>• Make qualitative observations using the five senses (7.1.B.2a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Make observations using simple tools and equipment (i.e. magnifiers/hand lenses, magnets, equal arm balances, thermometers) (7.1.B.2b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Measure length, mass, and temperature using standard and nonstandard units (7.1.B.2c)</td>
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<td></td>
<td></td>
<td>• Compare amounts/measurements (7.1.B.2d)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use observations as support for reasonable explanations (7.1.C.2a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use observations as support for reasonable explanations (7.1.C.2b)</td>
</tr>
</tbody>
</table>
- Compare explanations with prior knowledge (7.1C.2c)
- Communicate simple procedures and results of investigations and explanations through oral presentations, drawings and maps, data tables, graphs (bar, pictograph), writings (7.1D.2a)
- Describe how tools have helped scientists make better observations, measurements, or equipment for investigations (i.e. magnifiers, balances, stethoscopes, thermometers) (8.1A.2b)

### HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?

<table>
<thead>
<tr>
<th>ASSESSMENT DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Match unit vocabulary words with their definitions</td>
</tr>
<tr>
<td>Journal entries to record observations</td>
</tr>
<tr>
<td>Unit Common Assessment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASSESSMENT TYPE? (i.e. formative, summative, obstrusive, unobtrusive, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formative</td>
</tr>
<tr>
<td>Unobtrusive</td>
</tr>
<tr>
<td>Summative</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOK Level 1</td>
</tr>
<tr>
<td>DOK Level 2</td>
</tr>
<tr>
<td>DOK Level 3</td>
</tr>
</tbody>
</table>

### HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STUDENT LEARNING TASK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

### HOW WILL WE RESPOND IF STUDENTS HAVE ALREADY LEARNED?

<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>STUDENT LEARNING TASK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

MATERIALS / INSTRUCTIONAL RESOURCES FOR THIS UNIT:
- Rulers
- Bottles
- Rubberbands
- Various materials to construct a musical instrument
- Nonfiction texts to support the content (sound)
- Discoveryeducation.com (TechBook)

ENDURING UNDERSTANDINGS:
- Forms of energy have a source, a means of transfer (work and heat), and a receiver

BIG IDEA(S):
- Energy has a source, can be stored, and can be transferred but is conserved within a system

ESSENTIAL QUESTIONS:
- What is sound?
- What are some sounds we hear around us?
- How is sound created?
- How does sound travel?
- What is volume?
- What is pitch?
- What are some ways to change the pitch and volume of sounds?
- How does the ear work to receive sounds?

WHAT SHOULD STUDENTS KNOW, UNDERSTAND, AND BE ABLE TO DO AT THE END OF THIS UNIT?

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD</th>
<th>STANDARDS: Content specific standards that will be addressed in this unit.</th>
<th>MAJOR STANDARD</th>
<th>SUPPORTING STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.e. GLE/CLE/MLS/NGSS</td>
<td>Be sure to include connections to strands 7 &amp; 8 as supporting standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2A.2a</td>
<td>Identify air, water and solids as mediums that sound travels through</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Describe different ways to change the pitch of a sound (i.e., changes in size, such as length or thickness, and in tightness/tension of the source)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1.2A.2b</td>
<td>Describe how the ear serves as a receiver of sound (i.e., sound vibrates eardrum)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1.2A.2c</td>
<td>Describe how to change the loudness of a sound (i.e., increase or decrease the force causing vibrations)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1A.2a</td>
<td>Pose questions about objects, materials, organisms, and events in the environment</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1A.2b</td>
<td>Plan and conduct a simple investigation (fair test) to answer a question</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1B.2a</td>
<td>Make qualitative observations using the five senses</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1C.2a</td>
<td>Use observations as support for reasonable explanations</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1C.2b</td>
<td>Use observations to describe relationships and patterns and to make predictions to be tested</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1C.2c</td>
<td>Compare explanations with prior knowledge</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7.1D.2a</td>
<td>Communicate simple procedures and results of investigations and explanations through: oral presentations, drawings and maps, data tables, graphs (bar, pictograph) and writings</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>8.3A.2b</td>
<td>Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member (Assess Locally)</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
**OBJECTIVE # 1**  
Energy has a source, can be stored, and can be transferred but is conserved within a system

**REFERENCES/STANDARDS**  
i.e. GLE/CLE/MLS/NGSS

- 1.2A.2a
- 1.2A.2b
- 1.2A.2c
- 1.2A.2d

**WHAT SHOULD STUDENTS...**

<table>
<thead>
<tr>
<th>KNOW?</th>
<th>UNDERSTAND?</th>
<th>BE ABLE TO DO?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FACTS, NAMES, DATES, PLACES, INFORMATION, ACADEMIC VOCABULARY</strong></td>
<td><strong>CONCEPTS; ESSENTIAL TRUTHS THAT GIVE MEANING TO THE TOPIC; IDEAS THAT TRANSFER ACROSS SITUATIONS.</strong></td>
<td><strong>SKILLS; PRODUCTS</strong></td>
</tr>
</tbody>
</table>
| - eardrum - the part of the ear that vibrates from sound  
- loudness - how loud or quiet a sound is  
- medium - a substance through which something, such as sound, can travel or move  
- pitch - how high or low a sound is  
- sound - energy that is heard when an object vibrates  
- tension - the state of being stretched or strained  
- vibrate - to move back and forth quickly and repeatedly  
- volume - a measure of the loudness or intensity of a sound | - Forms of energy have source, a means of transfer (work and heat), and a receiver  
- Students will be able to describe the volume and pitch of a sound  
- Students will be able to change the volume and pitches of sounds and explain several ways to do it (i.e., changes in size, such as length or thickness, and in tightness/tension of a source).  
- Students will be able to identify the mediums through which sound travels (solids, liquids, and gases).  
- Students will be able to describe how the ear serves as a receiver of sound (i.e., sound vibrates eardrum). | |

**FACILITATING ACTIVITIES – STRATEGIES AND METHODS FOR TEACHING AND LEARNING**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUCH AS: Teacher will... (Provide possible examples of teacher involvement)</strong></td>
<td><strong>SUCH AS: Students will... (Provide possible examples)</strong></td>
<td><strong>(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</strong></td>
</tr>
</tbody>
</table>
| - Teacher will provide students with opportunities to observe and record sounds.  
- Teacher will provide opportunities to explore sound traveling through all forms of matter.  
- Teacher will introduce experiments for students to explore changing the pitch and volume of sounds (i.e., sliding a vibrating ruler back from the edge of a desk, blowing into or tapping several bottles containing varying amounts of water).  
- Teacher will present texts and information about the ear as a receiver of sound.  
- Teacher will provide a drum as a model of an eardrum. | - Students will record different sounds that they observe and categorize them as loud or soft sounds.  
- Students will associate different animals with making different types of sounds (soft, loud, low, high).  
- Students will hold a ruler down on the end of a desk, allowing half of the ruler to hang over the edge. Then, students will push down and release the overhanging end to observe the change in sound. | **DOK 1**  
**DOK 2** |
- Teacher will provide an opportunity for students to create musical instruments.
- Teacher will show educational videos and share informational texts to introduce the topic and enhance knowledge.
- Teacher will provide students with opportunities to share their findings and discoveries in a variety of ways.

<table>
<thead>
<tr>
<th>INTERDISCIPLINARY CONNECTION</th>
<th>PRIOR KNOWLEDGE CONNECTIONS</th>
<th>CONNECTIONS TO STRANDS 7 &amp;/OR 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Connect to Communication Arts: Teachers and students will read a variety of texts about the topic.</td>
<td>- Students need to know the three states of matter (i.e., solids, liquids, gases).</td>
<td>- Pose questions about objects, materials, organisms, and events in the environment (7.1A.2a)</td>
</tr>
<tr>
<td>- Shared Reading: Reading A-Z projectable texts, <em>Sound All Around</em> (Level M; Fountas &amp; Pinnell Level L) and <em>How Sound Works</em> (Level U; Fountas &amp; Pinnell Level Q) can be read and explored while learning nonfiction text features.</td>
<td></td>
<td>- Plan and conduct a simple investigation (fair test) to answer a question (7.1A.2b)</td>
</tr>
<tr>
<td>- Compare and contrast different texts on the topic of sound.</td>
<td></td>
<td>- Make qualitative observations using the five senses (7.1B.2a)</td>
</tr>
<tr>
<td>- Connect to Communication Arts: Students will write about their predictions, discoveries, and conclusions in a science notebook.</td>
<td></td>
<td>- Use observations as support for reasonable explanations (7.1C.2a)</td>
</tr>
<tr>
<td>- Connect to Math: Students will create a tally table and graph of the different types of sounds observed (i.e., how many high-pitched sounds, how many low-pitched sounds, how many loud sounds, how many soft sounds).</td>
<td></td>
<td>- Use observations to describe relationships and patterns and to make predictions to be tested (7.1C.2b)</td>
</tr>
</tbody>
</table>

- Students will blow across three or four bottles that contain varying amounts of water and observe the differences in pitch.
- Students will tap a drum and feel the vibration as a demonstration of how an eardrum works.
- Students will complete activities to learn content vocabulary.
- Students will participate in discussions, collaborate with peers, and share ideas and discoveries through formal and informal presentations.
- Students will design a musical instrument using a variety of provided materials.

- DOK 2
- DOK 2
- DOK 1
- DOK 3
- DOK 4
### HOW DO WE KNOW WHAT STUDENTS HAVE LEARNED?

<table>
<thead>
<tr>
<th>ASSESSMENT DESCRIPTION</th>
<th>ASSESSMENT TYPE? (i.e. formative, summative, obtrusive, unobtrusive, etc.)</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Observations (unobtrusive, formative)</td>
<td>unobtrusive</td>
<td></td>
</tr>
<tr>
<td>Student Journal Entries (unobtrusive, formative)</td>
<td>unobtrusive</td>
<td></td>
</tr>
<tr>
<td>Unit Common Assessment (obtrusive, summative)</td>
<td>summative</td>
<td></td>
</tr>
</tbody>
</table>

### HOW WILL WE RESPOND IF STUDENTS HAVE NOT LEARNED?

**Possible Interventions**

<table>
<thead>
<tr>
<th>TEACHER INSTRUCTIONAL ACTIVITY</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET (1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher will explore different animal sounds with students and assist students in describing those sounds as high, low, loud, or soft.</td>
<td>Students will make a list of animal sounds and classify them.</td>
<td>DOK 1&amp;2</td>
</tr>
<tr>
<td>Teachers will share powerpoint presentation with students to further explain characteristics of sound.</td>
<td>Students will observe and participate during powerpoint presentation on sound.</td>
<td>DOK 1&amp;2</td>
</tr>
</tbody>
</table>

*Images:*

- Trumpet and drum with text: "good vibrations"
- Guitar and piano keys

*(in teacher share science folder)*
<table>
<thead>
<tr>
<th>INSTRUCTIONAL ACTIVITY/METHOD</th>
<th>STUDENT LEARNING TASK</th>
<th>DOK TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Teacher will provide opportunities for students to create posters to teach others</td>
<td>• Students will design posters to teach classmates about the main ideas of how sound</td>
<td>• DOK 4</td>
</tr>
<tr>
<td>about the characteristics of sound.</td>
<td>works.</td>
<td></td>
</tr>
<tr>
<td>• Teachers will prompt students to think about what else they would like to know</td>
<td>• Students will list additional questions they have about sound and research to</td>
<td>• DOK 3&amp;4</td>
</tr>
<tr>
<td>about sound and provide opportunities and materials and tools for students to</td>
<td>find new information and summarize the information to teach their any new</td>
<td></td>
</tr>
<tr>
<td>research the topic further to answer additional questions.</td>
<td>knowledge and/or discoveries.</td>
<td></td>
</tr>
</tbody>
</table>

Possible Extensions/Enrichments

(1=Recall, 2=Skill/Concept, 3=Strategic Thinking, 4=Extended Thinking)
K-2 Science

Appendix
Missouri students must build a solid foundation of factual knowledge and basic skills in the traditional content areas. The statements listed here represent such a foundation in reading, writing, mathematics, world and American history, forms of government, geography, science, health/physical education and the fine arts. This foundation of knowledge and skills should also be incorporated into courses in vocational education and practical arts. Students should acquire this knowledge base at various grade levels and through various courses of study. Each grade level and each course sequence should build on the knowledge base that students have previously acquired.

These concepts and areas of study are indeed significant to success in school and in the workplace. However, they are neither inclusive nor are they likely to remain the same over the years. We live in an age in which “knowledge” grows at an ever-increasing rate, and our expectations for students must keep up with that expanding knowledge base.

Combining what students must know and what they must be able to do may require teachers and districts to adapt their curriculum. To assist districts in this effort, teachers from across the state are developing curriculum frameworks in each of the content areas. These frameworks show how others might balance concepts and abilities for students at the elementary, middle and secondary levels. These models, however, are only resources. Missouri law assures local control of education. Each district has the authority to determine the content of its curriculum, how it will be organized and how it will be presented.

**Communication Arts**

In Communication Arts, students in Missouri public schools will acquire a solid foundation which includes knowledge of and proficiency in:

1. speaking and writing standard English (including grammar, usage, punctuation, spelling, capitalization)
2. reading and evaluating fiction, poetry and drama
3. reading and evaluating nonfiction works and material (such as biographies, newspapers, technical manuals)
4. writing formally (such as reports, narratives, essays) and informally (such as outlines, notes)
5. comprehending and evaluating the content and artistic aspects of oral and visual presentations (such as story-telling, debates, lectures, multi-media productions)
6. participating in formal and informal presentations and discussions of issues and ideas
7. identifying and evaluating relationships between language and culture

**Mathematics**

In Mathematics, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

1. addition, subtraction, multiplication and division; other number sense, including numerosation and estimation; and the application of these operations and concepts in the workplace and other situations
2. geometric and spatial sense involving measurement (including area, volume), trigonometry, and similarity and transformations of shapes
3. data analysis, probability and statistics
4. patterns and relationships within and among functions and algebraic, geometric and trigonometric concepts
5. mathematical systems (including real numbers, whole numbers, integers, fractions), geometry, and number theory (including primes, factors, multiples)
6. discrete mathematics (such as graph theory, counting techniques, matrices)

**Social Studies**

In Social Studies, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

1. principles expressed in the documents shaping constitutional democracy in the United States
2. continuity and change in the history of Missouri, the United States and the world
3. principles and processes of governance systems
4. economic concepts (including productivity and the market system) and principles (including the laws of supply and demand)
5. the major elements of geographical study and analysis (such as location, place, movement, regions) and their relationships to changes in society and environment
6. relationships of the individual and groups to institutions and cultural traditions
7. the use of tools of social science inquiry (such as surveys, statistics, maps, documents)

**Fine Arts**

In Fine Arts, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

1. process and techniques for the production, exhibition or performance of one or more of the visual or performed arts
2. the principles and elements of different art forms
3. the vocabulary to explain perceptions about and evaluations of works in dance, music, theater and visual arts
4. relationships of visual and performing arts and the relationships of the arts to other disciplines
5. visual and performing arts in historical and cultural contexts

**Science**

In Science, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

1. properties and principles of matter and energy
2. properties and principles of force and motion
3. characteristics and interactions of living organisms
4. changes in ecosystems and interactions of organisms with their environments
5. processes (such as plate movement, water cycle, air flow) and interactions of Earth’s biosphere, atmosphere, lithosphere and hydrosphere
6. composition and structure of the universe and the motions of the objects within it
7. processes of scientific inquiry (such as formulating and testing hypotheses)
8. impact of science, technology and human activity on resources and the environment

**Health/Physical Education**

In Health/Physical Education, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

1. structures of, functions of, and relationships among human body systems
2. principles and practices of physical and mental health (such as personal health habits, nutrition, stress management)
3. diseases and methods for prevention, treatment and control
4. principles of movement and physical fitness
5. methods used to assess health, reduce risk factors, and avoid high-risk behaviors (such as violence, tobacco, alcohol and other drug use)
6. consumer health issues (such as the effects of mass media and technologies on safety and health)
7. responses to emergency situations

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**The Show-Me Standards**

**KNOWLEDGE + PERFORMANCE = ACADEMIC SUCCESS**

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**Missouri Department of Elementary and Secondary Education • DESE 3220-5 Rep 12/09**
The Show-Me Standards

**GOAL 1**

Students in Missouri public schools will acquire the knowledge and skills to gather, analyze and apply information and ideas.

Students will demonstrate within and integrate across all content areas the ability to:

1. develop questions and ideas to initiate and refine research
2. conduct research to answer questions and evaluate information and ideas
3. design and conduct field and laboratory investigations to study nature and society
4. use technological tools and other resources to locate, select and organize information
5. comprehend and evaluate written, visual and oral presentations and works
6. discover and evaluate patterns and relationships in information, ideas and structures
7. evaluate the accuracy of information and the reliability of its sources
8. organize data, information and ideas into useful forms (including charts, graphs, outlines) for analysis or presentation
9. identify, analyze and compare the institutions, traditions and art forms of past and present societies
10. apply acquired information, ideas and skills to different contexts as students, workers, citizens and consumers

**GOAL 2**

Students in Missouri public schools will acquire the knowledge and skills to communicate effectively within and beyond the classroom.

Students will demonstrate within and integrate across all content areas the ability to:

1. plan and make written, oral and visual presentations for a variety of purposes and audiences
2. review and revise communications to improve accuracy and clarity
3. exchange information, questions and ideas while recognizing the perspectives of others
4. present perceptions and ideas regarding works of the arts, humanities and sciences
5. perform or produce works in the fine and practical arts
6. apply communication techniques to the job search and to the workplace
7. use technological tools to exchange information and ideas

**GOAL 3**

Students in Missouri public schools will acquire the knowledge and skills to recognize and solve problems.

Students will demonstrate within and integrate across all content areas the ability to:

1. identify problems and define their scope and elements
2. develop and apply strategies based on ways others have prevented or solved problems
3. develop and apply strategies based on one’s own experience in preventing or solving problems
4. evaluate the processes used in recognizing and solving problems
5. reason inductively from a set of specific facts and deductively from general premises
6. examine problems and proposed solutions from multiple perspectives
7. evaluate the extent to which a strategy addresses the problem
8. assess costs, benefits and other consequences of proposed solutions

**GOAL 4**

Students in Missouri public schools will acquire the knowledge and skills to make decisions and act as responsible members of society.

Students will demonstrate within and integrate across all content areas the ability to:

1. explain reasoning and identify information used to support decisions
2. understand and apply the rights and responsibilities of citizenship in Missouri and the United States
3. analyze the duties and responsibilities of individuals in societies
4. recognize and practice honesty and integrity in academic work and in the workplace
5. develop, monitor and revise plans of action to meet deadlines and accomplish goals
6. identify tasks that require a coordinated effort and work with others to complete those tasks
7. identify and apply practices that preserve and enhance the safety and health of self and others
8. explore, prepare for and seek educational and job opportunities

**Note to Readers:** What should high school graduates in Missouri know and be able to do? The Missourians who developed these standards wrestled with that question. In the end, they agreed that “knowing” and “doing” are actually two sides of the same coin. To perform well in school or on the job, one must have a good foundation of basic knowledge and skills. Equally important, though, is the ability to use and apply one’s knowledge in real-life situations.

These standards (73 in all) are intended to define what students should learn by the time they graduate from high school. On this side are 33 “performance” standards, listed under four broad goals. On the reverse side are 40 “knowledge” standards, listed in six subject areas. Taken together, they are intended to establish higher expectations for students throughout the Show-Me State. These standards do not represent everything a student will or should learn. However, graduates who meet these standards should be well-prepared for further education, work and civic responsibilities.

All Missourians are eager to ensure that graduates of Missouri’s public schools have the knowledge, skills and competencies essential to leading productive, fulfilling and successful lives as they continue their education, enter the workforce and assume their civic responsibilities. Schools need to establish high expectations that will challenge all students. To that end, the Outstanding Schools Act of 1993 called together master teachers, parents and policy-makers from around the state to create Missouri academic standards. These standards are the work of that group.

The standards are built around the belief that the success of Missouri’s students depends on both a solid foundation of knowledge and skills and the ability of students to apply their knowledge and skills to the kinds of problems and decisions they will likely encounter after they graduate.

The academic standards incorporate and strongly promote the understanding that active, hands-on learning will benefit students of all ages. By integrating and applying basic knowledge and skills in practical and challenging ways across all disciplines, students experience learning that is more engaging and motivating. Such learning stays in the mind long after the tests are over and acts as a springboard to success beyond the classroom.

These standards for students are not a curriculum. Rather, the standards serve as a blueprint from which local school districts may write challenging curriculum to help all students achieve. Missouri law assures local control of education. Each school district will determine how its curriculum will be structured and the best methods to implement that curriculum in the classroom.

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**KNOWLEDGE + PERFORMANCE = ACADEMIC SUCCESS**

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**Missouri Department of Elementary and Secondary Education • DESE 3220-5 Rep 12/09**

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Authority for the Show-Me Standards: Section 160.514, Revised Statutes of Missouri, and the Code of State Regulations, 5 CSR 50-375.100.
K-5 - Updated Version 11/24/08

The Science Course Level Expectations document is an updated version to the April, 2005 K-12 Science Grade Level Expectations.

The GLEs will provide the framework for instruction and assessment for elementary and intermediate science courses.

**Science Grade Level Expectations:**
* A Framework for Instruction and Assessment

The *Science Course Level Expectations* outline related ideas, concepts, skills and processes that form the foundation for understanding and learning science. It includes updates to the April, 2005 *K-12 Science Grade Level Expectations*. In addition, it provides a framework to bring focus to teaching, learning, and assessing science.

Since the Outstanding Schools Act of 1993, several documents have been developed prior to the 2005 K-12 *Grade Level Expectations* to aid Missouri school districts in creating curriculum that will enable all students to achieve their maximum potential. Those include:

- The *Show-Me Standards* which identify broad content knowledge and process skills for all students to be successful as they continue their education, enter the workforce, and assume civic responsibilities
- The *Framework for Curriculum Development* which provides districts with a “frame” for building curricula using the *Show-Me Standards* as a foundation
- The *Assessment Annotations for the Curriculum Frameworks* which identify content and processes that should be assessed at the local and state level

Essential content, aligned to state and national documents that support inquiry-based instruction, included in the Grade Level Expectations should be addressed in contexts that promote problem solving, reasoning, communication, making connections, and designing and analyzing representations. Each Grade and Course Level Expectation is aligned to the Show-Me Content and Process Standards (1996). A Depth-of-Knowledge level will be assigned to each grade or course level expectation before formal adoption of this document. The Depth of Knowledge identifies the highest level at which the expectation will be assessed, based upon the demand of the GLE. Depth-of-Knowledge levels include: Level 1-recall; Level 2-skill/concept; Level 3-strategic thinking; and Level 4-extended thinking.

* Indicates that an item is essential to the curricula of the Course but will not be assessed at the State level. The indicated expectations should be taught and assessed locally.

Sources: National Science Education Standards (NRC); Project 2061 (AAAS) Benchmarks for Science Literacy and Atlas: Research related to science education (e.g., Driver’s work re: misconceptions); Show Me Standards, Framework for Curriculum Development in Science, and MAP documents; National Assessment of Education Progress (NAEP) Science Framework; Curriculum documents from school districts and other states.

Important resources for districts’ use as they develop curriculum and assessments and plan instruction include: the Project 2061 (AAAS) Benchmarks (online at http://www.project2061.org/tools/benchol/bolintro.htm) and ATLAS (a compendium of concept maps showing grade-level appropriateness, sequencing of expectations in order to build conceptual understanding, and connections across science strands); Young People’s Images of Science and Making Sense of Secondary Science by Rosalind Driver et al. (both present research related to student misconceptions K-12); The National Science Education Standards (online at http://www.nap.edu/readingroom/books/nses/html/); How Students Learn Science (available from the National Research Council (The National Academies Press)
SCOPE AND SEQUENCE

This is one model of a curriculum scope and sequence. Grade level expectations are clustered into suggested units and arranged to support development of conceptual understanding. School district personnel are encouraged to adapt this model as necessary in order to better meet the needs of their students. The Expectations described in Strand 7: Inquiry and Strand 8: Science/Technology/Human Activity should be made a priority and integrated throughout every teaching unit in each of the other strands. Science assessments based from GLE 2.0 will begin 2009-2010 school year.

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
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<th>Fifth</th>
<th>Sixth</th>
<th>Seventh</th>
<th>Eighth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Investigating Sound</td>
<td></td>
<td>Forms of Energy: Sound</td>
<td>Earth, Sun and Moon</td>
<td>Forms of Energy: Electrical Circuits</td>
<td>Forms of Energy: Light and Sound</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Strand 2 Force &amp; Motion</strong></td>
<td>Change in Position</td>
<td>Investigating Motion</td>
<td>Forces and Motion</td>
<td>Laws of Motion</td>
<td>Work and Simple Machines</td>
<td>Force, Motion, and Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Strand 3 Living Organisms</strong></td>
<td>Plants and Animals</td>
<td>Characteristics of Plants and Animals</td>
<td>Life Cycles of Animals</td>
<td>Plants</td>
<td>Classification of Plants and Animals</td>
<td>Characteristics of Living Organisms</td>
<td>Cells and Body Systems</td>
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<td></td>
<td>Parent-Offspring Relationships</td>
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<td>Disease</td>
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<tr>
<td><strong>Strand 4 Ecology</strong></td>
<td>Weather and Seasons</td>
<td></td>
<td>Food Chains</td>
<td>Interactions among Organisms and their Environments</td>
<td></td>
<td>Ecosystems and Populations</td>
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<td></td>
<td>Rock Cycle and Plate Tectonics</td>
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</tr>
<tr>
<td><strong>Strand 6 Universe</strong></td>
<td>Objects in the Sky</td>
<td>Earth, Sun, and Moon</td>
<td></td>
<td></td>
<td>Solar System</td>
<td></td>
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</tr>
<tr>
<td><strong>Strand 7 Scientific Inquiry</strong></td>
<td>Inquiry</td>
<td>Inquiry</td>
<td>Inquiry</td>
<td>Inquiry</td>
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<td>Inquiry</td>
<td>Inquiry</td>
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<tr>
<td><strong>Strand 8 Science, Technology, &amp; Human Activity</strong></td>
<td>Science, Technology, and Human Activity</td>
<td>Science, Technology, and Human Activity</td>
<td>Science, Technology, and Human Activity</td>
<td>Science, Technology, and Human Activity</td>
<td>Science, Technology, and Human Activity</td>
<td>Science, Technology, and Human Activity</td>
<td>Science, Technology, and Human Activity</td>
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</tbody>
</table>

Science K-8 Assessment Document 12/03/08  Missouri Department of Elementary and Secondary Education – Curriculum and Assessment; Level of DOK was assigned by Group Consensus led by Dr. Norman Webb
## Strand 1: Properties and Principles of Matter and Energy

### 1. Changes in properties and states of matter provide evidence of the atomic theory of matter

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td><strong>Scope and Sequence – Properties of Matter</strong></td>
<td><strong>Scope and Sequence – Mass and Temperature</strong></td>
<td><strong>Scope and Sequence – Properties of Rocks and Soil</strong></td>
<td><strong>Scope and Sequence – Mixtures and Solutions</strong></td>
<td><strong>Note that NAEP acknowledges the confusion between mass and weight and does not expect students to differentiate between the two (accepting either mass/weight interchangeably) until after grade 4</strong></td>
</tr>
<tr>
<td></td>
<td>a. Describe physical properties of objects (i.e., size, shape, color, mass) by using the senses, simple tools (e.g., magnifiers, equal arm balances), and/or nonstandard measures (e.g., bigger/smaller; more/less)</td>
<td>a. Given an equal-arm balance and various objects, illustrate arrangements in which the beam is balanced</td>
<td>a. Describe and compare the physical properties of objects by using simple tools (i.e., thermometer, magnifier, centimeter ruler, balance, magnet)</td>
<td>a. Describe and compare the masses (the amount of matter in an object) of objects to the nearest gram using balances</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Identify materials (e.g., cloth, paper, wood, rock, metal) that make up an object and some of the physical properties of the materials (e.g., color, texture, shiny/dull, odor, sound, taste, flexibility)</td>
<td>b. Measure and compare the mass of objects (more/less)</td>
<td>b. Classify objects/substances as &quot;one kind of material&quot; or a mixture (e.g. m &amp; m’s® vs. trail mix, water vs. kool aid®)</td>
<td>b. Describe and compare the volumes (the amount of space an object occupies) of objects using a graduated cylinder</td>
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<tr>
<td></td>
<td>c. Sort objects based on observable physical properties (e.g., size, material, color, shape, mass)</td>
<td>c. Order objects according to mass</td>
<td>c. Identify situations where no two objects can occupy the same space at the same time (e.g. water level rises when an object or substance such as a rock is placed in a quantity of water)</td>
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<td><strong>DOK</strong></td>
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a – 2, b – 2, c – 1, d – 2
### Strand 1: Properties and Principles of Matter and Energy

1. Changes in properties and states of matter provide evidence of the atomic theory of matter -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
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</thead>
<tbody>
<tr>
<td><strong>B</strong></td>
<td></td>
<td><strong>Scope and Sequence – Properties of Rocks and Soil</strong></td>
<td></td>
<td><strong>Scope and Sequence – Mixtures and Solutions/ Changes on the Earth’s Surface</strong></td>
<td></td>
</tr>
<tr>
<td>Properties of mixtures depend upon the concentrations, properties, and interactions of particles</td>
<td></td>
<td>a. Observe and describe how mixtures are made by combining solids</td>
<td></td>
<td>a. Identify water as a solvent that dissolves materials (Do NOT assess the term solvent)</td>
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<tr>
<td></td>
<td></td>
<td>b. Describe ways to separate the components of a mixture by their physical properties (e.g., sorting, magnets, screening)</td>
<td></td>
<td>b. Observe and describe how mixtures are made by combining solids or liquids, or a combination of these</td>
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<td></td>
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<td>c. Distinguish between the components in a mixture/solution (e.g., trail mix, conglomerate rock, salad, soil, salt water)</td>
<td></td>
<td>c. Distinguish between the components in a mixture/solution (e.g., trail mix, conglomerate rock, salad, soil, salt water)</td>
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<td></td>
<td>d. Describe ways to separate the components of a mixture/solution by their properties (i.e., sorting, filtration, magnets, screening)</td>
<td></td>
<td>d. Describe ways to separate the components of a mixture/solution by their properties (i.e., sorting, filtration, magnets, screening)</td>
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<tr>
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<th>a – 1, b – 1, c – 1, d – 1</th>
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</thead>
</table>

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### Strand 1: Properties and Principles of Matter and Energy

#### 1. Changes in properties and states of matter provide evidence of the atomic theory of matter -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<tr>
<td>C</td>
<td></td>
<td></td>
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<td></td>
<td>Scope and Sequence – Water Cycle and Weather</td>
</tr>
</tbody>
</table>

- Properties of matter can be explained in terms of moving particles too small to be seen without tremendous magnification

<table>
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<tr>
<th>DOK</th>
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<td>a - 1</td>
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</tbody>
</table>
## Strand 1: Properties and Principles of Matter and Energy

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<td><strong>D</strong></td>
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<tr>
<td>Physical changes in the state of matter that result from thermal changes can be explained by the Kinetic Theory of Matter</td>
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<tr>
<td><strong>Scope and Sequence – Investigating States of Matter</strong></td>
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<tr>
<td>a. Compare the observable physical properties of solids, liquids, or gases (air) (i.e., visible vs. invisible, changes in shape, changes in the amount of space occupied)</td>
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<td>b. Identify everyday objects/substances as solid, liquid, or gas (e.g., air, water)</td>
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<td>c. Observe and identify that water evaporates (liquid water changes into a gas as it moves into the air)</td>
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<tr>
<td>d. Measure and compare the temperature of water when it exists as a solid to its temperature when it exists as a liquid</td>
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<tr>
<td>e. Investigate and observe that water can change from a liquid to a solid (freeze), and back again to a liquid (melt), as the result of temperature changes</td>
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<tr>
<td>f. Describe the changes in the physical properties of water (i.e., shape, volume) when frozen or melted</td>
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<tr>
<td>g. Predict and investigate the effect of heat (thermal energy) (i.e., change in temperature, melting, evaporation) on objects and materials</td>
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<tr>
<td>a = 2, b = 1, c = 1, d = 2, e = 1, f = 1, g = 2</td>
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<td>a = 1, b = 2</td>
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<tr>
<td><strong>E</strong></td>
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<tr>
<td>The atomic model describes the electrically neutral atom</td>
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<tr>
<td>Not assessed at this level</td>
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</table>

Science K-8 Assessment Document 12/03/08 Missouri Department of Elementary and Secondary Education – Curriculum and Assessment; Level of DOK was assigned by Group Consensus led by Dr. Norman Webb
### Strand 1: Properties and Principles of Matter and Energy

#### 1. Changes in properties and states of matter provide evidence of the atomic theory of matter -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<td><strong>F</strong></td>
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<tr>
<td>The periodic table organizes the elements according to their atomic structure and chemical reactivity</td>
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<td><strong>G</strong></td>
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<tr>
<td>Properties of objects and states of matter can change chemically and/or physically</td>
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<tr>
<td><strong>H</strong></td>
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<tr>
<td>Chemical bonding is the combining of different pure substances (elements, compounds) to form new substances with different properties</td>
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<td><strong>I</strong></td>
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<tr>
<td>Mass is conserved during any physical or chemical change</td>
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<tr>
<td><strong>Scope and Sequence – Mixtures and Solutions</strong></td>
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<tr>
<td>a. Observe that the total mass of a material remains constant whether it is together, in parts, or in a different state</td>
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<tr>
<td><strong>Scope and Sequence – Water Cycle and Weather</strong></td>
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<tr>
<td>a. Observe the mass of water remains constant as it changes state (as evidenced in a closed container)</td>
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</table>

Not assessed at this level
### Strand 1: Properties and Principles of Matter and Energy

#### 2. Energy has a source, can be stored, and can be transferred but is conserved within a system

<table>
<thead>
<tr>
<th>A</th>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
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<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forms of energy have a source, a means of transfer (work and heat), and a receiver</td>
<td><strong>Scope and Sequence – Investigating Sound</strong></td>
<td><strong>Scope and Sequence – Properties of Matter: Mass and Temperature</strong></td>
<td><strong>Scope and Sequence – Forms of Energy: Sound</strong></td>
<td><strong>Scope and Sequence – Investigating States of Matter</strong></td>
<td><strong>Scope and Sequence – Forms of Energy: Solar System</strong></td>
<td></td>
</tr>
<tr>
<td>a. Identify the sounds and their source of vibrations in everyday life (e.g., alarms, car horns, animals, machines, musical instruments)</td>
<td>a. Identify the source of energy that causes an increase in the temperature of an object (e.g., Sun, stove, flame, light bulb)</td>
<td>a. Identify air, water, and solids as mediums that sound travels through</td>
<td>a. Identify sources of thermal energy (e.g., Sun, stove, fire, body) that can cause solids to change to liquids, and liquids to change to gas</td>
<td>a. Construct and diagram a complete electric circuit by using a source (e.g., battery), means of transfer (e.g., wires), and receiver (e.g., resistance bulbs, motors, fans)</td>
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<tr>
<td>b. Compare different sounds (i.e., loudness, pitch, rhythm)</td>
<td>b. Compare the temperature of hot and cold objects using a simple thermometer</td>
<td>b. Describe different ways to change the pitch of a sound (i.e., changes in size, such as length or thickness, and in tightness/tension of the source)</td>
<td>b. Describe how the evidence of energy transfer in a closed series circuit (e.g., lit bulb, moving motor, fan)</td>
<td>b. Observe and describe how an object (e.g., moon, mirror, objects in a room) can only be seen when light is reflected from that object to the receiver (eye)</td>
<td></td>
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</tr>
<tr>
<td>c. Identify the ear as a receiver of vibrations that produce sound</td>
<td>c. Describe the change in temperature of an object as warmer or cooler</td>
<td>c. Describe how the ear serves as a receiver of sound (i.e., sound vibrates eardrum)</td>
<td>c. Observe light being transferred from the source to the receiver (eye) through space</td>
<td>c. Classify materials as conductors or insulators of electricity when placed within a circuit (e.g., wood, pencil lead, plastic, glass, aluminum foil, lemon juice, air, water)</td>
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<tr>
<td>d. Describe how to change the loudness of a sound (i.e., increase or decrease the force causing vibrations)</td>
<td>d. Describe how to change the loudness of a sound (i.e., increase or decrease the force causing vibrations)</td>
<td>d. Identify the three things (light source, object, and surface) necessary to produce a shadow</td>
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</tbody>
</table>

**DOK**

| a – 1, b – 1, c – 1 | a – 2, b – 2, c – 1 | a – 1, b – 1 |

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### Scope and Sequence

- **Investigating Sound**
  - a. Identify the sounds and their source of vibrations in everyday life (e.g., alarms, car horns, animals, machines, musical instruments)
  - b. Compare different sounds (i.e., loudness, pitch, rhythm)
  - c. Identify the ear as a receiver of vibrations that produce sound

- **Properties of Matter: Mass and Temperature**
  - a. Identify the source of energy that causes an increase in the temperature of an object (e.g., Sun, stove, flame, light bulb)
  - b. Compare the temperature of hot and cold objects using a simple thermometer
  - c. Describe the change in temperature of an object as warmer or cooler

- **Forms of Energy: Sound**
  - a. Identify air, water, and solids as mediums that sound travels through
  - b. Describe different ways to change the pitch of a sound (i.e., changes in size, such as length or thickness, and in tightness/tension of the source)
  - c. Describe how the ear serves as a receiver of sound (i.e., sound vibrates eardrum)
  - d. Describe how to change the loudness of a sound (i.e., increase or decrease the force causing vibrations)

- **Investigating States of Matter**
  - a. Identify sources of thermal energy (e.g., Sun, stove, fire, body) that can cause solids to change to liquids, and liquids to change to gas

- **Earth, Sun, and Moon**
  - a. Identify sources of light energy (e.g., Sun, bulbs, flames)
  - b. Observe light being transferred from the source to the receiver (eye) through space
  - c. Observe how an object (e.g., moon, mirror, objects in a room) can only be seen when light is reflected from that object to the receiver (eye)

- **Forms of Energy: Electrical Circuits**
  - a. Construct and diagram a complete electric circuit by using a source (e.g., battery), means of transfer (e.g., wires), and receiver (e.g., resistance bulbs, motors, fans)
  - b. Observe the evidence of energy transfer in a closed series circuit (e.g., lit bulb, moving motor, fan)
  - c. Classify materials as conductors or insulators of electricity when placed within a circuit (e.g., wood, pencil lead, plastic, glass, aluminum foil, lemon juice, air, water)

### Additional Information

- **Not assessed at this level**

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## Strand 1: Properties and Principles of Matter and Energy

### 2. Energy has a source, can be stored, and can be transferred but is conserved within a system -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<th>Third</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>C</strong></td>
<td></td>
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</tr>
<tr>
<td>Electromagnetic energy from the Sun (solar radiation) is a major source of energy on Earth</td>
<td>Scope and Sequence – Characteristics of Plants and Animals</td>
<td>Scope and Sequence – Earth, Sun, and Moon/Food Chains</td>
<td>a. Identify the Sun as the primary source of light and food energy on Earth</td>
<td></td>
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</tr>
<tr>
<td>a. Identify light from the Sun as a basic need of most plants</td>
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<td><strong>D</strong></td>
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<tr>
<td>Chemical reactions involve changes in the bonding of atoms with the release or absorption of energy</td>
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</tr>
<tr>
<td><strong>E</strong></td>
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</tr>
<tr>
<td>Nuclear energy is a major source of energy throughout the universe</td>
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<tr>
<td><strong>F</strong></td>
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</tr>
<tr>
<td>Energy can be transferred within a system as the total amount of energy remains constant (i.e., Law of Conservation of Energy)</td>
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</tr>
</tbody>
</table>

- Not assessed at this level

- Not assessed at this level

- Not assessed at this level
## Strand 2: Properties and Principles of Force and Motion

### 1. The motion of an object is described by its change in position relative to another object or point

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td><strong>Scope and Sequence – Changes in Position</strong></td>
<td><strong>Scope and Sequence – Investigating Motion</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Describe an object’s position relative to another object (e.g., above, below, in front of, behind)</td>
<td>a. Compare the position of an object relative to another object (e.g., left of or right of)</td>
<td>b. Describe an object’s motion as straight, circular, vibrating (back and forth), zigzag, stopping, starting, or falling</td>
<td>c. Compare the speeds (faster vs. slower) of two moving objects</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DOK**

### B

An object that is accelerating is speeding up, slowing down, or changing direction

<table>
<thead>
<tr>
<th>Scope and Sequence – Forces and Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Describe Earth’s gravity as a force that pulls objects on or near the Earth toward the Earth without touching the object</td>
</tr>
</tbody>
</table>

**DOK**

### C

Magnetic forces are related to electrical forces as different aspects of a single electromagnetic force

| Not assessed at this level |

**DOK**
## Strand 2: Properties and Principles of Force and Motion

### 2. Forces affect motion

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Forces are classified as either contact (pushes, pulls, friction, buoyancy) or non-contact forces (gravity, magnetism), that can be described in terms of direction and magnitude</td>
<td><strong>Scope and Sequence – Changes in Position</strong></td>
<td><strong>Scope and Sequence – Investigating Motion</strong></td>
<td><strong>Scope and Sequence – Forces and Motion</strong></td>
<td><strong>Scope and Sequence – Laws of Motion</strong></td>
<td><strong>Scope and Sequence – Work and Simple Machines</strong></td>
</tr>
<tr>
<td>a. Identify ways (push, pull) to cause some objects to move by touching them</td>
<td>a. Identify the force (i.e., push or pull) required to do work (move an object)</td>
<td>a. Identify magnets attract and repel each other and certain materials</td>
<td>b. Describe magnetism as a force that can push or pull other objects without touching them</td>
<td>b. Identify the forces acting on the motion of objects traveling in a straight line (specify that forces should be acting in the same line as the motion, provide examples)</td>
<td>a. Identify the forces acting on a load and use a spring scale to measure the weight (resistance force) of the load</td>
</tr>
<tr>
<td>b. Identify magnets cause some objects to move without touching them</td>
<td></td>
<td>c. Measure (using non-standard units) and compare the force (i.e., push or pull) required to overcome friction and move an object over different surfaces (i.e., rough, smooth)</td>
<td>c. Describe and compare forces (measured by a spring scale in Newton’s) applied to objects in a single line.</td>
<td>c. Observe and identify friction as a force that slows down or stops a moving object that is touching another object or surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d. Compare the forces (measured by a spring scale in Newton’s) required to overcome friction when an object moves over different surfaces (i.e., rough/smooth)</td>
<td>d. Compare the forces (measured by a spring scale in Newton’s) required to overcome friction when an object moves over different surfaces (i.e., rough/smooth)</td>
<td></td>
</tr>
</tbody>
</table>

DOK

a – 1, b – 2, c – 1, d – 2 a – 2

---

Science K-8 Assessment Document 12/03/08 Missouri Department of Elementary and Secondary Education – Curriculum and Assessment; Level of DOK was assigned by Group Consensus led by Dr. Norman Webb
## Strand 2: Properties and Principles of Force and Motion

### 2. Forces affect motion -- Continued

<table>
<thead>
<tr>
<th>B</th>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every object exerts a gravitational force on every other object</td>
<td>Scope and Sequence – Forces and Motion</td>
<td>a. Describe Earth’s gravity as a force that pulls objects on or near the Earth toward the Earth without touching the object</td>
<td></td>
<td></td>
<td>Scope and Sequence – Laws of Motion</td>
<td>a. Determine the gravitational pull of the Earth on an object (weight) using a spring scale</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C</th>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic forces are related to electrical forces as different aspects of a single electromagnetic force</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>a – 1</td>
<td></td>
</tr>
</tbody>
</table>

Not assessed at this level
<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D</strong> Newton’s Laws of Motion explain the interaction of mass and forces, and are used to predict changes in motion</td>
<td>Scope and Sequence – Investigating Motion</td>
<td>Scope and Sequence – Forces and Motion</td>
<td>Scope and Sequence – Laws of Motion</td>
<td>Scope and Sequence – Work and Simple Machines</td>
<td></td>
</tr>
<tr>
<td>a. Describe ways to change the motion of an object (i.e., how to cause an object to go slower, go faster, go farther, change direction, stop)</td>
<td>a. Describe the direction and amount of force (i.e., direction of push or pull, strong/weak push or pull) needed to change an object’s motion (i.e., faster/slower, change in direction)</td>
<td>a. Observe that balanced forces do not affect an object’s motion (need to clarify that balanced forces means no change in forces acting on an object)</td>
<td>a. Describe how unbalanced forces acting on an object changes its speed (faster/slower), direction of motion, or both (need to clarify that unbalanced forces means any change in forces acting on an object)</td>
<td>a. Describe how friction affects the amount of force needed to do work over different surfaces or through different media</td>
<td></td>
</tr>
<tr>
<td>b. Describe and compare the distances traveled by heavier/lighter objects after applying the same amount of force (i.e., push or pull) in the same direction</td>
<td>b. Describe how unbalanced forces acting on an object changes its speed (faster/slower), direction of motion, or both (need to clarify that unbalanced forces means any change in forces acting on an object)</td>
<td>c. Predict how the change in speed of an object (i.e., faster/slower/remain the same) is affected by the amount of force applied to an object and the mass of the object</td>
<td>d. Predict the effects of an electrostatic force (static electricity) on the motion of objects (attract or repel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Describe and compare the distances traveled by objects with the same mass after applying different amounts of force (i.e., push or pull) in the same direction</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

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# Strand 2: Properties and Principles of Force and Motion

## 2. Forces affect motion -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
</table>

### E

**Perpendicular forces act independently of each other**

Not assessed at this level

### F

**Work transfers energy into and out of a mechanical system**

**Scope and Sequence – Forces and Motion**

a. Compare and describe the amount of force (i.e., more, less, or same push or pull) needed to raise an object to a given height, with or without using inclined planes (ramps) of different slopes

b. Compare and describe the amount of force (i.e., more, less, or same push or pull) needed to raise an object to a given height, with or without using levers

c. Apply the use of an inclined plane (ramp) and/or lever to different real life situations in which objects are raised

**Work and Simple Machines**

a. Explain how work can be done on an object (force applied and distance moved) (No formula calculations at this level)

b. Identify the simple machines in common tools and household items

c. Compare the measures of effort force (measured using a spring scale to the nearest Newton) needed to lift a load with and without the use of simple machines

d. Observe and explain that simple machines change the amount of effort force and/or direction of force

DOK: a - 1, b - 1, c - 1, d - 1
## Strand 3: Characteristics and Interactions of Living Organisms

1. There is a fundamental unity underlying the diversity of all living organisms

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Organisms have basic needs for survival</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>Scope and Sequence – Characteristics of Plants and Animals</td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>a. Identify the basic needs of most animals (i.e., air, water, food, shelter)</td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
</tr>
<tr>
<td>b. Identify the basic needs of most plants (i.e., air, water, light)</td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
</tr>
<tr>
<td>c. Predict and investigate the growth of plants when growing conditions are altered (e.g., dark vs. light, water vs. no water)</td>
<td><img src="image16.png" alt="Image" /></td>
<td><img src="image17.png" alt="Image" /></td>
<td><img src="image18.png" alt="Image" /></td>
<td><img src="image19.png" alt="Image" /></td>
<td><img src="image20.png" alt="Image" /></td>
</tr>
</tbody>
</table>

| DOK | a = 1 |

| **B** |       |        |       |        |       |
| Organisms progress through life cycles unique to different types of organisms |       |        |       |        |       |
| ![Image](image21.png) | Scope and Sequence – Life Cycles of Animals | ![Image](image22.png) | ![Image](image23.png) | ![Image](image24.png) | ![Image](image25.png) |
| a. Identify and sequence life cycles (birth, growth, and development, reproduction and death) of animals (i.e., butterfly, frog, chicken, snake, dog) | ![Image](image26.png) | ![Image](image27.png) | ![Image](image28.png) | ![Image](image29.png) | ![Image](image30.png) |
| b. Record observations on the life cycle of different animals (e.g., butterfly, dog, frog, chicken, snake) | ![Image](image31.png) | ![Image](image32.png) | ![Image](image33.png) | ![Image](image34.png) | ![Image](image35.png) |

| DOK | a = 1 |

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**Strand 3: Characteristics and Interactions of Living Organisms**

1. **There is a fundamental unity underlying the diversity of all living organisms -- Continued**

<table>
<thead>
<tr>
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<th>Second</th>
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<th>Fourth</th>
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</thead>
<tbody>
<tr>
<td><strong>C</strong></td>
<td></td>
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</tr>
<tr>
<td>Cells are the fundamental units of structure and function of all living things</td>
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<td>DOK</td>
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</tbody>
</table>

Not assessed at this level
**Strand 3: Characteristics and Interactions of Living Organisms**

1. There is a fundamental unity underlying the diversity of all living organisms -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope and Sequence – Plants and Animals</strong></td>
<td><strong>Scope and Sequence – Characteristics of Plants and Animals</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Scope and Sequence – Classification of Plants and Animals</strong></td>
</tr>
<tr>
<td>a. Observe and compare the structures and behaviors of different kinds of plants and animals</td>
<td>a. Identify and compare the physical structures of a variety of plants (e.g., stem, leaves, flowers, seeds, roots)</td>
<td>b. Identify and compare the physical structures of a variety of animals (e.g., sensory organs, beaks, appendages, body covering) (Do NOT assess terms: sensory organs, appendages)</td>
<td>c. Identify the relationships between the physical structures of plants and the function of those structures (e.g., absorption of water, absorption of light energy, support, reproduction)</td>
<td>d. Identify the relationships between the physical structures of animals and the function of those structures (e.g., taking in water, support, movement, obtaining food, reproduction)</td>
<td>a. Compare structures (e.g., wings vs. fins vs. legs; gills vs. lungs; feathers vs. hair vs. scales) that serve similar functions for animals belonging to different vertebrate classes</td>
</tr>
</tbody>
</table>

**DOK**

- **a** – 1
- **a** – 2
## Strand 3: Characteristics and Interactions of Living Organisms

**1. There is a fundamental unity underlying the diversity of all living organisms -- Continued**

<table>
<thead>
<tr>
<th>Kindergarten</th>
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</thead>
<tbody>
<tr>
<td><strong>E</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biological classifications are based on how organisms are related</td>
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<td></td>
</tr>
<tr>
<td><em>Scope and Sequence – Characteristics of Plants and Animals</em></td>
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<td></td>
</tr>
<tr>
<td>a. Distinguish between plants and animals based on observable structures and behaviors</td>
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</tbody>
</table>

| DOK | | | | | |
| a – 2, b – 1, c – 1, d – 1, e – 1 | | | | | |
## Strand 3: Characteristics and Interactions of Living Organisms

### 2. Living organisms carry out life processes in order to survive

<table>
<thead>
<tr>
<th></th>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> The cell contains a set of structures called organelles that interact to carry out life processes through physical and chemical means</td>
<td>Not assessed at this level</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>B</strong> All living organisms have genetic material (DNA) that carries hereditary information</td>
<td>Not assessed at this level</td>
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<td></td>
</tr>
<tr>
<td><strong>C</strong> Complex multicellular organisms have systems that interact to carry out life processes through physical and chemical means</td>
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<tr>
<td>DOK</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scope and Sequence – Plants</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>a. Illustrate and trace the path of water and nutrients as they move through the transport system of a plant</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scope and Sequence – Classification of Plants and Animals</strong></td>
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<td></td>
</tr>
<tr>
<td>a. Compare the major organs/organ systems (e.g. support, reproductive, digestive, transport/circulatory, excretory, response) that perform similar functions for animals belonging to different vertebrate classes</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

DOK a – 1 a – 1
Strand 3: Characteristics and Interactions of Living Organisms

<table>
<thead>
<tr>
<th>2. Living organisms carry out life processes in order to survive -- Continued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td><strong>D</strong></td>
</tr>
<tr>
<td>Cells carry out chemical transformations that use energy for the synthesis or breakdown of organic compounds</td>
</tr>
<tr>
<td><strong>E</strong></td>
</tr>
<tr>
<td>Protein structure and function are coded by the DNA (Deoxyribonucleic acid) molecule</td>
</tr>
<tr>
<td><strong>F</strong></td>
</tr>
<tr>
<td>Cellular activities and responses can maintain stability internally while external conditions are changing (homeostasis)</td>
</tr>
<tr>
<td><strong>G</strong></td>
</tr>
<tr>
<td>Life processes can be disrupted by disease (intrinsic failures of the organ systems or by infection due to other organisms)</td>
</tr>
</tbody>
</table>
## Strand 3: Characteristics and Interactions of Living Organisms

3. There is a genetic basis for the transfer of biological characteristics from one generation to the next through productive processes

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproduction can occur asexually or sexually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not assessed at this level</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All living organisms have genetic material (DNA) that carries hereditary information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not assessed at this level</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromosomes are components of cells that occur in pairs and carry hereditary information from one cell to daughter cells and from parent to offspring during reproduction</td>
<td></td>
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<td></td>
<td></td>
<td>Not assessed at this level</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There is heritable variation within every species of organism</td>
<td>Scope and Sequence – Parent-Offspring Relationships</td>
<td>Scope and Sequence – Life Cycles of Animals</td>
<td>Scope and Sequence – Plants</td>
<td>a – 2</td>
<td></td>
</tr>
<tr>
<td>a. Identify that living things have offspring based on the organisms’ physical similarities and differences</td>
<td>a. Identify and relate the similarities and differences among animal parents and their offspring or multiple offspring</td>
<td>a. Identify and relate the similarities and differences between plants and their offspring (i.e., seedlings)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### Strand 3: Characteristics and Interactions of Living Organisms

#### 3. There is a genetic basis for the transfer of biological characteristics from one generation to the next through productive processes -- Continued

<table>
<thead>
<tr>
<th>E</th>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td>The pattern of inheritance for many traits can be predicted by using the principles of Mendelian genetics</td>
<td>Not assessed at this level</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

### 1. Organisms are interdependent with one another and with their environment

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
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<th>Fourth</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem</td>
<td><strong>Scope and Sequence – Weather and Seasons</strong></td>
<td><strong>Scope and Sequence – Characteristics of Plants and Animals</strong></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>a. Describe how the seasons affect the behavior of plants and animals.</td>
<td>a. Identify ways man depends on plants and animals for food, clothing, and shelter</td>
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<td></td>
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<td>b. Describe how the seasons affect the everyday life of humans (e.g., clothing, activities)</td>
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<tr>
<td><strong>DOK</strong></td>
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<td>a – 1, b – 1</td>
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</tr>
<tr>
<td><strong>B</strong></td>
<td>Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite</td>
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<td></td>
<td>Not assessed at this level</td>
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<tr>
<td><strong>DOK</strong></td>
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</tbody>
</table>
Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

| 1. Organisms are interdependent with one another and with their environment -- Continued |
|-----------------------------------------|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                                        | Kindergarten | First | Second | Third | Fourth | Fifth |
| **C**                                  | All organisms, including humans, and their activities cause changes in their environment that affect the ecosystem | |||||
| **DOK**                                | |||||
| **D**                                  | The diversity of species within an ecosystem is affected by changes in the environment, which can be caused by other organisms or outside processes | |||||
| **DOK**                                | |||||
| **Scope and Sequence -- Interactions among Organisms and their Environment** | |||||
| a. Identify examples in Missouri where human activity has had a beneficial or harmful effect on other organisms (e.g., feeding birds, littering vs. picking up trash, hunting/conservation of species, paving/restoring green space) | |||||
| **DOK**                                | a - 1 |||||
## Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

### 2. Matter and energy flow through an ecosystem

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<tbody>
<tr>
<td><strong>A</strong></td>
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<tr>
<td>As energy flows through the ecosystem, all organisms capture a portion of that energy and transform it to a form they can use</td>
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<tr>
<td><strong>B</strong></td>
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<tr>
<td>Matter is recycled through an ecosystem</td>
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</tbody>
</table>

**Scope and Sequence – Food Chains**

- Identify sunlight as the primary source of energy plants use to produce their own food
- Classify populations of organisms as producers or consumers by the role they serve in the ecosystem
- Sequence the flow of energy through a food chain beginning with the Sun
- Predict the possible effects of removing an organism from a food chain

**Scope and Sequence – Interactions among Organisms and their Environment**

- Classify populations of organisms as producers and consumers by the role they serve in the ecosystem
- Differentiate between the types of consumers (herbivore, carnivore, omnivore, and detrivore/decomposer)
- Categorize organisms as predator or prey in a given ecosystem

**DOK**

- A – 1, B – 1, C – 1, D – 2
- a – 1, b – 1, c – 1, d – 2
- a – 1, b – 1, c – 2

Not assessed at this level
## Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

### 3. Genetic variation sorted by the natural selection process explains evidence of biological evolution

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<tbody>
<tr>
<td><strong>A</strong></td>
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<tr>
<td>Evidence for the nature and rates of evolution can be found in anatomical and molecular characteristics of organisms and in the fossil record</td>
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<td>Scope and Sequence – Change's in the Earth's Surface</td>
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<td></td>
<td>a. Compare and contrast common fossils found in Missouri (i.e., trilobites, ferns, crinoids, gastropods, bivalves, fish, mastodons) to organisms present on Earth today</td>
<td></td>
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<tr>
<td><strong>DOK</strong></td>
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<td>a – 2</td>
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<tr>
<td><strong>B</strong></td>
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<tr>
<td>Reproduction is essential to the continuation of every species</td>
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<td>Not assessed at this level</td>
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</tbody>
</table>
### Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

#### 3. Genetic variation sorted by the natural selection process explains evidence of biological evolution -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<tr>
<td>C</td>
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<tr>
<td>Natural selection is the process of sorting individuals based on their ability to survive and reproduce within their ecosystem</td>
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</tbody>
</table>

- **Scope and Sequence – Interactions among Organisms and their Environment**
  - a. Identify specialized structures and describe how they help plants survive in their environment (e.g., root, cactus needles, thorns, winged seed, waxy leaves)
  - b. Identify specialized structures and senses and describe how they help animals survive in their environment (e.g., antennae, body covering, teeth, beaks, whiskers, appendages)
  - c. Identify internal cues (e.g., hunger) and external cues (e.g., changes in the environment) that cause organisms to behave in certain ways (e.g., hunting, migration, hibernation)
  - d. Predict which plant or animal will be able to survive in a specific environment based on its special structures or behaviors.

**DOK**

- a – 2, b – 2, c – 1, d – 2
Strand 5: Processes and Interactions of the Earth’s Systems  
(Geosphere, Atmosphere, and Hydrosphere)

1. Earth’s systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures

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<thead>
<tr>
<th>Kindergarten</th>
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<tr>
<td><strong>A</strong></td>
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<tr>
<td>The Earth’s crust is composed of various materials, including soil, minerals, and rocks, with characteristic properties</td>
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</table>

**Scope and Sequence - Earth Materials: Rocks and Minerals**

a. Observe and describe the physical properties (e.g., odor, color, appearance, relative grain size, texture, absorption of water) and different components (i.e., sand, clay, humus) of soils

b. Observe and describe the physical properties of rocks (e.g., size, shape, color, presence of fossils)

**Scope and Sequence – Changes in the Earth’s Surface**

a. Identify and describe the components of soil (e.g., plant roots and debris, bacteria, fungi, worms, types of rock) and its properties (e.g., odor, color, resistance to erosion, texture, fertility, relative grain size, absorption rate)

b. Compare the physical properties (i.e., size, shape, color, texture, layering, presence of fossils) of rocks (mixtures of different Earth materials, each with observable physical properties)

**DOK**

a – 1, b – 2
### Strand 5: Processes and Interactions of the Earth’s Systems
(Geosphere, Atmosphere, and Hydrosphere)

1. Earth’s systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures -- Continued

<table>
<thead>
<tr>
<th>B</th>
<th>Kindergarten</th>
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</thead>
<tbody>
<tr>
<td>The hydrosphere is composed of water (a material with unique properties) and other materials</td>
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<td>Scope and Sequence – Water Cycle and Weather</td>
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<th>Kindergarten</th>
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</thead>
<tbody>
<tr>
<td>The atmosphere (air) is composed of a mixture of gases, including water vapor, and minute particles</td>
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<td>Scope and Sequence – Weather and Seasons</td>
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<tr>
<td>Scope and Sequence – Weather and Seasons</td>
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<td></td>
<td>Scope and Sequence – Water Cycle and Weather</td>
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<tr>
<td>a. Observe wind as moving air that is felt</td>
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<td></td>
<td>a. Recognize the atmosphere is composed of a mixture of gases, water, and minute particles</td>
</tr>
</tbody>
</table>

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<tr>
<th>DOK</th>
<th>a – 1, b – 1, c – 1</th>
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</table>

Science K-8 Assessment Document 12/03/08  Missouri Department of Elementary and Secondary Education – Curriculum and Assessment; Level of DOK was assigned by Group Consensus led by Dr. Norman Webb
**Strand 5: Processes and Interactions of the Earth’s Systems**  
(Geosphere, Atmosphere, and Hydrosphere)

1. Earth’s systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures -- Continued

<table>
<thead>
<tr>
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<th>Kindergarten</th>
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<tbody>
<tr>
<td>Climate is a description of average weather conditions in a given area over time</td>
<td>Not assessed at this level</td>
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</tbody>
</table>
2. Earth’s systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes

<table>
<thead>
<tr>
<th>A</th>
<th>Kindergarten</th>
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</tr>
</thead>
<tbody>
<tr>
<td>The Earth’s materials and surface features are changed through a variety of external processes</td>
<td>Scope and Sequence – Earth Materials: Rocks and Minerals</td>
<td>a. Observe and identify examples of slow changes in the Earth’s surface and surface materials (e.g., rock, soil layers) due to processes such as decay (rotting), freezing, thawing, breaking, or wearing away by running water or wind</td>
<td>a. Observe and describe the breakdown of plant and animal material into soil through decomposition processes (i.e., decay/rotting, composting, digestion)</td>
<td>a. Observe and describe the breakdown of plant and animal material into soil through decomposition processes (i.e., decay/rotting, composting, digestion)</td>
<td>a. Observe and describe the breakdown of plant and animal material into soil through decomposition processes (i.e., decay/rotting, composting, digestion)</td>
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<tr>
<td>DOK</td>
<td>a – 1, b – 1, c – 1, d – 1, e – 2</td>
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</tbody>
</table>

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### Strand 5: Processes and Interactions of the Earth’s Systems  
(geosphere, atmosphere, and hydrosphere)

2. Earth’s systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes -- Continued

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<td><strong>B</strong></td>
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<tr>
<td>There are internal processes and sources of energy within the geosphere that cause changes in Earth’s crustal plates</td>
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<td><strong>DOK</strong></td>
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<td><strong>C</strong></td>
<td></td>
<td></td>
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<tr>
<td>Continual changes in Earth’s materials and surface that result from internal and external processes are described by the rock cycle</td>
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<td><strong>D</strong></td>
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<tr>
<td>Changes in the Earth over time can be inferred through rock and fossil evidence</td>
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</table>
### Strand 5: Processes and Interactions of the Earth’s Systems
(Geosphere, Atmosphere, and Hydrosphere)

2. Earth’s systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes -- Continued

<table>
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</thead>
<tbody>
<tr>
<td><strong>E</strong> Changes in the form of water as it moves through Earth’s systems are described as the water cycle</td>
<td></td>
<td></td>
<td><strong>Scope and Sequence – Investigating States of Matter</strong></td>
<td></td>
<td><strong>Scope and Sequence – Water Cycle and Weather</strong></td>
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<tr>
<td></td>
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<td></td>
<td>a. Describe clouds and precipitation as forms of water</td>
<td></td>
<td>a. Describe and trace the path of water as it cycles through the hydrosphere, geosphere, and atmosphere (i.e., the water cycle: evaporation, condensation, precipitation, surface run-off, groundwater flow)</td>
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<td>b. Identify the different forms water can take (e.g., snow, rain, sleet, fog, clouds, dew) as it moves through the water cycle</td>
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<td><strong>DOK</strong></td>
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<td>a – 1, b – 1</td>
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</tbody>
</table>
**Strand 5: Processes and Interactions of the Earth’s Systems**  
(Geosphere, Atmosphere, and Hydrosphere)

2. Earth’s systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes -- Continued

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<tbody>
<tr>
<td>Scope and Sequence – Weather and Seasons</td>
<td>Scope and Sequence – Observing Water and Weather</td>
<td></td>
<td></td>
<td></td>
<td>Scope and Sequence Water Cycle and Weather</td>
</tr>
<tr>
<td><strong>F</strong> Climate is a description of average weather conditions in a given area due to the transfer of energy and matter through Earth’s systems</td>
<td>a. Observe and describe daily weather: precipitation (e.g., snow, rain, sleet, fog), wind (i.e., light breezes to strong wind), cloud cover, temperature</td>
<td>a. Observe, measure, record weather data throughout the year (i.e., cloud cover, temperature, precipitation, wind speed) by using thermometers, rain gauges, wind socks</td>
<td>b. Observe and describe the general weather conditions that occur during each season</td>
<td>b. Compare temperatures in different locations (e.g., inside, outside, in the sun, in the shade)</td>
<td>a. Identify and use appropriate tools (i.e., thermometer, anemometer, wind vane, rain gauge, satellite images, weather maps) to collect weather data (i.e., temperature, wind speed and direction, precipitation, cloud type and cover.)</td>
</tr>
<tr>
<td></td>
<td>b. Observe and describe the general weather conditions that occur during each season</td>
<td>b. Compare temperatures in different locations (e.g., inside, outside, in the sun, in the shade)</td>
<td>c. Compare weather data observed at different times throughout the year (e.g., hot vs. cold, cloudy vs. clear, types of precipitation, windy vs. calm)</td>
<td>b. Identify and summarize relationships between weather data (e.g., temperature and time of day, cloud cover and temperature, wind direction and temperature) collected over a period of time.</td>
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<tr>
<td></td>
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<td>d. Identify patterns indicating relationships between observed weather data and weather phenomena (e.g., temperature and types of precipitation, clouds and amounts of precipitation)</td>
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</table>

DOK a – 2, b – 3

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## Strand 5: Processes and Interactions of the Earth’s Systems  
(Geosphere, Atmosphere, and Hydrosphere)

### 3. Human activity is dependent upon and affects Earth’s resources and systems

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</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Earth’s materials are limited natural resource’s affected by human activity</td>
<td><strong>Scope and Sequence – Observing Water and Weather</strong></td>
<td><strong>Scope and Sequence – Earth materials: Rocks and Soil</strong></td>
<td><strong>Scope and Sequence – Changes in the Earth’s Surface</strong></td>
<td><strong>Scope and Sequence – Water Cycle and Weather</strong></td>
<td></td>
</tr>
<tr>
<td>a. Observe and describe ways water, both as a solid and liquid, is used in everyday activities at different times of the year (e.g., bathe, drink, make ice cubes, build snowmen, cook, swim)</td>
<td>a. Observe and describe ways humans use Earth’s materials (e.g., soil, rocks) in a daily life</td>
<td>a. Identify the ways humans affect the erosion and deposition of Earth’s materials (e.g., clearing of land, planting vegetation, paving land construction of new buildings)</td>
<td>a. Explain how major bodies of water are important natural resources for human activity(e.g., food recreation, habitat, irrigation, solvent, transportation)</td>
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<td></td>
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<td>b. Propose ways to solve simple environmental problems (e.g., recycling, composting, ways to decrease soil erosion) that result from human activity</td>
<td>b. Describe how human needs and activities (e.g., irrigation damming of rivers, waste management, sources of drinking water) have affected the quantity and quality of major bodies of fresh water</td>
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<td>c. Propose solutions to problems related to water quality and availability that result from human activity</td>
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| DOK | | | **a – 1, b – 2** | **a – 2, b – 3, c – 3** |

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Science K-8 Assessment Document 12/03/08  
Missouri Department of Elementary and Secondary Education – Curriculum and Assessment; Level of DOK was assigned by Group Consensus led by Dr. Norman Webb
1. **The universe has observable properties and structure**

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<tbody>
<tr>
<td><strong>A</strong></td>
<td>Scope and Sequence – Objects in the Sky</td>
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<tr>
<td>The Earth, Sun, and Moon are part of a larger system that includes other planets and smaller celestial bodies</td>
<td>a. Observe and describe the presence of the Sun, Moon, and stars in the sky</td>
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<tr>
<td>b. Observe there are more stars in the sky than anyone can count and that they are scattered unevenly and vary in brightness</td>
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<td><strong>DOK</strong></td>
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<tr>
<td><strong>B</strong></td>
<td>Scope and Sequence – Earth, Sun, and Moon</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The Earth has a composition and location suitable to sustain life</td>
<td>a. Describe our Sun as a star because it provides light energy to the solar system</td>
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<tr>
<td>b. Observe and identify the Moon as a reflection of light</td>
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<tr>
<td>c. Identify that planets look like stars and appear to move across the sky among the stars</td>
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<tr>
<td><strong>DOK</strong></td>
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</table>

Science K-8 Assessment Document 12/03/08  Missouri Department of Elementary and Secondary Education – Curriculum and Assessment; Level of DOK was assigned by Group Consensus led by Dr. Norman Webb
### Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It

#### 1. The universe has observable properties and structure -- Continued

<table>
<thead>
<tr>
<th></th>
<th>Kindergarten</th>
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</thead>
<tbody>
<tr>
<td><strong>C</strong></td>
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</tr>
<tr>
<td>Most of the information we know about the universe comes from the electromagnetic spectrum</td>
<td>Not assessed at this level</td>
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<tr>
<td>DOK</td>
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</table>
**Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It**

2. Regular and predictable motions of objects in the universe can be described and explained as the result of gravitational forces.

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<thead>
<tr>
<th>Kindergarten</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong>&lt;br&gt;The apparent position of the Sun and other stars, as seen from Earth, change in observable patterns</td>
<td>Scope and Sequence – Objects in the Sky</td>
<td></td>
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</tr>
<tr>
<td>a. Describe the Sun as only being seen in the daytime and appears to move across the sky from morning to night</td>
<td></td>
<td></td>
<td>Scope and Sequence – Earth, Sun, and Moon</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B</strong>&lt;br&gt;The apparent position of the Moon, as seen from Earth, and its actual position relative to Earth change in observable patterns</td>
<td>Scope and Sequence – Objects in the Sky</td>
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</tr>
<tr>
<td>a. Observe the Moon can be seen sometimes at night and sometimes during the daytime</td>
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<td></td>
<td></td>
<td>Scope and Sequence – Earth, Sun, and Moon</td>
<td></td>
</tr>
<tr>
<td>b. Observe that the Moon appears to change shape over the course of a month</td>
<td></td>
<td></td>
<td>a. Illustrate and describe how the Moon appears to move slowly across the sky from east to west during the day and/or night</td>
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<td></td>
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<td></td>
<td>b. Describe the pattern of change that can be observed in the Moon’s appearance relative to time of day and month as it occurs over several months (Do NOT assess moon phases)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DOK**<br>a – 1, b – 2
## Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It

### 2. Regular and predictable motions of objects in the universe can be described and explained as the result of gravitational forces -- Continued

<table>
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<tr>
<th>Kindergarten</th>
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<tbody>
<tr>
<td>C</td>
<td>Scope and Sequence – Weather and Seasons</td>
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<tr>
<td>a. Observe and describe the characteristics of the four seasons as they cycle through the year (summer, fall, winter, spring)</td>
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<tr>
<td>D</td>
<td>Gravity is a force of attraction between objects in the solar system that governs their motion</td>
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Not assessed at this level
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</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
</tr>
<tr>
<td>Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation</td>
<td>a. Pose questions about objects, materials, organisms and events in the environment</td>
<td>a. Pose questions about objects, materials, organisms and events in the environment</td>
<td>a. Pose questions about objects, materials, organisms and events in the environment</td>
<td>a. Formulate testable questions and explanations (hypotheses)</td>
<td>a. Formulate testable questions and explanations (hypotheses)</td>
</tr>
<tr>
<td></td>
<td>b. Conduct a simple investigation (fair test) to answer a question</td>
<td>b. Plan and conduct a simple investigation (fair test) to answer a question</td>
<td>b. Plan and conduct a simple investigation (fair test) to answer a question</td>
<td>b. Recognize the characteristics of a fair and unbiased test</td>
<td>b. Recognize the characteristics of a fair and unbiased test</td>
</tr>
<tr>
<td>DOK</td>
<td>a – 2, b – 3</td>
<td>a – 2, b – 3</td>
<td>a – 2, b – 3</td>
<td>a – 3, b – 2, c – 2</td>
<td>a – 3, b – 2, c – 2, d – 3</td>
</tr>
</tbody>
</table>
# Strand 7: Scientific Inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking -- Continued

<table>
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<td>Scope and Sequence - All Units</td>
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<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
</tr>
<tr>
<td>B</td>
<td>Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations</td>
<td>a. Make qualitative observations using the five senses</td>
<td>a. Make qualitative observations using the five senses</td>
<td>a. Make qualitative observations using the five senses</td>
<td>a. Make qualitative observations using the five senses</td>
<td>a. Make qualitative observations using the five senses</td>
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<td></td>
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<td>b. Make observations using simple tools and equipment (e.g., magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
<td>b. Make observations using simple tools and equipment (e.g., magnifiers/hand lenses, magnets, equal arm balances, thermometers)</td>
<td>b. Make observations using simple tools and equipment (e.g., hand lenses, magnets, thermometers, metric rulers, balances, graduated cylinders)</td>
<td>b. Make observations using simple tools and equipment (e.g., hand lenses, magnets, thermometers, metric rulers, balances, graduated cylinders)</td>
<td>b. Determine the appropriate tools and techniques to collect data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Measure length and mass using non-standard units</td>
<td>c. Measure length, mass, and temperature using standard and non-standard units</td>
<td>c. Measure length, mass, and temperature using standard and non-standard units</td>
<td>c. Measure length to the nearest centimeter, mass using grams, temperature using degrees Celsius, volume using liters</td>
<td>c. Measure length to the nearest centimeter, mass using grams, temperature using degrees Celsius, volume to the nearest milliliter, force/weight to the nearest Newton</td>
</tr>
<tr>
<td></td>
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<td>d. Compare amounts/measurements</td>
<td>d. Compare amounts/measurements</td>
<td>d. Compare amounts/measurement</td>
<td>d. Compare amounts/measurements</td>
<td>d. Compare amounts/measurements</td>
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<tr>
<td></td>
<td></td>
<td>e. Judge whether measurements and computation of quantities are reasonable</td>
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<td></td>
<td></td>
<td>f. Judge whether measurements and computation of quantities are reasonable</td>
</tr>
</tbody>
</table>

DOK:

- a – 2, b – 1, c – 1, d – 2, e – 2
- a – 2, b – 1, c – 1, d – 2, e – 2
- a – 1, b – 2, c – 1, d – 1, e – 2, f – 3
**Strand 7: Scientific Inquiry**

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking --Continued

<table>
<thead>
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<tbody>
<tr>
<td><strong>C</strong></td>
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</tr>
<tr>
<td><strong>Scientific inquiry includes evaluation of explanations (laws/principles, theories/models) in light of evidence (data) and scientific principles (understandings)</strong></td>
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<tr>
<td>See CLEs: This concept became C, as the previous concept was eliminated and the GLEs were moved to this concept, and redundancy was eliminated</td>
<td></td>
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</tbody>
</table>

| Scope and Sequence - All Units | Use observations as support for reasonable explanations | Use observations as support for reasonable explanations | Use quantitative and qualitative data as support for reasonable explanations | Use quantitative and qualitative data as support for reasonable explanations | Use quantitative and qualitative data as support for reasonable explanations |
| Scope and Sequence - All Units | Use observations to describe relationships and patterns and to make predictions to be tested | Use observations to describe relationships and patterns and to make predictions to be tested | Use data as support for observed patterns and relationships, and to make predictions to be tested | Use data as support for observed patterns and relationships, and to make predictions to be tested | Use data as support for observed patterns and relationships, and to make predictions to be tested |
| Scope and Sequence - All Units | Compare explanations with prior knowledge | Compare explanations with prior knowledge | Compare explanations with prior knowledge | Compare explanations with prior knowledge | Compare explanations with prior knowledge |

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1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking - Continued

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<tbody>
<tr>
<td><strong>D</strong></td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
</tr>
</tbody>
</table>
| The nature of science relies upon communication of results and justification of explanations | a. Communicate observations using words, pictures, and numbers | a. Communicate simple procedures and results of investigations and explanations through:  
  ↦ oral presentations  
  ↦ drawings and maps  
  ↦ data tables  
  ↦ graphs (bar, pictograph)  
  ↦ writings | a. Communicate simple procedures and results of investigations and explanations through:  
  ↦ oral presentations  
  ↦ drawings and maps  
  ↦ data tables  
  ↦ graphs (bar, pictograph)  
  ↦ writings | a. Communicate the procedures and results of investigations and explanations through:  
  ↦ oral presentations  
  ↦ drawings and maps  
  ↦ data tables  
  ↦ graphs (bar, single line, pictograph)  
  ↦ writings | a. Communicate the procedures and results of investigations and explanations through:  
  ↦ oral presentations  
  ↦ drawings and maps  
  ↦ data tables  
  ↦ graphs (bar, single line, pictograph)  
  ↦ writings |

See CLEs: This concept became D, as the original C concept was eliminated

<table>
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<tr>
<th>DOK</th>
<th>Kindergarten</th>
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</table>
Strand 8: Impact of Science, Technology and Human Activity

1. The nature of technology can advance, and is advanced by, science as it seeks to apply scientific knowledge in ways that meet human needs

<table>
<thead>
<tr>
<th>A</th>
<th>Kindergarten</th>
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<th>Fourth</th>
<th>Fifth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designed objects are used to do things better or more easily and to do some things that could not otherwise be done at all</td>
<td>Scope and Sequence – Properties of Matter/Weather and Seasons</td>
<td>Scope and Sequence – Properties of Matter/Weather and Seasons</td>
<td>Scope and Sequence – Forms of Energy: Sound</td>
<td>Scope and Sequence – Investigating States of Matter/ Earth, Sun, and Moon</td>
<td>Scope and Sequence – Forms of Energy: Electrical Circuits</td>
<td>Scope and Sequence – Work and Simple Machines</td>
</tr>
<tr>
<td>a. Observe and identify that some objects occur in nature (natural objects); others have been designed and made by people</td>
<td>a. Observe and identify that some objects occur in nature (natural objects); others have been designed and made by people</td>
<td>a. Design and construct a musical instrument using materials (e.g., cardboard, wood, plastic, metal) and/or existing objects (e.g., toy wheels, gears, boxes, sticks) that can be used to perform a task (Assess Locally)</td>
<td>a. Observe and identify that some objects or materials (e.g., Sun, fire, ice, snow) occur in nature (natural objects); others (e.g., stoves, refrigerators, bulbs, candles, lanterns) have been designed and made by people to solve human problems and enhance the quality of life (human-made objects)</td>
<td>a. Design and construct an electrical device, using materials and/or existing objects, that can be used to perform a task (Assess Locally)</td>
<td>a. Design and construct a machine, using materials and/or existing objects, that can be used to perform a task (Assess Locally)</td>
<td></td>
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</tbody>
</table>

DOK

| DOK | a – 1 | a – 3 | a – 3 |
Strand 8: Impact of Science, Technology and Human Activity

1. The nature of technology can advance, and is advanced by, science as it seeks to apply scientific knowledge in ways that meet human needs -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
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<th>Second</th>
<th>Third</th>
<th>Fourth</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Scope and Sequence – Properties of Matter/Plants and Animals</td>
<td>Scope and Sequence – Properties of Matter/Characteristics of Plants and Animals</td>
<td>Scope and Sequence – Forms of Energy: Sound/Properties of Rocks and Soil</td>
<td>Scope and Sequence – Investigating States of Matter/Earth, Sun, and Moon/Plants</td>
<td>Scope and Sequence – Mixtures and Solutions/Forms of Energy: Electrical Circuits</td>
<td>Scope and Sequence – Work and Simple Machines/Water Cycle and Weather/Solar System/Classification of Plants and Animals</td>
</tr>
<tr>
<td>a. Describe how tools have helped scientists make better observations (i.e., magnifiers)</td>
<td>a. Describe how tools have helped scientists make better observations (i.e., magnifiers, balances, thermometers)</td>
<td>a. Describe how tools have helped scientists make better observations, measurements, or equipment for investigations (i.e., magnifiers, balances, stethoscopes, thermometers)</td>
<td>a. Describe how new technologies have helped scientists make better observations and measurements for investigations (i.e., telescopes, magnifiers, balances, microscopes, computers, stethoscopes, thermometers)</td>
<td>a. Describe how new technologies have helped scientists make better observations and measurements for investigations (i.e., telescopes, magnifiers, balances, microscopes, computers, stethoscopes, thermometers)</td>
<td>a. Describe how new technologies have helped scientists make better observations and measurements for investigations (i.e., telescopes, electronic balances, electronic microscopes, computer probes such as thermometers)</td>
</tr>
</tbody>
</table>

DOK a–2 a–2 a–2
### Strand 8: Impact of Science, Technology and Human Activity

1. The nature of technology can advance, and is advanced by, science as it seeks to apply scientific knowledge in ways that meet human needs -- Continued

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First</th>
<th>Second</th>
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<th>Fourth</th>
<th>Scope and Sequence – Forms of Energy: Electrical Circuits/Laws of Motion/Interactions among Organisms and Their Environments</th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td></td>
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<td></td>
<td>a. Identify how the effects of inventions or technological advances (e.g., different types of light bulbs, semiconductors/integrated circuits and electronics, satellite imagery, robotics, communication, transportation, generation of energy, renewable materials) may be helpful, harmful, or both (Assess Locally)</td>
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## Strand 8: Impact of Science, Technology and Human Activity

2. Historical and cultural perspectives of scientific explanations help to improve understanding of the nature of science and how science knowledge and technology evolve over time

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<td><strong>A</strong></td>
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<tr>
<td>People of different gender and ethnicity have contributed to scientific discoveries and the invention of technological innovations</td>
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<td><strong>B</strong></td>
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<td>Scientific theories are developed based on the body of knowledge that exists at any particular time and must be rigorously questioned and tested for validity</td>
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### Strand 8: Impact of Science, Technology and Human Activity

#### 3. Science and technology affect, and are affected by, society

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<tr>
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<tr>
<td><strong>A</strong></td>
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<tr>
<td>People, alone or in groups, are always making discoveries about nature and inventing new ways to solve problems and get work done</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
<td>Scope and Sequence - All Units</td>
</tr>
<tr>
<td>a. Identify a question that was asked, or could be asked, or a problem that needed to be solved when given a brief scenario (fiction or nonfiction of individuals solving everyday problems or learning through discovery)</td>
<td>a. Identify a question that was asked, or could be asked, or a problem that needed to be solved when given a brief scenario (fiction or nonfiction of individuals solving everyday problems or learning through discovery)</td>
<td>a. Identify a question that was asked, or could be asked, or a problem that needed to be solved when given a brief scenario (fiction or nonfiction of individuals solving everyday problems or learning through discovery)</td>
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<td>a. Identify a question that was asked, or could be asked, or a problem that needed to be solved when given a brief scenario (fiction or nonfiction of individuals solving everyday problems or learning through discovery)</td>
</tr>
<tr>
<td>b. Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member (Assess Locally)</td>
<td>b. Work with a group to solve a problem, giving due credit to the ideas and contributions of each group member (Assess Locally)</td>
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**B**

Social, political, economic, ethical and environmental factors strongly influence, and are influenced by, the direction of progress of science and technology

**DOK**

Not assessed at this level
### Strand 8: Impact of Science, Technology and Human Activity

#### 3. Science and technology affect, and are affected by, society -- Continued

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Scientific ethics require that scientists must not knowingly</td>
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<td>Km</td>
<td>Km</td>
<td>Km</td>
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<tr>
<td>subject people or the community to health or property risks</td>
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<tr>
<td>without their knowledge and consent</td>
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<thead>
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</thead>
<tbody>
<tr>
<td>Scientific information is presented through a number of credible</td>
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<td>Km</td>
<td>Km</td>
<td>Km</td>
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<tr>
<td>sources, but is at times influenced in such a way to become</td>
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Not assessed at this level
Topic Arrangements of the Next Generation Science Standards

At the beginning of the NGSS development process, in order to eliminate potential redundancy, seek an appropriate grain size, and seek natural connections among the Disciplinary Core Ideas (DCIs) identified within the *Framework for K-12 Science Education*, the writers arranged the DCIs into topics around which to develop the standards. This structure provided the original basis of the standards, and is preferred by many states. However, the coding structure of individual performance expectations reflects the DCI arrangement in the *Framework*.

Due to the fact that the NGSS progress toward end-of-high school core ideas, the standards may be rearranged in any order within a grade level.

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Elementary Standards

Students in kindergarten through fifth grade begin to develop an understanding of the four disciplinary core ideas: physical sciences; life sciences; earth and space sciences; and engineering, technology, and applications of science. In the earlier grades, students begin by recognizing patterns and formulating answers to questions about the world around them. By the end of fifth grade, students are able to demonstrate grade-appropriate proficiency in gathering, describing, and using information about the natural and designed world(s). The performance expectations in elementary school grade bands develop ideas and skills that will allow students to explain more complex phenomena in the four disciplines as they progress to middle school and high school. While the performance expectations shown in kindergarten through fifth grade couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.
Kindergarten

The performance expectations in kindergarten help students formulate answers to questions such as: “What happens if you push or pull an object harder? Where do animals live and why do they live there? What is the weather like today and how is it different from yesterday?”

Kindergarten performance expectations include PS2, PS3, LS1, ESS2, ESS3, and ETS1 Disciplinary Core Ideas from the *NRC Framework*. Students are expected to develop understanding of patterns and variations in local weather and the purpose of weather forecasting to prepare for, and respond to, severe weather. Students are able to apply an understanding of the effects of different strengths or different directions of pushes and pulls on the motion of an object to analyze a design solution. Students are also expected to develop understanding of what plants and animals (including humans) need to survive and the relationship between their needs and where they live. The crosscutting concepts of patterns; cause and effect; systems and system models; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the kindergarten performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.
### K.Force and Interactions: Pushes and Pulls

**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.]

**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.]

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### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>PS2.A: Forces and Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2)</td>
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<tr>
<td>Pushing or pulling on an object can change the speed or direction of its motion and start or stop it. (K-PS2-1),(K-PS2-2)</td>
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<tr>
<th>PS2.B: Types of Interactions</th>
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</thead>
<tbody>
<tr>
<td>When objects touch or collide, they push on one another and can change motion. (K-PS2-1)</td>
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</table>

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<tr>
<th>PS3.C: Relationship Between Energy and Forces</th>
</tr>
</thead>
<tbody>
<tr>
<td>A bigger push or pull makes things speed up or slow down more quickly. (Secondary to K-PS2-1)</td>
</tr>
</tbody>
</table>

### Science and Engineering Practices

**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)

### Crosscutting Concepts

**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)

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### Connections to Nature of Science

- Scientists use different ways to study the world. (K-PS2-1)

### Connections to Other DCIs

- **K.ETS1.A** (K-PS2-2); **K.ETS1.B** (K-PS2-2)

### Articulation of DCIs across grades

- **2.EET1.B** (K-PS2-2); **3.PS2.A** (K-PS2-1),(K-PS2-2); **3.PS2.B** (K-PS2-1); **4.PS3.A** (K-PS2-1); **4.EET1.A** (K-PS2-2)

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### Common Core State Standards Connections:

- **ELA/Literacy - RI.K.1** With prompting and support, ask and answer questions about key details in a text. (K-PS2-2)
- **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS2-1)
- **SL.K.3** Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-PS2-2)
- **Mathematics** - **MP.2** Reason abstractly and quantitatively. (K-PS2-1)
- **K.MD.A.1** Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-PS2-1)
- **K.MD.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-PS2-1)

---

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*
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. Students can:

- Use a model to represent relationships in the natural world. (K-ESS3-1)

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Students can:

- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-LS1-1)

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). Students can:

- Construct an argument with evidence to support a claim. (K-ESS2-2)

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. Students can:

- Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.* (K-ESS1-3)

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

The performance expectations above were developed using the following elements from the NRC document A Framework for K–12 Science Education:

- Patterns: 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)
- Cause and Effect: 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, K-ESS3-3)

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)

**Disciplinary Core Ideas**

**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)
- ESS2.E: Biogeology
- Plants and animals can change their environment. (K-ESS2-2)
- 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.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, K-ESS3-3)

**Crosscutting Concepts**

- **Patterns**: Scientists look for patterns and order when making observations about the world. (K-LS1-1)
- **Patterns**: 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)
- **Cause and Effect**: Events have causes that generate observable patterns. (K-ESS3-3)
- **Systems and System Models**: Systems in the natural and designed world have parts that work together. (K-ESS2-2, K-ESS3-1)

**Common Core State Standards Connections**

**ELA/Literacy** -
- RI.K.1: With prompting and support, ask and answer questions about key details in a text. (K-ESS2-2)
- W.K.1: Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book. (K-ESS2-2)
- 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. (K-ESS2-2, K-ESS3-3)
- W.K.7: Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-LS1-1)
- SL.K.5: Add drawings or other visual displays to descriptions as desired to provide additional detail. (K-ESS3-1)

**Mathematics** -
- MP.2: Reason abstractly and quantitatively. (K-ESS3-1)
- MP.4: Model with mathematics. (K-ESS3-1)
- K.CC: Counting and Cardinality (K-ESS3-1)
- K.MD.A.1: Directly compare two objects with a measurable attribute in common, to see which object has “more of”/“less of” the attribute, and describe the difference. (K-LS1-1)

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

K. Weather and Climate

Students who demonstrate understanding can:

**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.]

**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.]

**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.]

**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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education:*

### Disciplinary Core Ideas

**PS3.B: Conservation of Energy and Energy Transfer**
- Sunlight warms Earth’s surface. (K-PS3-1),(K-PS3-2)
- 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)

**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)

**ETS1.A: Defining and Delimiting an Engineering Problem**
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary to K-ESS3-2)

### Crosscutting Concepts

**Patterns**
- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1)

**Cause and Effect**
- Events have causes that generate observable patterns. (K-PS3-1),(K-PS3-2),(K-ESS3-2)

### 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 different without technology. (K-ESS3-2)

### Asking Questions and Defining Problems

**Science and Engineering Practices**

- 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)

**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)

**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)

**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)

**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/or use media to obtain scientific information to describe patterns in the natural world. (K-ESS3-2)

### Scientific Investigations Use a Variety of Methods

- Scientists use different ways to study the world. (K-PS3-1)
- Science Knowledge is Based on Empirical Evidence
- Scientists look for patterns and order when making observations about the world. (K-ESS2-1)

**Connections to other DCIs in kindergarten:** K.ETS1.A (K-PS3-2),(K-ESS3-2); K.ETS1.L.B (K-PS3-2)

**Articulation of DCIs across grade levels:** 1.PS4.B (K-PS3-1),(K-PS3-2); 2.ESS1.C (K-ESS3-2); 2.ESS2.A (K-ESS2-1); 2.ESS2.B (K-ESS2-1); 3.ESS2.D (K-PS3-2); 3.ESS3.B (K-ESS3-2); 4.ESS2.A (K-ESS1-2); 4.ESS3.B (K-ESS3-2); 4.ESS3.A (K-ESS3-2); 4.ETS1.A (K-PS3-2)

**Common Core State Standards Connections:**

- **ELA/Literacy - RI.K.1** With prompting and support, ask and answer questions about key details in a text. (K-ESS3-2)
- **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS3-1),(K-PS3-2),(K-ESS2-1)
- **SL.K.3** Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-ESS3-2)
- **Mathematics**
  - **MP.2** Reason abstractly and quantitatively. (K-ESS2-1)
  - **MP.4** Model with mathematics. (K-ESS2-1)
  - **K.CC** Counting and Cardinality (K-ESS3-2)
  - **K.CC.A.1** Know number names and the count sequence. (K-ESS2-1)
  - **K.CC.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-PS3-1),(K-PS3-2)
  - **K.MD.B.3** Classify objects into given categories; count the number of objects in each category and sort the categories by count. (K-ESS2-1)

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

First Grade

The performance expectations in first grade help students formulate answers to questions such as: “What happens when materials vibrate? What happens when there is no light? What are some ways plants and animals meet their needs so that they can survive and grow? How are parents and their children similar and different? What objects are in the sky and how do they seem to move?” First grade performance expectations include PS4, LS1, LS3, and ESS1 Disciplinary Core Ideas from the NRC Framework. Students are expected to develop understanding of the relationship between sound and vibrating materials as well as between the availability of light and ability to see objects. The idea that light travels from place to place can be understood by students at this level through determining the effect of placing objects made with different materials in the path of a beam of light. Students are also expected to develop understanding of how plants and animals use their external parts to help them survive, grow, and meet their needs as well as how behaviors of parents and offspring help the offspring survive. The understanding is developed that young plants and animals are like, but not exactly the same as, their parents. Students are able to observe, describe, and predict some patterns of the movement of objects in the sky. The crosscutting concepts of patterns; cause and effect; structure and function; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the first grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.
1.Waves: Light and Sound

Students who demonstrate understanding can:

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.]

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.]

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).] [Assessment Boundary: Assessment does not include the speed of light.]

1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.* [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.]

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and Carrying Out...</td>
<td>PS4.A: Wave Properties</td>
<td>Cause and Effect</td>
</tr>
<tr>
<td></td>
<td>- Sound can make matter vibrate, and vibrating matter can make sound. (1-PS4-1)</td>
<td>- 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)</td>
</tr>
<tr>
<td>Constructing Explanations...</td>
<td>PS4.B: Electromagnetic Radiation</td>
<td>- Connections to Engineering, Technology, and Applications of Science</td>
</tr>
<tr>
<td></td>
<td>- Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4-2)</td>
<td>- People depend on various technologies in their lives; human life would be very different without technology. (1-PS4-4)</td>
</tr>
<tr>
<td>Designing Solutions</td>
<td>PS4.C: Information Technologies and Instrumentation</td>
<td></td>
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<tr>
<td></td>
<td>- 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)</td>
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<td>- Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4-2)</td>
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</table>

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade levels: K.E.TS1.A (1-PS4-1); 1.E.TS1.A (1-PS4-2); 1.E.TS1.B (1-PS4-3); 1.E.TS1.C (1-PS4-4); 2.E.TS1.A (1-PS4-1); 2.E.TS1.B (1-PS4-2); 2.E.TS1.C (1-PS4-3); 2.E.TS1.D (1-PS4-4); 3.E.TS1.C (1-PS4-3); 3.E.TS1.D (1-PS4-4); 4.E.TS1.A (1-PS4-1); 4.E.TS1.B (1-PS4-2); 4.E.TS1.C (1-PS4-3); 4.E.TS1.D (1-PS4-4);

Common Core State Standards Connections: ELA/Literacy -

W.1.2 Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure. (1-PS4-2)

W.1.7 Participate in shared research and writing projects (e.g., explore a number of “how-to” books on a given topic and use them to write a sequence of instructions). (1-PS4-1),(1-PS4-2),(1-PS4-3),(1-PS4-4)

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-PS4-1),(1-PS4-2),(1-PS4-3)

SL.1.1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. (1-PS4-1),(1-PS4-2),(1-PS4-3)

Mathematics -

MP.5 Use appropriate tools strategically. (1-PS4-4)

1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-PS4-4)

1.MD.A.2 Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. (1-PS4-4)
### Science and Engineering Practices

**Constructing Explanations and Designing Solutions**

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.*

2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

3. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

### Disciplinary Core Ideas

#### 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.

#### 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.

#### 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.

#### 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.

#### 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.

### Crosscutting Concepts

#### Patterns
- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

#### Structure and Function
- The shape and stability of structures of natural and designed objects are related to their function(s).

### Connections to Nature of Science

**Scientific Knowledge is Based on Empirical Evidence**

1. Scientists look for patterns and order when making observations about the world.

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

1. Space Systems: Patterns and Cycles

Students who demonstrate understanding can:

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.]

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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices
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)

Disciplinary Core Ideas
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)

Crosscutting Concepts
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)

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade levels: 3.PS2.A (1-ESS1-1); 5.PS2.B (1-ESS1-1),(1-ESS1-2) 5-ESS1.B (1-ESS1-1),(1-ESS1-2)

Common Core State Standards Connections:
ELA/Literacy –
W.1.7 Participate in shared research and writing projects (e.g., explore a number of “how-to” books on a given topic and use them to write a sequence of instructions). (1-ESS1-1),(1-ESS1-2)
W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-ESS1-1),(1-ESS1-2)

Mathematics –
MP.2 Reason abstractly and quantitatively. (1-ESS1-2)
MP.4 Model with mathematics. (1-ESS1-1)
MP.5 Use appropriate tools strategically. (1-ESS1-2)
1.OA.A.1 Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations to represent the problem. (1-ESS1-2)
1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. (1-ESS1-2)
Second Grade

The performance expectations in second grade help students formulate answers to questions such as: “How does land change and what are some things that cause it to change? What are the different kinds of land and bodies of water? How are materials similar and different from one another, and how do the properties of the materials relate to their use? What do plants need to grow? How many types of living things live in a place?” Second grade performance expectations include PS1, LS2, LS4, ESS1, ESS2, and ETS1 Disciplinary Core Ideas from the NRC Framework. Students are expected to develop an understanding of what plants need to grow and how plants depend on animals for seed dispersal and pollination. Students are also expected to compare the diversity of life in different habitats. An understanding of observable properties of materials is developed by students at this level through analysis and classification of different materials. Students are able to apply their understanding of the idea that wind and water can change the shape of the land to compare design solutions to slow or prevent such change. Students are able to use information and models to identify and represent the shapes and kinds of land and bodies of water in an area and where water is found on Earth. The crosscutting concepts of patterns; cause and effect; energy and matter; structure and function; stability and change; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the second grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.
2. Structure and Properties of Matter

Students who demonstrate understanding can:

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.]

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.]

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.]

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.]

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Science and Engineering Practices

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 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)

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Disciplinary Core Ideas


- 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 materials share observable patterns. (2-PS1-2)
- A 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 observable changes in its observable properties. (2-PS1-4)

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Crosscutting Concepts

Patterns
- Patterns in the natural and human designed world can be observed. (2-PS1-1)
- Causes 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)

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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)

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Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Scientists search for cause and effect relationships to explain natural events. (2-PS1-4)

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-levels: 4.ESS2.A (2-PS1-3); 5.PS1.A (2-PS1-1),(2-PS1-2),(2-PS1-3); 5.PS1.B (2-PS1-4); 5.LS2.A (2-PS1-3)

Common Core State Standards Connections:
- ELA/Literacy -
  - RI.2.1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (2-PS1-4)
  - RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. (2-PS1-4)
  - RI.2.8 Describe how reasons support specific points the author makes in a text. (2-PS1-2),(2-PS1-3)
  - W.2.1 Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., because, and, also) to connect opinion and reasons, and provide a concluding statement or section. (2-PS1-4)
  - W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-2),(2-PS1-3)
  - W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1),(2-PS1-2),(2-PS1-3)
- Mathematics -
  - MP.2 Reason abstractly and quantitatively. (2-PS1-2)
  - MP.4 Model with mathematics. (2-PS1-1),(2-PS1-2)
  - MP.5 Use appropriate tools strategically. (2-PS1-2)
  - 2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-2)

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2. Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

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.]

2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

### Science and Engineering Practices

**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)
  - Make observations (firsthand or from media) to collect data which can be used to make comparisons. (2-LS4-1)

### Disciplinary Core Ideas

**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)

**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)

**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)

### Crosscutting Concepts

**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)

### Scientific Knowledge is Based on Empirical Evidence
- Scientists look for patterns and order when making observations about the world. (2-LS4-1)

**Connections to Nature of Science**
- Scientists look for patterns and order when making observations about the world. (2-LS4-1)

**Common Core State Standards Connections:**

**ELA/Literacy - W.2.7**
- Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS2-1),(2-LS4-1)

**W.2.8**
- Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1),(2-LS4-1)

**SL.2.5**
- Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (2-LS2-2)

**Mathematics - MP.2**
- Reason abstractly and quantitatively. (2-LS2-1),(2-LS4-1)

**MP.4**
- Model with mathematics. (2-LS2-1),(2-LS4-1)

**MP.5**
- Use appropriate tools strategically. (2-LS2-1)

**2.MD.D.10**
- Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems. (2-LS2-2),(2-LS4-1)

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2. Earth’s Systems: Processes that Shape the Earth

Students who demonstrate understanding can:

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.]

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 designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.]

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.]

2-ESS2.3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices

<table>
<thead>
<tr>
<th>Developing and Using Models</th>
<th>Disciplinary Core Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>ESS1.C: The History of Planet Earth</td>
</tr>
<tr>
<td></td>
<td>• Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)</td>
</tr>
<tr>
<td></td>
<td>ESS2.A: Earth Materials and Systems</td>
</tr>
<tr>
<td></td>
<td>• Wind and water can change the shape of the land. (2-ESS2-1)</td>
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<tr>
<td></td>
<td>ESS2.B: Plate Tectonics and Large-Scale System Interactions</td>
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<td>• Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2)</td>
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<td>ESS2.C: The Roles of Water in Earth's Surface Processes</td>
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<td>• Water exists as solid ice and in liquid form. (2-ESS2-3)</td>
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<td>ETS1.C: Optimizing the Design Solution</td>
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<td>• 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)</td>
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<tbody>
<tr>
<td>Patterns</td>
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<tr>
<td>• Patterns in the natural world can be observed. (2-ESS2-2),(2-ESS2-3)</td>
</tr>
<tr>
<td>Stability and Change</td>
</tr>
<tr>
<td>• Things may change slowly or rapidly. (2-ESS1-1),(2-ESS2-1)</td>
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<th>Connections to Engineering, Technology, and Applications of Science</th>
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<tr>
<td>Influence of Engineering, Technology, and Science on Society and the Natural World</td>
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<tr>
<td>• Developing and using technology has impacts on the natural world. (2-ESS2-1)</td>
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<tr>
<th>Connections to Nature of Science</th>
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<tbody>
<tr>
<td>Science Addresses Questions About the Natural and Material World</td>
</tr>
<tr>
<td>• Scientists study the natural and material world. (2-ESS2-1)</td>
</tr>
</tbody>
</table>

Articulation of DCIs across grade levels:

- 2.ETS1.A (2-ESS2-3)
- 3.LS1.B (2-ESS2-1); 4.ETS1.C (2-ESS2-1); 2.ESS1.A (2-ESS2-1); 4.ETS1.B (2-ESS2-1); 4.ETS1.C (2-ESS2-1); 5.ESS2.A (2-ESS2-2); 5.ESS2.C (2-ESS2-2); (2-ESS2-3)

Common Core State Standards Connections:

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<tr>
<td>W.2.6</td>
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<td>W.2.7</td>
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<td>W.2.8</td>
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<tr>
<td>SL.2.2</td>
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<tr>
<td>SL.2.5</td>
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</tbody>
</table>

Mathematics -

| MP.2 | Reason abstractly and quantitatively. (2-ESS2-1),(2-ESS2-2),(2-ESS2-2) |
| MP.4 | Model with mathematics. (2-ESS1-1),(2-ESS2-1),(2-ESS2-2) |
| MP.5 | Use appropriate tools strategically. (2-ESS2-1) |
| 2.NBT.A | Understand place value. (2-ESS1-1) |
| 2.NBT.A.3 | Read and write numbers to 1000 using base-ten numerals, number names, and expanded form. (2-ESS2-2) |
| 2.MD.B.5 | Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem. (2-ESS2-1) |

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K-2. Engineering Design

Students who demonstrate understanding can:

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices

<table>
<thead>
<tr>
<th>Asking Questions and Defining Problems</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking questions and defining problems in K-2 builds on prior experiences and progresses to simple descriptive questions.</td>
<td><strong>ETS1A: Defining and Delimiting Engineering Problems</strong></td>
<td></td>
</tr>
<tr>
<td>• Ask questions based on observations to find more information about the natural and/or designed world. (K-2-ETS1-1)</td>
<td>• A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1)</td>
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<tr>
<td>• Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)</td>
<td>• Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)</td>
<td></td>
</tr>
<tr>
<td>Developing and Using Models</td>
<td><strong>ETS1B: Developing Possible Solutions</strong></td>
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<td>• 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)</td>
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<tr>
<td>• Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)</td>
<td><strong>ETS1C: Optimizing the Design Solution</strong></td>
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<td>Analyzing and Interpreting Data</td>
<td>• Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)</td>
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<tr>
<td>Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations.</td>
<td><strong>Structure and Function</strong></td>
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<td>• Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)</td>
<td>• The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)</td>
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The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Connections to K-2-ETS1-A: Defining and Delimiting Engineering Problems include:

Kindergarten: K-PS2-2, K-ESS3-2

Connections to K-2-ETS1-B: Developing Possible Solutions to Problems include:

Kindergarten: K-ESS3-3, First Grade: 1-PS4-4, Second Grade: 2-LS2-2

Connections to K-2-ETS1-C: Optimizing the Design Solution include:

Second Grade: 2-ESS2-1

Articulation of DCIs across grade-bands: **3-5.ETS1A** (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3); **3-5.ETS1B** (K-2-ETS1-2),(K-2-ETS1-3); **3-5.ETS1C** (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3)

Common Core State Standards Connections:

**ELA/Literacy –**

RI.2.1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (K-2-ETS1-1)

W.2.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. (K-2-ETS1-1),(K-2-ETS1-3)

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1),(K-2-ETS1-3)

SL.2.3 Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (K-2-ETS1-2)

**Mathematics –**

MP.2 Reason abstractly and quantitatively. (K-2-ETS1-1),(K-2-ETS1-3)

MP.4 Model with mathematics. (K-2-ETS1-1),(K-2-ETS1-3)

MP.5 Use appropriate tools strategically. (K-2-ETS1-1),(K-2-ETS1-3)

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1),(K-2-ETS1-3)

Third Grade

The performance expectations in third grade help students formulate answers to questions such as: “What is typical weather in different parts of the world and during different times of the year? How can the impact of weather-related hazards be reduced? How do organisms vary in their traits? How are plants, animals, and environments of the past similar or different from current plants, animals, and environments? What happens to organisms when their environment changes? How do equal and unequal forces on an object affect the object? How can magnets be used?” Third grade performance expectations include PS2, LS1, LS2, LS3, LS4, ESS2, and ESS3 Disciplinary Core Ideas from the NRC Framework. Students are able to organize and use data to describe typical weather conditions expected during a particular season. By applying their understanding of weather-related hazards, students are able to make a claim about the merit of a design solution that reduces the impacts of such hazards. Students are expected to develop an understanding of the similarities and differences of organisms’ life cycles. An understanding that organisms have different inherited traits, and that the environment can also affect the traits that an organism develops, is acquired by students at this level. In addition, students are able to construct an explanation using evidence for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. Students are expected to develop an understanding of types of organisms that lived long ago and also about the nature of their environments. Third graders are expected to develop an understanding of the idea that when the environment changes some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die. Students are able to determine the effects of balanced and unbalanced forces on the motion of an object and the cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. They are then able to apply their understanding of magnetic interactions to define a simple design problem that can be solved with magnets. The crosscutting concepts of patterns; cause and effect; scale, proportion, and quantity; systems and system models; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the third grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions and defining problems; developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.
3. Forces and Interactions

Students who demonstrate understanding can:

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.] (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 or other forces do not affect the object) (3-PS2-1)

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 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.] (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 or other forces do not affect the object) (3-PS2-2)

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 electric force could include the force on hair from an electrically charged ball 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) (3-PS2-3)

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.] (3-PS2-4)

Science and Engineering Practices

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)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in grades 3-5 builds on grades 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)

Disciplinary Core Ideas

3-PS2-1: 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: 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)

3-PS2-2: 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)

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, tools, and techniques. (3-PS2-1)

Crosscutting Concepts

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 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)

Common Core State Standards Connections:

ELA/Literacy Standards -
RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-PS2-1),(3-PS2-3)
RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-PS2-3)
RI.3.8 Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence). (3-PS2-3)
W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-1),(3-PS2-2)
W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-PS2-1),(3-PS2-2)
SL.3.3 Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. (3-PS2-3)

Mathematics -
MP.2 Reason abstractly and quantitatively. (3-PS2-1)
MP.5 Use appropriate tools strategically. (3-PS2-1)
3.MD.A.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. (3-PS2-1)
### 3. Interdependent Relationships in Ecosystems

#### Students who demonstrate understanding can:

**3-LS2-1. Construct an argument that some animals form groups that help members survive.**

**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.]

**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.]

**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.]

#### Disciplinary Core Ideas

**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)

**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. (Note: Moved from K–2) (3-LS4-1)

**LS4.A: Evidence of Common Ancestry and Diversity**

- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (Note: Moved from K–2) (3-LS4-1)

**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)

#### Science and Engineering Practices

**Analyzing and Interpreting Data**

- Analyzing data 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 worlds.

**Engaging in Argument from Evidence**

- Construct an argument with evidence, data, and/or a model. (3-LS2-1)

**Making a Claim**

- 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)

#### Crosscutting Concepts

**Cause and Effect**

- Cause and effect relationships are routinely identified and used to explain change. (3-LS2-1), (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)

#### 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)

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*

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3.1 Inheritance and Variation of Traits: Life Cycles and Traits

Students who demonstrate understanding can:

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.]

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.]

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.]

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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

**Science and Engineering Practices**

- Developing and Using Models
  - Modeling in 3-5 builds on K-2 experiences and progresses to representing events and design solutions.
  - Develop models to describe phenomena. (3-LS1-1)

- 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.

- 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.

- Science and Engineering Practices

- Using evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)

- Using evidence (e.g., observations, patterns) to construct an explanation. (3-LS4-2)

**Disciplinary Core Ideas**

- 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)

- LS3.A: Inheritance of Traits
  - Many characteristics of organisms are inherited from their parents. (3-LS1-1)

- LS3.B: Variation of Traits
  - Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)

- LS3.C: Variation of Traits
  - The environment also affects the traits that an organism develops. (3-LS3-2)

- 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)

**Crosscutting Concepts**

- Patterns
  - Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS1-1)

- Change and Cause
  - Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2), (3-LS4-2)

**Scientific Knowledge is Based on Empirical Evidence**

- Science findings are based on recognizing patterns. (3-LS1-1)

- Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)

- Use evidence (e.g., observations, patterns) to construct an explanation. (3-LS4-2)

**Connections to Nature of Science**

**Common Core State Standards Connections: ELA/Literacy -**

- RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS3-1), (3-LS4-2)

- RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. (3-LS3-1), (3-LS3-2), (3-LS4-2)

- RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS3-1), (3-LS3-2), (3-LS4-2)

- RI.3.4 Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). (3-LS1-1)

- W.3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS3-1), (3-LS3-2), (3-LS4-2)

- SL.3.4 Report on a topic or tell a story, recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS3-1), (3-LS3-2), (3-LS4-2)

- SL.3.5 Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details. (3-LS1-1)

**Mathematics -**

- MP.2 Reason abstractly and quantitatively. (3-LS3-1), (3-LS3-2), (3-LS4-2)

- MP.4 Model with mathematics. (3-LS3-1), (3-LS3-2), (3-LS3-2), (3-LS4-2)

- 3.NBT Number and Operations in Base Ten. (3-LS1-1)

- 3.NF Number and Operations—Fractions. (3-LS1-1)

- 3.MD.B.3 Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more?” and “how many less?” problems using information presented in scaled bar graphs. (3-LS4-2)

- 3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. (3-LS3-1), (3-LS3-2)

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

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3. Weather and Climate

Students who demonstrate understanding can:

**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.]

**3-ESS2-2.** Obtain and combine information to describe climates in different regions of the world.

**3-ESS3-1.** Make a claim about the merit of a design solution that reduces the impacts of 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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

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### Disciplinary Core Ideas

**3-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)
- **3-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.)*

### Crosscutting Concepts

**Patterns**

- Patterns of change can be used to make predictions. (3-ESS2-1), (3-ESS2-2)

**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

**Science is a Human Endeavor**

- 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

**Cause and Effect**

- Evaluating the merit and accuracy of ideas and methods.
- 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.
- 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). (3-ESS3-1)

### Crosscutting Concepts

**Patterns**

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**Cause and Effect**

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- 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). (3-ESS3-1)

### Crosscutting Concepts

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- 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). (3-ESS3-1)

### Crosscutting Concepts

**Patterns**

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### Connections to Nature of Science

**Cause and Effect**

- Evaluating the merit and accuracy of ideas and methods.
- 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.
- 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). (3-ESS3-1)
Fourth Grade

The performance expectations in fourth grade help students formulate answers to questions such as: “What are waves and what are some things they can do? How can water, ice, wind and vegetation change the land? What patterns of Earth’s features can be determined with the use of maps? How do internal and external structures support the survival, growth, behavior, and reproduction of plants and animals? What is energy and how is it related to motion? How is energy transferred? How can energy be used to solve a problem?” Fourth grade performance expectations include PS3, PS4, LS1, ESS1, ESS2, ESS3, and ETS1 Disciplinary Core Ideas from the NRC Framework. Students are able to use a model of waves to describe patterns of waves in terms of amplitude and wavelength, and that waves can cause objects to move. Students are expected to develop understanding of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. They apply their knowledge of natural Earth processes to generate and compare multiple solutions to reduce the impacts of such processes on humans. In order to describe patterns of Earth’s features, students analyze and interpret data from maps. Fourth graders are expected to develop an understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. By developing a model, they describe that an object can be seen when light reflected from its surface enters the eye. Students are able to use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object. Students are expected to develop an understanding that energy can be transferred from place to place by sound, light, heat, and electric currents or from object to object through collisions. They apply their understanding of energy to design, test, and refine a device that converts energy from one form to another. The crosscutting concepts of patterns; cause and effect; energy and matter; systems and system models; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the fourth grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.
4.Energy

Students who demonstrate understanding can:

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.]

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.]

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.]

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.]

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; non-renewable 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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices

| Asking Questions and Defining Problems | Disciplinary Core Ideas
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</tr>
</thead>
<tbody>
<tr>
<td>Asking questions and defining problems in grades 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.</td>
<td>PS3.A: Definitions of Energy</td>
</tr>
<tr>
<td>• Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3)</td>
<td>• The faster a given object is moving, the more energy it possesses. (4-PS3-1)</td>
</tr>
<tr>
<td>Planning and Carrying Out Investigations</td>
<td>PS3.B: Conservation of Energy and Energy Transfer</td>
</tr>
<tr>
<td>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.</td>
<td>• Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from a single object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2),(4-PS3-3)</td>
</tr>
<tr>
<td>• Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2)</td>
<td>• Light also transfers energy from place to place. (4-PS3-2)</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>PS3.C: Relationship Between Energy and Forces</td>
</tr>
<tr>
<td>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.</td>
<td>• When objects collide, the contact forces transfer energy so as to change the objects’ motions. (4-PS3-3)</td>
</tr>
<tr>
<td>• Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1)</td>
<td>PS3.D: Energy in Chemical Processes and Everyday Life</td>
</tr>
<tr>
<td>• Apply scientific ideas to solve design problems. (4-PS3-4)</td>
<td>• The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4)</td>
</tr>
<tr>
<td>Obtaining, Evaluating, and Communicating Information</td>
<td>ESS3.A: Natural Resources</td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.</td>
<td>• 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)</td>
</tr>
<tr>
<td>• Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)</td>
<td>ETS1.A: Defining Engineering Problems</td>
</tr>
<tr>
<td></td>
<td>• 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)</td>
</tr>
</tbody>
</table>

Connections to other DCIs in fourth grade: N/A

Articulation of DCIs across grade-levels: K.PS2.B (4-PS3-3); K.ETS1.A (4-PS3-4); 2.ETS1.B (4-PS3-1); 3.PS2.A (4-PS3-3); 5.PS3.D (4-PS3-4); 5.LS1.C (4-PS3-4); 5.ESS3.C (4-ESS3-1); MS.PS2.A (4-PS3-3); MS.PS2.B (4-PS3-2); MS.PS2.A (4-PS3-1); MS.PS2.B (4-PS3-1); MS.PS3.B (4-PS3-3); MS.PS3.A (4-PS3-4); MS.PS3.B (4-PS3-2); MS.PS3.A (4-PS3-1); MS.PS3.B (4-PS3-1); MS.PS3.D (4-PS3-4); MS.PS4.B (4-PS3-1); MS.ESS2.A (4-ESS3-1); MS.ESS3.A (4-ESS3-1); MS.ESS3.C (4-ESS3-1); MS.ESS3.D (4-ESS3-1); MS.ETS1.B (4-PS3-4); MS.ETS1.C (4-PS3-4);

Common Core State Standards Connections:

ELA/Literacy –

RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS3-1)

RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. (4-PS3-1)

RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS3-1)

W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (4-PS3-1)

W.4.3 Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-2),(4-PS3-3),(4-PS3-4),(4-ESS3-1)

W.4.4 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-PS3-2),(4-PS3-3),(4-PS3-4)

W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-PS3-1),(4-ESS3-1)

Mathematics –

MP.2 Reason abstractly and quantitatively. (4-ESS3-1)

MP.4 Use the process of mathematical modeling to solve problems. (4-ESS3-1)

MP.4.A Identify a multiplicative measurement equation as a comparison, e.g., interpret 35 = 5 × 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations. (4-ESS3-1)

MP.4.A.3 Solve multistep word problems posed with whole numbers and have whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. (4-PS3-4)

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


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### Disciplinary Core Ideas

#### 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.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 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)*

### Crosscutting Concepts

#### 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)

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**The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas.* Integrated and reprinted with permission from the National Academy of Sciences.**

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Structure, Function, and Information Processing

Students who demonstrate understanding can:

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.]

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.]

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.]
4. Earth’s Systems: Processes that Shape the Earth

Students who demonstrate understanding can:

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 the geological formations or layers. Assessment is limited to relative time.]

4-ESS1-2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS1-1, 4-ESS2-1, 4-ESS3-2)

4-ESS1-3. Plan and carry out investigations to answer questions about how changes in the climate are expected to alter life on Earth. (secondary to 4-ESS3-2)

4-ESS1-4. Design a solution to a problem involving the factors that affect the distribution of weathering, erosion, precipitation, and flood regimes. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.)

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.]

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.]

4-ESS2-3. Design a solution to a problem involving the factors that cause plate tectonics to move. (4-ESS3-2)

4-ESS2-4. Develop a model using an equation to describe how the cycling of water, carbon, and nutrients affect global weather and climate. (4-ESS1-1, 4-ESS2-2, 4-ESS3-2)

4-ESS3-1. The impact of human activity on the environment can be evaluated using a variety of tools and technologies to reduce their effects. (secondary to 4-ESS3-2)

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes 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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 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 include more rigorous 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)

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)

- 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)

Connections to other DCIs in fourth grade: 4.ESSL.C (4-ESS3-2)

Articulation of DCIs across grade-leveles: K.ESSL.A (4-ESS3-2), 1.ESSL.C (4-ESS1-1, 4-ESS2-1, 4-ESS3-1), 2.ESSL.A (4-ESS3-2), 3.ESSL.C (4-ESS1-1, 4-ESS2-1), 3.LSA (4-ESS1-1), 4.ESSL.C (4-ESS2-2), 5.ESSL.A (4-ESS2-1, 4-ESS2-2, 4-ESS3-2), MS.ESSL.B (4-ESS1-1, 4-ESS2-1, 4-ESS3-2), MS.ESSL.B (4-ESS3-2), MS.ESSL.B (4-ESS3-2), MS.ESSL.B (4-ESS3-2), MS.ESSL.B (4-ESS3-2)

Common Core State Standards Connections:

ELA/Literacy -

RI.4.1 - Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-ESS3-2)

RI.4.7 - Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. (4-ESS2-2)

RI.4.9 - Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-ESS3-2)

W.4.7 - Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS1-1, 4-ESS2-1)

W.4.8 - Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS1-1, 4-ESS3-2)

W.4.9 - Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-ESS1-1)

Mathematics -

MP.2 - Reason abstractly and quantitatively. (4-ESS1-1, 4-ESS2-1, 4-ESS3-2)

MP.4 - Model with mathematics. (4-ESS1-1, 4-ESS2-1, 4-ESS3-2)

MP.5 - Use appropriate tools strategically. (4-ESS2-1)

4.MDA.1 - Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS1-1, 4-ESS2-1)

4.MDA.2 - Use the four operations to solve word problems involving one operation of addition, subtraction, multiplication, or division, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale. (4-ESS2-1, 4-ESS3-2)

4.OAA.1 - Interpret a multiplication equation as a comparison, e.g., compare 35 = 5 x 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as equations. (4-ESS3-2)

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Fifth Grade

The performance expectations in fifth grade help students formulate answers to questions such as: “When matter changes, does its weight change? How much water can be found in different places on Earth? Can new substances be created by combining other substances? How does matter cycle through ecosystems? Where does the energy in food come from and what is it used for? How do lengths and directions of shadows or relative lengths of day and night change from day to day, and how does the appearance of some stars change in different seasons?”

Fifth grade performance expectations include PS1, PS2, PS3, LS1, LS2, ESS1, ESS2, and ESS3 Disciplinary Core Ideas from the NRC Framework. Students are able to describe that matter is made of particles too small to be seen through the development of a model. Students develop an understanding of the idea that regardless of the type of change that matter undergoes, the total weight of matter is conserved. Students determine whether the mixing of two or more substances results in new substances. Through the development of a model using an example, students are able to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. They describe and graph data to provide evidence about the distribution of water on Earth. Students develop an understanding of the idea that plants get the materials they need for growth chiefly from air and water. Using models, students can describe the movement of matter among plants, animals, decomposers, and the environment and that energy in animals’ food was once energy from the sun. Students are expected to develop an understanding of patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. The crosscutting concepts of patterns; cause and effect; scale, proportion, and quantity; energy and matter; and systems and systems models are called out as organizing concepts for these disciplinary core ideas. In the fifth grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, engaging in argument from evidence, and obtaining, evaluating, and communicating information; and to use these practices to demonstrate understanding of the core ideas.
**5. Structure and Properties of Matter**

**5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence 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.]

**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.]

**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.]

**5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:  

- **Science and Engineering Practices**
- **Disciplinary Core Ideas**
- **Crosscutting Concepts**
- **Connections to Nature of Science**
- **Common Core State Standards Connections:**  
  - **ELA/Literacy - RI.5.7**
  - **Mathematics - MP.2, MP.4, MP.5**

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas.* Integrated and reprinted with permission from the National Academy of Sciences.

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5. Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

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.]

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.]

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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education.
5. Earth's Systems

Students who demonstrate understanding can:

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, landscape 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. (5-ESS2-1)]

5-ESS2-2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. [Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere. (5-ESS2-1), (5-ESS3-1)]

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices

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)

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/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)

Disciplinary Core Ideas

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.B: The Role 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-ESS2-1)

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)

Crosscutting Concepts

Scale, Proportion, and Quantity
- Standard units are used to measure and describe physical quantities such as weight, and volume. (5-ESS2-1)

Systems and System Models
- A system can be described in terms of its components and their interactions. (5-ESS2-1), (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)

Common Core State Standards Connections:

ELA/Literacy -

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-ESS3-1)

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS2-1), (5-ESS3-1)

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS3-1)

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-ESS2-1), (5-ESS3-1)

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-ESS3-1)

SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-ESS2-1), (5-ESS3-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. (5-ESS2-1), (5-ESS3-1)

MP.4 Model with mathematics. (5-ESS2-1), (5-ESS3-1)

S.G.2 Represent real-world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS2-1)

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

# 5.Space Systems: Stars and the Solar System

## Students who demonstrate understanding can:

### 5-PS2-1. 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.]

### 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 mass, age, stage).]

### 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.]

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### Disciplinary Core Ideas

#### 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)

#### 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)

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### Crosscutting Concepts

#### 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)

#### Cause and Effect
- Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1)

#### Scale, Proportion, and Quantity
- Natural objects exist from the very small to the immensely large. (5-ESS1-1)

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### Science and Engineering Practices

#### 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 experiences and progresses to critiquing the scientific reasoning presented and explaining why the evidence supports or does not support the argument.
- Support an argument with evidence, data, or a model. (5-PS2-1),(5-ESS1-2)

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### Connections to other DCIs in fifth grade: N/A

### Articulation of DCIs across grade levels:
- **1.ESS1.A** (5-ESS1-2); **1.ESS1.B** (5-ESS1-2); **3.PS2.A** (5-PS2-1),(5-ESS1-2); **3.PS2.B** (5-PS2-1); **MS.PS2.B** (5-PS2-1); **MS.ESS1.A** (5-ESS1-1); **MS.ESS1.B** (5-ESS1-1); **5-ESS1-1); **5-ESS1-2); **5-ESS1-2); **5-ESS2.C** (5-ESS2-1)

### Common Core State Standards Connections:

#### ELA/Literacy -
- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-PS2-1),(5-ESS1-1)
- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS1-1)
- **RI.5.8** Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). (5-ESS1-1)
- **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-PS2-1),(5-ESS1-1)
- **W.5.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-PS2-1),(5-ESS1-1)
- **SL.5.5** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-ESS1-2)

#### Mathematics -
- **MP.2** Reason abstractly and quantitatively. (5-ESS1-1),(5-ESS1-2)
- **MP.4** Model with mathematics. (5-ESS1-1),(5-ESS1-2)
- **5.NBT.A.2** Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. (5-ESS1-1)
- **5.G.A.2** Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS1-2)

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


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3-5. Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. 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.

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

- **Science and Engineering Practices**
  - Asking Questions and Defining Problems
  - Planning and Carrying Out Investigations
  - Constructing Explanations and Designing Solutions

- **Disciplinary Core Ideas**
  - 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 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)

- **Crosscutting Concepts**
  - Influence of Science, Engineering, and Technology 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)

**Articulation of DCIs across grade-bands**
- K-2.ETS1.A (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3); K-2.ETS1.B (3-5-ETS1-2), K-2.ETS1.C (3-5-ETS1-2), (3-5-ETS1-3); MS.ETS1.A (3-5-ETS1-1), MS.ETS1.B (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3); MS.ETS1.C (3-5-ETS1-2), (3-5-ETS1-3)

**Common Core State Standards Connections:**

<table>
<thead>
<tr>
<th>ELA/Literacy -</th>
<th>Mathematics -</th>
</tr>
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<tbody>
<tr>
<td><strong>RI.5.1</strong></td>
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<tr>
<td><strong>RI.5.9</strong></td>
<td>Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (3-5-ETS1-2)</td>
</tr>
<tr>
<td><strong>W.5.7</strong></td>
<td>Draw evidence from literary or informational texts to support analysis, reflection, and research. (3-5-ETS1-1), (3-5-ETS1-3)</td>
</tr>
<tr>
<td><strong>W.5.8</strong></td>
<td>Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-1), (3-5-ETS1-3)</td>
</tr>
<tr>
<td><strong>W.5.9</strong></td>
<td>Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1), (3-5-ETS1-3)</td>
</tr>
<tr>
<td><strong>MS.ETS1.A</strong></td>
<td>Model with mathematics. (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)</td>
</tr>
<tr>
<td><strong>MS.ETS1.B</strong></td>
<td>Use appropriate tools strategically. (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)</td>
</tr>
<tr>
<td><strong>MS.ETS1.C</strong></td>
<td>Operations and Algebraic Thinking (3-5-ETS1-1), (3-5-ETS1-2)</td>
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</table>

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Middle School Physical Science

Students in middle school continue to develop understanding of four core ideas in the physical sciences. The middle school performance expectations in the Physical Sciences build on the K – 5 ideas and capabilities to allow learners to explain phenomena central to the physical sciences but also to the life sciences and earth and space science. The performance expectations in physical science blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge to explain real world phenomena in the physical, biological, and earth and space sciences. In the physical sciences, performance expectations at the middle school level focus on students developing understanding of several scientific practices. These include developing and using models, planning and conducting investigations, analyzing and interpreting data, using mathematical and computational thinking, and constructing explanations; and to use these practices to demonstrate understanding of the core ideas. Students are also expected to demonstrate understanding of several of engineering practices including design and evaluation.

The performance expectations in the topic **Structure and Properties of Matter** help students to formulate an answer to the questions: “How can particles combine to produce a substance with different properties? How does thermal energy affect particles?” by building understanding of what occurs at the atomic and molecular scale. By the end of middle school, students will be able to apply understanding that pure substances have characteristic properties and are made from a single type of atom or molecule. They will be able to provide molecular level accounts to explain states of matters and changes between states. The crosscutting concepts of cause and effect; scale, proportion and quantity; structure and function; interdependence of science, engineering, and technology; and influence of science, engineering and technology on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, and obtaining, evaluating, and communicating information. Students use these scientific and engineering practices to demonstrate understanding of the core ideas.

The performance expectations in the topic **Chemical Reactions** help students to formulate an answer to the questions: “What happens when new materials are formed? What stays the same and what changes?” by building understanding of what occurs at the atomic and molecular scale during chemical reactions. By the end of middle school, students will be able to provide molecular level accounts to explain that chemical reactions involve regrouping of atoms to form new substances, and that atoms rearrange during chemical reactions. Students are also able to apply an understanding of the design and the process of optimization in engineering to chemical reaction systems. The crosscutting concepts of patterns and energy and matter are called out as organizing concepts for these disciplinary core ideas. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, analyzing and interpreting data, and designing solutions. Students use these scientific and engineering practices to demonstrate understanding of the core ideas.

The performance expectations in the topic **Forces and Interactions** focus on helping students understand ideas related to why some objects will keep moving, why objects fall to the ground and why some materials are attracted to each other while others are not. Students answer the question, “How can one describe physical interactions between objects and within systems of objects?” At the middle school level, the PS2 Disciplinary Core Idea from the **NRC Framework** is broken down into two sub-ideas: Forces and Motion and Types of interactions. By the end of
middle school, students will be able to apply Newton’s Third Law of Motion to relate forces to explain the motion of objects. Students also apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other while other repel. In particular, students will develop understanding that gravitational interactions are always attractive but that electrical and magnetic forces can be both attractive and negative. Students also develop ideas that objects can exert forces on each other even though the objects are not in contact, through fields. Students are also able to apply an engineering practice and concept to solve a problem caused when objects collide. The crosscutting concepts of cause and effect; system and system models; stability and change; and the influence of science, engineering, and technology on society and the natural world serve as organizing concepts for these disciplinary core ideas. In these performance expectations, students are expected to demonstrate proficiency in asking questions, planning and carrying out investigations, and designing solutions, and engaging in argument; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in the topic **Energy** help students formulate an answer to the question, “How can energy be transferred from one object or system to another?” At the middle school level, the PS3 Disciplinary Core Idea from the *NRC Framework* is broken down into four sub-core ideas: Definitions of Energy, Conservation of Energy and Energy Transfer, the Relationship between Energy and Forces, and Energy in Chemical Process and Everyday Life. Students develop their understanding of important qualitative ideas about energy including that the interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another, and that that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Students understand that objects that are moving have kinetic energy and that objects may also contain stored (potential) energy, depending on their relative positions. Students will also come to know the difference between energy and temperature, and begin to develop an understanding of the relationship between force and energy. Students are also able to apply an understanding of design to the process of energy transfer. The crosscutting concepts of scale, proportion, and quantity; systems and system models; and energy are called out as organizing concepts for these disciplinary core ideas. These performance expectations expect students to demonstrate proficiency in developing and using models, planning investigations, analyzing and interpreting data, and designing solutions, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas in PS3.

The performance expectations in the topic **Waves and Electromagnetic Radiation** help students formulate an answer to the question, “What are the characteristic properties of waves and how can they be used?” At the middle school level, the PS4 Disciplinary Core Idea from the *NRC Framework* is broken down into Wave Properties, Electromagnetic Radiation, and Information Technologies and Instrumentation. Students are able to describe and predict characteristic properties and behaviors of waves when the waves interact with matter. Students can apply an understanding of waves as a means to send digital information. The crosscutting concepts of patterns and structure and function are used as organizing concepts for these disciplinary core ideas. These performance expectations focus on students demonstrating proficiency in developing and using models, using mathematical thinking, and obtaining, evaluating and communicating information; and to use these practices to demonstrate understanding of the core ideas.
Middle School Life Science

Students in middle school develop understanding of key concepts to help them make sense of life science. The ideas build upon students’ science understanding from earlier grades and from the disciplinary core ideas, science and engineering practices, and crosscutting concepts of other experiences with physical and earth sciences. There are four life science disciplinary core ideas in middle school: 1) From Molecules to Organisms: Structures and Processes, 2) Ecosystems: Interactions, Energy, and Dynamics, 3) Heredity: Inheritance and Variation of Traits, 4) Biological Evolution: Unity and Diversity. The performance expectations in middle school blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge across the science disciplines. While the performance expectations in middle school life science couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many science and engineering practices integrated in the performance expectations.

The performance expectations in **LS1: From Molecules to Organisms: Structures and Processes** help students formulate an answer to the question, “How can one explain the ways cells contribute to the function of living organisms.” The LS1 Disciplinary Core Idea from the *NRC Framework* is organized into four sub-ideas: Structure and Function, Growth and Development of Organisms, Organization for Matter and Energy Flow in Organisms, and Information Processing. Students can gather information and use this information to support explanations of the structure and function relationship of cells. They can communicate understanding of cell theory. They have a basic understanding of the role of cells in body systems and how those systems work to support the life functions of the organism. The understanding of cells provides a context for the plant process of photosynthesis and the movement of matter and energy needed for the cell. Students can construct an explanation for how environmental and genetic factors affect growth of organisms. They can connect this to the role of animal behaviors in reproduction of animals as well as the dependence of some plants on animal behaviors for their reproduction. Crosscutting concepts of cause and effect, structure and function, and matter and energy are called out as organizing concepts for the core ideas about processes of living organisms.

The performance expectations in **LS2: Interactions, Energy, and Dynamics Relationships in Ecosystems** help students formulate an answer to the question, “How does a system of living and non-living things operate to meet the needs of the organisms in an ecosystem?” The LS2 Disciplinary Core Idea is divided into three sub-ideas: Interdependent Relationships in Ecosystems; Cycles of Matter and Energy Transfer in Ecosystems; and Ecosystem Dynamics, Functioning, and Resilience. Students can analyze and interpret data, develop models, and construct arguments and demonstrate a deeper understanding of resources and the cycling of matter and the flow of energy in ecosystems. They can also study patterns of the interactions among organisms within an ecosystem. They consider biotic and abiotic factors in an ecosystem and the effects these factors have on population. They evaluate competing design solutions for maintaining biodiversity and ecosystem services.

The performance expectations in **LS3: Heredity: Inheritance and Variation of Traits** help students formulate an answer to the question, “How do living organisms pass traits from one generation to the next?” The LS3 Disciplinary Core Idea from the *NRC Framework* includes two sub-ideas: Inheritance of Traits, and Variation of Traits. Students can use models to describe
ways gene mutations and sexual reproduction contribute to genetic variation. Crosscutting concepts of cause and effect and structure and function provide students with a deeper understanding of how gene structure determines differences in the functioning of organisms.

The performance expectations in **LS4: Biological Evolution: Unity and Diversity** help students formulate an answer to the question, “How do organisms change over time in response to changes in the environment?” The LS4 Disciplinary Core Idea is divided into four sub-ideas: Evidence of Common Ancestry and Diversity, Natural Selection, Adaptation, and Biodiversity and Humans. Students can construct explanations based on evidence to support fundamental understandings of natural selection and evolution. They can use ideas of genetic variation in a population to make sense of organisms surviving and reproducing, hence passing on the traits of the species. They are able to use fossil records and anatomical similarities of the relationships among organisms and species to support their understanding. Crosscutting concepts of patterns and structure and function contribute to the evidence students can use to describe biological evolution.
Middle School Earth and Space Sciences

Students in middle school develop understanding of a wide range of topics in Earth and space science (ESS) that build upon science concepts from elementary school through more advanced content, practice, and crosscutting themes. There are six ESS standard topics in middle school: Space Systems, History of Earth, Earth’s Interior Systems, Earth’s Surface Systems, Weather and Climate, and Human Impacts. The content of the performance expectations are based on current community-based geoscience literacy efforts such as the Earth Science Literacy Principles (Wysession et al., 2012), and is presented with a greater emphasis on an Earth Systems Science approach. The performance expectations strongly reflect the many societally relevant aspects of ESS (resources, hazards, environmental impacts) as well as related connections to engineering and technology. While the performance expectations shown in middle school ESS couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.

The performance expectations in **MS.Space Systems** help students formulate answers to the questions: “What is Earth’s place in the Universe?” and “What makes up our solar system and how can the motion of Earth explain seasons and eclipses?” Two sub-ideas from the NRC Framework are addressed in these performance expectations: ESS1.A and ESS1.B. Middle school students can examine the Earth’s place in relation to the solar system, Milky Way galaxy, and universe. There is a strong emphasis on a systems approach, using models of the solar system to explain astronomical and other observations of the cyclic patterns of eclipses, tides, and seasons. There is also a strong connection to engineering through the instruments and technologies that have allowed us to explore the objects in our solar system and obtain the data that support the theories that explain the formation and evolution of the universe. The crosscutting concepts of patterns; scale, proportion, and quantity; systems and system models; and interdependence of science, engineering, and technology are called out as organizing concepts for these disciplinary core ideas. In the MS.Space Systems performance expectations, students are expected to demonstrate proficiency in developing and using models and analyzing and interpreting data; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **MS.History of Earth** help students formulate answers to the questions: “How do people figure out that the Earth and life on Earth have changed over time?” and “How does the movement of tectonic plates impact the surface of Earth?” Four sub-ideas from the NRC Framework are addressed in these performance expectations: ESS1.C, ESS2.A, ESS2.B, and ESS2.C. Students can examine geoscience data in order to understand the processes and events in Earth’s history. Important concepts in this topic are “Scale, Proportion, and Quantity” and “Stability and Change,” in relation to the different ways geologic processes operate over the long expanse of geologic time. An important aspect of the history of Earth is that geologic events and conditions have affected the evolution of life, but different life forms have also played important roles in altering Earth’s systems. In the MS.History of Earth performance expectations, students are expected to demonstrate proficiency in analyzing and
interpreting data, and constructing explanations; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **MS.Earth’s Systems** help students formulate answers to the questions: “How do the materials in and on Earth’s crust change over time?” and “How does water influence weather, circulate in the oceans, and shape Earth’s surface?” Three sub-ideas from the NRC Framework are addressed in these performance expectations: ESS2.A, ESS2.C, and ESS3.A. Students understand how Earth’s geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students can investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data. Of special importance in both topics are the ways that geoscience processes provide resources needed by society but also cause natural hazards that present risks to society; both involve technological challenges, for the identification and development of resources and for the mitigation of hazards. The crosscutting concepts of cause and effect, energy and matter, and stability and change are called out as organizing concepts for these disciplinary core ideas. In the MS.Earth’s Systems performance expectations, students are expected to demonstrate proficiency in developing and using models and constructing explanations; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **MS.Weather and Climate** help students formulate an answer to the question: “What factors interact and influence weather and climate?” Three sub-ideas from the NRC Framework are addressed in these performance expectations: ESS2.C, ESS2.D, and ESS3.D. Students can construct and use models to develop understanding of the factors that control weather and climate. A systems approach is also important here, examining the feedbacks between systems as energy from the sun is transferred between systems and circulates though the ocean and atmosphere. The crosscutting concepts of cause and effect, systems and system models, and stability and change are called out as organizing concepts for these disciplinary core ideas. In the MS.Weather and Climate performance expectations, students are expected to demonstrate proficiency in asking questions, developing and using models, and planning and carrying out investigations; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **MS.Human Impacts** help students formulate answers to the questions: “How can natural hazards be predicted?” and “How do human activities affect Earth systems?” Two sub-ideas from the NRC Framework are addressed in these performance expectations: ESS3.B and ESS3.C. Students understand the ways that human activities impacts Earth’s other systems. Students can use many different practices to understand the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts of their development. The crosscutting concepts of patterns; cause and effect; and interdependence of science, engineering, and technology are called out as organizing concepts for these disciplinary core ideas.
Middle School Engineering Design

By the time students reach middle school they should have had numerous experiences in engineering design. The goal for middle school students is to define problems more precisely, to conduct a more thorough process of choosing the best solution, and to optimize the final design.

Defining the problem with “precision” involves thinking more deeply than is expected in elementary school about the needs a problem is intended to address, or the goals a design is intended to reach. How will the end user decide whether or not the design is successful? Also at this level students are expected to consider not only the end user, but also the broader society and the environment. Every technological change is likely to have both intended and unintended effects. It is up to the designer to try to anticipate the effects it may have, and to behave responsibly in developing a new or improved technology. These considerations may take the form of either criteria or constraints on possible solutions.

Developing possible solutions does not explicitly address generating design ideas since students were expected to develop the capability in elementary school. The focus in middle school is on a two stage process of evaluating the different ideas that have been proposed: by using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising, and by testing different solutions, and then combining the best ideas into new solution that may be better than any of the preliminary ideas.

Improving designs at the middle school level involves an iterative process in which students test the best design, analyze the results, modify the design accordingly, and then re-test and modify the design again. Students may go through this cycle two, three, or more times in order to reach the optimal (best possible) result.

Connections with other science disciplines help students develop these capabilities in various contexts. For example, in the life sciences students apply their engineering design capabilities to evaluate plans for maintaining biodiversity and ecosystem services (MS-LS2-5). In the physical sciences students define and solve problems involving a number of core ideas in physical science, including: chemical processes that release or absorb energy (MS-PS1-6), Newton’s third law of motion (MS-PS2-1), and energy transfer (MS-PS3-3). In the Earth and space sciences students apply their engineering design capabilities to problems related the impacts of humans on Earth systems (MS-ESS3-3).

By the end of 8th grade students are expected to achieve all four performance expectations (MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. These include defining a problem by precisely specifying criteria and constraints for solutions as well as potential impacts on society and the natural environment, systematically evaluating alternative solutions, analyzing data from tests of different solutions and combining the best ideas into an improved solution, and developing a model and iteratively testing and improving it to reach an optimal solution. While the performance expectations shown in Middle School Engineering Design couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.
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)

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.

- 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)


- 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-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2)
- 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 one another; 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. (MS-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2 and MS-PS1-5)

PS3.A: Definitions of Energy

- The term “heat” as used in everyday language refers both 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)

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)

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, 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 new technological systems. (MS-PS1-1)

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 other DCIs in this grade-band

- MS.LS2.A (MS-PS1-1); MS.LS4.D (MS-PS1-1); MS.ESS2.C (MS-PS1-1); (MS-PS1-4); MS.ESS3.A (MS-PS1-1); MS.ESS3.C (MS-PS1-3)
- Articulation across grade-bands: 5.PS1.A (MS-PS1-1); HS.PS1.A (MS-PS1-1); (MS-PS1-3); (MS-PS1-4); HS.PS1.B (MS-PS1-1); HS.PS3.A (MS-PS1-1); HS.LS2.A (MS-PS1-1); HS.LS4.D (MS-PS1-1); HS.ESS1.A (MS-PS1-1); HS.ESS3.A (MS-PS1-1)

Common Core State Standards Connections:

- ELA/Literacy - RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-PS1-3)
- WHST.6-8.8: Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-PS1-3)
- Mathematics – MP.2: Reason abstractly and quantitatively. (MS-PS1-1)

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>MP.4</td>
<td>Model with mathematics. <em>(MS-PS1-1)</em></td>
</tr>
<tr>
<td>6.RP.A.3</td>
<td>Use ratio and rate reasoning to solve real-world and mathematical problems. <em>(MS-PS1-1)</em></td>
</tr>
<tr>
<td>6.NS.C.5</td>
<td>Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. <em>(MS-PS1-4)</em></td>
</tr>
<tr>
<td>8.EE.A.3</td>
<td>Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. <em>(MS-PS1-1)</em></td>
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</tbody>
</table>

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**MS.Chemical Reactions**

**Science and Engineering Practices**

**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-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.

**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)

**Disciplinary Core Ideas**

**PS1.A: Structure and Properties of Matter**
- 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) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3)

**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. (MS-PS1-2), (MS-PS1-5) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3)

- 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)

**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)

**Crosscutting Concepts**

**Patterns**
- Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)

**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)

**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**
- Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

**Connections to other DCIs in this grade band**
- MS.PS3.D (MS-PS1-2), (MS-PS1-6); MS.LS1.C (MS-PS1-2), (MS-PS1-5); MS.LS2.B (MS-PS1-2), (MS-PS1-6); MS.ESS2.A (MS-PS1-2), (MS-PS1-5)

**Articulation across grade-bands**
- 5.PS1.B (MS-PS1-2), (MS-PS1-6); 6.PS1.A (MS-PS1-6); 6.PS1.B (MS-PS1-2), (MS-PS1-6); 6.PS1.C (MS-PS1-2), (MS-PS1-6); 6.PS3.B (MS-PS1-2), (MS-PS1-6); 6.PS3.D (MS-PS1-6)

**Common Core State Standards Connections**

- **ELA/Literacy** -
  - RST.6-8.1
  - RST.6-8.2
  - RST.6-8.3

- **Science** -
  - WHST.6-8.7

- **Mathematics** -
  - MP.2
  - MP.4

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

### MS.Force and Interactions

**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. |

**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. Qualitative comparisons of forces, mass, and changes in motion (Newton’s Second Law) are expected. |
| 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. |

**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. |

**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 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 is limited to qualitative evidence for the existence of fields. |

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### Disciplinary Core Ideas

#### 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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### Crosscutting Concepts

#### Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (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-PS2-5)

#### 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)

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### Connections to Engineering, Technology, and Applications of Science

#### 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. (MS-PS2-1)

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### 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. Forces and Interactions

| RST.6-8.1 | Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions \(\text{(MS-PS2-1), (MS-PS2-2)}\) |
| RST.6-8.3 | Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. \(\text{(MS-PS2-1), (MS-PS2-2), (MS-PS2-5)}\) |
| WHST.6-8.1 | Write arguments focused on discipline-specific content. \(\text{(MS-PS2-4)}\) |
| WHST.6-8.7 | Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. \(\text{(MS-PS2-1), (MS-PS2-2), (MS-PS2-5)}\) |

**Mathematics -**

**MP.2**

Reason abstractly and quantitatively. \(\text{(MS-PS2-1), (MS-PS2-2), (MS-PS2-3)}\) 

**6.NS.C.5**

Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. \(\text{(MS-PS2-1)}\) 

**6.EE.A.2**

Write, read, and evaluate expressions in which letters stand for numbers. \(\text{(MS-PS2-1), (MS-PS2-2)}\) 

**7.EE.B.3**

Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. \(\text{(MS-PS2-1), (MS-PS2-2)}\) 

**7.EE.B.4**

Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. \(\text{(MS-PS2-1), (MS-PS2-2)}\)

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**MS.Energy**

Students who demonstrate understanding can:

**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.]

**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.]

**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.]

**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.]

**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 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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

**Science and Engineering Practices**

**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 many data are 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.
  - 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 empirical evidence and scientific reasoning to support or refute an argument.*
  - 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)

**Disciplinary Core Ideas**

**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 transferred 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**
- 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 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-PS3-2)

**Crosscutting Concepts**

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)

**Connections to other DCLS in this grade-band**
- **MS.PS1.A** (MS-PS3-4); **MS.PS1.B** (MS-PS3-3); **MS.PS2.A** (MS-PS3-1),(MS-PS3-4),(MS-PS3-5); **MS.ESS2.A** (MS-PS3-3); **MS.ESS2.C** (MS-PS3-3),(MS-PS3-4); **MS.ESS2.D** (MS-PS3-3),(MS-PS3-4); **MS.ESS3.D** (MS-PS3-4)

**Articulation across grade-bands**
- **4.PS3.B** (MS-PS3-1),(MS-PS3-3); **4.PS3.C** (MS-PS3-4),(MS-PS3-5); **HS.PS1.B** (MS-PS3-4); **HS.PS2.B** (MS-PS3-2); **HS.PS3.A** (MS-PS3-1),(MS-PS3-4),(MS-PS3-5); **HS.PS3.B** (MS-PS3-1),(MS-PS3-2),(MS-PS3-3),(MS-PS3-4),(MS-PS3-5); **HS.PS3.C** (MS-PS3-2)

**Common Core State Standards Connections**

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<th>ELA/Literacy –</th>
<th>Mathematics –</th>
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<tbody>
<tr>
<td>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS3-1),(MS-PS3-5)</td>
<td>MP.2 Reason abstractly and quantitatively. (MS-PS3-1),(MS-PS3-4),(MS-PS3-5)</td>
</tr>
<tr>
<td>RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3),(MS-PS3-4)</td>
<td>6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1),(MS-PS3-5)</td>
</tr>
<tr>
<td>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). (MS-PS3-1)</td>
<td>6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. (MS-PS3-1)</td>
</tr>
<tr>
<td>WHST.6-8.1 Write arguments focused on discipline content. (MS-PS3-3)</td>
<td>7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS3-1),(MS-PS3-5)</td>
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<td>WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3),(MS-PS3-4)</td>
<td>8.EE.A.1 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1),(MS-PS3-5)</td>
</tr>
<tr>
<td>SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)</td>
<td>6.SP.B.5 Summarize numerical data sets in relation to their context. (MS-PS3-4)</td>
</tr>
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MS.Waves and Electromagnetic Radiation

Students who demonstrate understanding can:

**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.]

**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.]

**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 digital signals (sent as wave pulses) being a more reliable way to encode and transmit information. 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.]

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### Science and Engineering Practices

**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 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 level builds on K–5 and progresses to using mathematical concepts to support explanations and arguments.
  - Use mathematical representations to describe and/or support scientific conclusions and design solutions. (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)

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### Disciplinary Core Ideas

**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 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)

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### Crosscutting Concepts

**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)

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### Connections to Nature of Science

**Science is a Human Endeavor**
- Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

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### Articulation across grade-bands:

**Articulation across grade-bands:** 
- **MS.LS1.D** (MS-PS4-2)

**Common Core State Standards Connections:**

**ELA/Literacy -**
- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-3)
- **RST.6-8.2** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-PS4-3)
- **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. (MS-PS4-3)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-3)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1), (MS-PS4-2)

**Mathematics -**
- **MP.2** Reason abstractly and quantitatively. (MS-PS4-1)
- **MP.4** Model with mathematics. (MS-PS4-1)
- **6.RP.A.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)
- **6.RP.A.3** Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS4-1)
- **7.RP.A.2** Recognize and represent proportional relationships between quantities. (MS-PS4-1)
- **8.F.A.3** Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS4-1)

*The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education.*

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### 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.

- Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
- Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

#### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>LS1.A: Structure and Function</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>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)</td>
<td>Cause and Effect</td>
</tr>
<tr>
<td>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)</td>
<td>Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)</td>
</tr>
<tr>
<td>In multicellular organisms, the body is a system of 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)</td>
<td>Systems and System Models</td>
</tr>
<tr>
<td>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)</td>
<td>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)</td>
</tr>
</tbody>
</table>

#### Science and Engineering Practices

- **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)

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

- **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)

- **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 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)

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

independent variables using graphs and tables, and relate these to the equation. \((MS-LS1-1),(MS-LS1-2),(MS-LS1-3)\)
Students who demonstrate understanding can:

**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.]

**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.]

**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 abundant and scarce resources.]

**MS-LS2-2.** Engage in argument from evidence to support 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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

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**Science and Engineering Practices**

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)
  - Develop a model to describe unobservable mechanisms. (MS-LS1-7)

Analyzing and Interpreting Data

- Analyzing data in 6-8 builds on K-5 experiences and progresses to extended quantitative analysis to test hypotheses, to investigate, and to make predictions. (MS-LS2-1)
- 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 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-LS1-6)

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).
  - 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)

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**Disciplinary Core Ideas**

**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)

**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-LS1-1)
  - 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)

**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**

- For 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**

- 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)

**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 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)

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**Crosscutting Concepts**

**Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

**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)
- 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)

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**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)

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**Connections to Other Disciplines**

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*The performance expectations marked with an asterisk integrate traditional scientific content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences. November 2013 ©2013 Achieve, Inc. All rights reserved. 50 of 102*
## MS. Matter and Energy in Organisms and Ecosystems

| Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-6), (MS-LS2-1), (MS-LS2-4) |
| Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-6) |
| 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). (MS-LS2-1) |
| Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-4) |
| Write arguments to support claims with clear reasons and relevant evidence. (MS-LS2-4) |
| Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-6) |
| Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-6), (MS-LS2-4) |
| Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-6), (MS-LS2-3) |

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MS.1 Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

**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.]

**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.]

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### Science and Engineering Practices

**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).
  - Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)

### Disciplinary Core Ideas

**LS2.A: Interdependent Relationships in Ecosystems**
- 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)
- 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)
- 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)
- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, drawing on multiple readings and research from print and digital sources. (MS-LS2-2)
- Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS2-2)

### Crosscutting Concepts

**Patterns**
- Patterns can be used to identify cause and effect relationships. (MS-LS2-2)
- Stability and Change
  - Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)

### Connections to Nature of Science

**Science Addresses Questions About the Natural and Material 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)

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education.*

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
MS.Growth, Development, and Reproduction of Organisms

Students who demonstrate understanding can:

**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.]

**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.]

**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.]

**MS-LS3-2.** Develop and use a model to describe 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.]

**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.]

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**Science and Engineering Practices**

**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)

**Construcing 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.
- Constructure 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-LS3-1)

**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 empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS3-4)

**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 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)

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**Disciplinary Core Ideas**

**LS1.B: Growth and Development of Organisms**
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LP4-5)
- 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)

**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 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)

**LS4.B: Natural Selection**
- 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)

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**Crosscutting Concepts**

**Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS2-5)
- 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), (MS-LS4-5)

**Structure and Function**
- Complex and microscopic natural structures/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)

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**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)

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**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-LS4-5)

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### ELA/Literacy -

**RST.6-8.1**  
Cite specific textual evidence to support analysis of science and technical texts.  (MS-LS1-4),(MS-LS1-5),(MS-LS3-1),(MS-LS3-2),(MS-LS4-5)

**RST.6-8.2**  
Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.  (MS-LS1-5)

**RST.6-8.4**  
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.  (MS-LS3-1),(MS-LS3-2)

**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).  (MS-LS3-1),(MS-LS3-2)

**RI.6.8**  
Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.  (MS-LS1-4)

**WHST.6-8.1**  
Write arguments focused on discipline content.  (MS-LS1-4)

**WHST.6-8.2**  
Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.  (MS-LS1-5)

**WHST.6-8.8**  
Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.  (MS-LS4-5)

**WHST.6-8.9**  
Draw evidence from informational texts to support analysis, reflection, and research.  (MS-LS1-5)

**SL.8.5**  
Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.  (MS-LS3-1),(MS-LS3-2)

### Mathematics -

**MP.4**  
Model with mathematics.  (MS-LS3-2)

**6.SP.A.2**  
Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.  (MS-LS1-4),(MS-LS1-5)

**6.SP.B.4**  
Summarize numerical data sets in relation to their context.  (MS-LS1-4),(MS-LS1-5)

**6.SP.B.5**  
Summarize numerical data sets in relation to their context.  (MS-LS3-2)
# MS.Natural Selection and Adaptations

Students who demonstrate understanding can:

**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.]

**MS-LS4-2.** Apply scientific ideas to construct an explanation for the anaotmical 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.]

**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.]

**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.]

**MS-LS4-6.** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [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.]

## Science and Engineering Practices

**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)

**Constructing Explanations and Designing 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.
- Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6)
- 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)

## Disciplinary Core Ideas

### 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)

### 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 environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)

## Crosscutting Concepts

### 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-LS4-1),(MS-LS4-6)

## 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-LS4-1),(MS-LS4-2)

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### Connections to other DCIs in this grade-band:
- **MS.LS2.A** (MS-LS4-1), (MS-LS4-4), (MS-LS4-6), (MS.LS2.C (MS-LS4-6), (MS.LS2.A (MS-LS4-2), (MS.LS4-1), (MS.LS4-4), (MS.LS4-1), (MS.LS4-4), (MS.LS4-1)
- **MS.ESS1.C** (MS-LS4-6), (MS.LS2.A (MS-LS4-1), (MS.LS4-2), (MS.LS4-6), (MS.ESS2.B (MS-LS4-1)

### Common Core State Standards Connections:
- **ELA/Literacy -**
  - **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-LS4-1), (MS-LS4-2), (MS-LS4-3), (MS-LS4-4).
  
- **RST.6-8.7** Interpret 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). (MS-LS4-1), (MS-LS4-3)
  
- **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. (MS-LS4-3), (MS-LS4-4)

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

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| WHST.6-8.2   | Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS4-2),(MS-LS4-4) |
| WHST.6-8.9  | Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-2),(MS-LS4-4) |
| SL.8.1      | Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-2),(MS-LS4-4) |
| SL.8.4      | Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS4-2),(MS-LS4-4) |

**Mathematics -**

| MP.4        | Model with mathematics. (MS-LS4-6) |
| 6.RP.A.1    | Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4),(MS-LS4-6) |
| 6.SP.B.5    | Summarize numerical data sets in relation to their context. (MS-LS4-4),(MS-LS4-6) |
| 6.EE.B.6    | Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-LS4-1),(MS-LS4-2) |
| 7.RP.A.2    | Recognize and represent proportional relationships between quantities. (MS-LS4-4),(MS-LS4-6) |

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*
MS.Space Systems

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.]

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.]

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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

**Science and Engineering Practices**

**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-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)

**Disciplinary Core Ideas**

**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. (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)

**Crosscutting Concepts**

**Patterns**
- Patterns can be used to identify cause and effect relationships. (MS-ESS1-1)

**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)

**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)

**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)

**Connections to Nature of Science**

**Common Core State Standards Connections**

**ELA/Literacy**
- Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-3)

**RST.6-8.1**
- 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). (MS-ESS1-3)

**SL.8.5**
- Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS1-1),(MS-ESS1-2)

**Mathematics –**
- Reason abstractly and quantitatively. (MS-ESS1-3)

**MP.2**
- Model with mathematics. (MS-ESS1-1),(MS-ESS1-2)

**6.RP.A.1**
- Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3)

**7.RP.A.2**
- Recognize and represent proportional relationships between quantities. (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3)

**6.EE.B.6**
- Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2)

**7.EE.B.4**
- Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-2)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*

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MS.History of Earth

Students who demonstrate understanding can:

**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 homin 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.]

**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 geochanical 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.]

**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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

**Science and Engineering Practices**

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 provide evidence for phenomena. (MS-ESS2-3)

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-ESS2-2)

**Disciplinary Core Ideas**

**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)
- 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**

- 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’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)

**Crosscutting Concepts**

- Patterns
  - Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-4),(MS-ESS2-2)
  - Scale, Proportion and Quantity
    - 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)

**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)

- Connections to other DCIs in this grade-band: MS.PS1.B (MS-ESS2-2); MS.LS2.B (MS-ESS2-2); MS.LS4.A (MS-ESS1-4),(MS-ESS2-3); MS.LS4.C (MS-ESS1-4)

- Articulation of DCIs across grade-bands: 3.LSA4 (MS-ESS1-4),(MS-ESS2-3); 3.LSA4.C (ESS1-4); 3.LSE3.B (MS-ESS2-3); 4.LSSE1.C (MS-ESS1-4),(MS-ESS2-2),(MS-ESS2-3); 4.LSSE2.A (MS-ESS2-2); 4.LSSE2.B (MS-ESS2-2); 4.LSSE2.E (MS-ESS2-2); 4.LSSE3.B (MS-ESS2-2); 5.LSSE2.A (MS-ESS2-2); HS.PS1.C (MS-ESS1-4); HS.PS3.D (MS-ESS2-2); HS.LS2.B (MS-ESS2-2); HS.LS4.A (MS-ESS1-4),(MS-ESS2-3); HS.LS4.C (MS-ESS1-4),(MS-ESS2-3); HS.LS51.C (MS-ESS1-4),(MS-ESS2-2),(MS-ESS2-3); HS.ESS2.A (MS-ESS1-4),(MS-ESS2-3); HS.ESS2.B (MS-ESS2-2),(MS-ESS2-3); HS.ESS2.C (MS-ESS2-2),(MS-ESS2-3); HS.ESS2.D (MS-ESS2-2); HS.ESS2.E (MS-ESS2-2); HS.ESS3.D (MS-ESS2-2)

**Common Core State Standards Connections:**

- ELA/Literacy –
  - RST.6-8.1
    - Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-4),(MS-ESS2-2),(MS-ESS2-3)
  - 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). (MS-ESS2-3)
  - 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. (MS-ESS2-3)
  - WHST.6-8.2
    - Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS1-4),(MS-ESS2-2)
  - SL.8.5
    - Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-2)

- Mathematics –
  - MP.2
    - Reason abstractly and quantitatively. (MS-ESS2-2),(MS-ESS2-3)
  - 6.EE.B.6
    - Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-4),(MS-ESS2-2),(MS-ESS2-3)
  - 7.EE.B.4
    - Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-4),(MS-ESS2-2),(MS-ESS2-3)

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

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### MS.Earth's Systems

Students who demonstrate understanding can:

**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.]

**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.]

**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).]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:"

### Science and Engineering Practices

**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)
  - Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

**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-ESS3-1)

### Disciplinary Core Ideas

**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 matters that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)

**ESS2.C: The Roles of Water in Earth's Surface Processes**
- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)
- Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)

**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)

### Crosscutting Concepts

**Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural and designed systems. (MS-ESS3-1)

**Energy and Matter**
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS3-4)

**Stability and Change**
- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS3-1)

### Connections to Other DCIs in this Grade Band

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### Articulation of DCIs Across Grade Bands

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### Common Core State Standards Connections:

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<td>Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1)</td>
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<td>Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1)</td>
<td>Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the hand at any number in a specified set. (MS-ESS3-1)</td>
<td>Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1)</td>
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MS.WEATHER AND CLIMATE

Students who demonstrate understanding can:

**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 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 sun-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 articulation of DCIs across

**MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures 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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education.

### Science and Engineering Practices

**Asking Questions and Defining Problems**
- 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 to identify and clarify evidence of an argument. (MS-ESS3-5)

**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-ESS2-6)

**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)

### Disciplinary Core Ideas

**ESS2.C: The Roles of Water in Earth's Surface Processes**
- 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)
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)

**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)

**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)

### Crosscutting Concepts

**Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

**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)

**Stability and Change**
- Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

### Common Core State Standards Connections:

**ELA/Literacy -**
- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5),(MS-ESS3-5)
- **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. (MS-ESS2-5)

**WHST.6-8.8** Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ESS2-5)

**SL.8.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-6)

**Mathematics –**
- **MP.2** Reason abstractly and quantitatively. (MS-ESS2-5),(MS-ESS3-5)
- **6.NS.C.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)
- **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number; or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-5)
- **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS2-5)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.

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MS.Human Impacts

Students who demonstrate understanding can:

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 hurricanes 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).]

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).]

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 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.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

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### Science and Engineering Practices

**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 applying statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2)

**Constructing Explanations and Designing Solutions**
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to including constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- 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 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)

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### Disciplinary Core Ideas

**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**
- 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-ESS3-4)

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### Crosscutting Concepts

**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-ESS3-4)

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### 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-ESS3-4)
- 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)

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### 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)

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Connections to other DCIs in this grade-band: **MS.PS3.C** (MS-ESS3-2); **MS.L5-2.A** (MS-ESS3-3),(MS-ESS3-4); **MS.L5.2.C** (MS-ESS3-3),(MS-ESS3-4); **MS.L5.2.D** (MS-ESS3-3),(MS-ESS3-4); **MS.L5.4.B** (MS-ESS3-3),(MS-ESS3-4); **MS.L5.4.D** (MS-ESS3-3),(MS-ESS3-4); **MS.L5.4.F** (MS-ESS3-3),(MS-ESS3-4); **MS.L5.4.H** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.2.A** (MS-ESS3-4); **HS.L5.2.B** (MS-ESS3-4); **HS.L5.2.C** (MS-ESS3-4); **HS.L5.2.D** (MS-ESS3-4); **HS.L5.4.C** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.D** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.E** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.F** (MS-ESS3-3),(MS-ESS3-4)

Articulation of DCIs across grade-bands: **3.LS2.C** (MS-ESS3-3),(MS-ESS3-4); **3.LS4.D** (MS-ESS3-3),(MS-ESS3-4); **3.ESS3.B** (MS-ESS3-2); **4.ESS3.B** (MS-ESS3-2); **5.ESS3.C** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.2.A** (MS-ESS3-4); **HS.L5.2.B** (MS-ESS3-4); **HS.L5.2.C** (MS-ESS3-4); **HS.L5.2.D** (MS-ESS3-4); **HS.L5.4.C** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.D** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.E** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.F** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.H** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.H** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.H** (MS-ESS3-3),(MS-ESS3-4); **HS.L5.4.H** (MS-ESS3-3),(MS-ESS3-4)

### Common Core State Standards Connections:

**ELA/Literacy - RST.6-8.1**
- Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-2),(MS-ESS3-4)

**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). (MS-ESS3-2)

**WHST.6-8.1**
- Write arguments focused on discipline content. (MS-ESS3-4)

**WHST.6-8.7**
- Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ESS3-3)

**WHST.6-8.8**
- Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ESS3-3)

**WHST.6-8.9**
- Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-4)

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


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<table>
<thead>
<tr>
<th>Mathematics -</th>
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<tbody>
<tr>
<td><strong>MP.2</strong></td>
<td>Reason abstractly and quantitatively. (MS-ESS3-2)</td>
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<tr>
<td><strong>6.RP.A.1</strong></td>
<td>Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3), (MS-ESS3-4)</td>
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<tr>
<td><strong>7.RP.A.2</strong></td>
<td>Recognize and represent proportional relationships between quantities. (MS-ESS3-3), (MS-ESS3-4)</td>
</tr>
<tr>
<td><strong>6.EE.B.6</strong></td>
<td>Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-4)</td>
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<tr>
<td><strong>7.EE.B.4</strong></td>
<td>Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-4)</td>
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MS. Engineering Design

Students who demonstrate understanding can:

**MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**

**MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**

**MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**

**MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

**Science and Engineering Practices**

- Asking Questions and Defining Problems: Asking questions and defining problems in grades K-5 builds on grades 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 grades K-5 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-ETS1-2)

- Analyzing and Interpreting Data: Analyzing data in grades K-5 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and making 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 grades K-5 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.
  - Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

**Disciplinary Core Ideas**

**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 basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

**Crosscutting Concepts**

- 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)

Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:

**Physical Science:** MS-PS1-3

Connections to MS-ETS1.B: Developing Possible Solutions Problems include:

**Physical Science:** MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5

Connections to MS-ETS1.C: Optimizing the Design Solution include:

**Physical Science:** MS-PS1-6

Articulation of DCIs across grade-bands: 3-5.ETS1.A (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3); 3-5.ETS1.B (MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); 3-5.ETS1.C (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); HS.ETS1.A (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3); HS.ETS1.B (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); HS.ETS1.C (MS-ETS1-3),(MS-ETS1-4)

Common Core State Standards Connections:

**ELA/Literacy –**

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ETS1-3)
- **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. (MS-ETS1-2),(MS-ETS1-3)
- **WHST.6-8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)
- **WHST.6-8.8** Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ETS1-1)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2)
- **SL.8.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ETS1-4)

**Mathematics –**

- **MP.2** Reason abstractly and quantitatively. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4)
- **7.EE.3** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)

Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (MS-ETS1-4)
High School Physical Sciences

Students in high school continue to develop their understanding of the four core ideas in the physical sciences. These ideas include the most fundamental concepts from chemistry and physics, but are intended to leave room for expanded study in upper-level high school courses. The high school performance expectations in Physical Science build on the middle school ideas and allow high school students to explain more in-depth phenomena central not only to the physical sciences, but to life and earth and space sciences as well. These performance expectations blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge to explain ideas across the science disciplines. In the physical science performance expectations at the high school level, there is a focus on several scientific practices. These include developing and using models, planning and conducting investigations, analyzing and interpreting data, using mathematical and computational thinking, and constructing explanations; and to use these practices to demonstrate understanding of the core ideas. Students are also expected to demonstrate understanding of several engineering practices, including design and evaluation.

The performance expectations in the topic **Structure and Properties of Matter** help students formulate an answer to the question, “How can one explain the structure and properties of matter?” Two sub-ideas from the *NRC Framework* are addressed in these performance expectations: the structure and properties of matter, and nuclear processes. Students are expected to develop understanding of the substructure of atoms and provide more mechanistic explanations of the properties of substances. Students are able to use the periodic table as a tool to explain and predict the properties of elements. Phenomena involving nuclei are also important to understand, as they explain the formation and abundance of the elements, radioactivity, the release of energy from the sun and other stars, and the generation of nuclear power. The crosscutting concepts of patterns, energy and matter, and structure and function are called out as organizing concepts for these disciplinary core ideas. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, planning and conducting investigations, and communicating scientific and technical information; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in the topic **Chemical Reactions** help students formulate an answer to the questions: “How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?” Chemical reactions, including rates of reactions and energy changes, can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. Using this expanded knowledge of chemical reactions, students are able to explain important biological and geophysical phenomena. Students are also able to apply an understanding of the process of optimization in engineering design to chemical reaction systems. The crosscutting concepts of patterns, energy and matter, and stability and change are called out as organizing concepts for these disciplinary core ideas. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, using mathematical thinking, constructing explanations, and designing solutions; and to use these practices to demonstrate understanding of the core ideas.

The Performance Expectations associated with the topic **Forces and Interactions** supports students’ understanding of ideas related to why some objects will keep moving, why objects fall
to the ground, and why some materials are attracted to each other while others are not. Students should be able to answer the question, “How can one explain and predict interactions between objects and within systems of objects?” The disciplinary core idea expressed in the Framework for PS2 is broken down into the sub ideas of Forces and Motion and Types of Interactions. The performance expectations in PS2 focus on students building understanding of forces and interactions and Newton’s Second Law. Students also develop understanding that the total momentum of a system of objects is conserved when there is no net force on the system. Students are able to use Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects. Students are able to apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. The crosscutting concepts of patterns, cause and effect, and systems and system models are called out as organizing concepts for these disciplinary core ideas. In the PS2 performance expectations, students are expected to demonstrate proficiency in planning and conducting investigations, analyzing data and using math to support claims, and applying scientific ideas to solve design problems; and to use these practices to demonstrate understanding of the core ideas.

The Performance Expectations associated with the topic Energy help students formulate an answer to the question, “How is energy transferred and conserved?” The disciplinary core idea expressed in the Framework for PS3 is broken down into four sub-core ideas: Definitions of Energy, Conservation of Energy and Energy Transfer, the Relationship between Energy and Forces, and Energy in Chemical Process and Everyday Life. Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system, and the total change of energy in any system is always equal to the total energy transferred into or out of the system. Students develop an understanding that energy at both the macroscopic and atomic scale can be accounted for as either motions of particles or energy associated with the configuration (relative positions) of particles. In some cases, the energy associated with the configuration of particles can be thought of as stored in fields. Students also demonstrate their understanding of engineering principles when they design, build, and refine devices associated with the conversion of energy. The crosscutting concepts of cause and effect; systems and system models; energy and matter; and the influence of science, engineering, and technology on society and the natural world are further developed in the performance expectations associated with PS3. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, planning and carry out investigations, using computational thinking, and designing solutions; and to use these practices to demonstrate understanding of the core ideas.

The Performance Expectations associated with the topic Waves and Electromagnetic Radiation are critical to understand how many new technologies work. As such, this disciplinary core idea helps students answer the question, “How are waves used to transfer energy and send and store information?” The disciplinary core idea in PS4 is broken down into Wave Properties, Electromagnetic Radiation, and Information Technologies and Instrumentation. Students are able to apply understanding of how wave properties and the interactions of electromagnetic radiation with matter can transfer information across long distances, store information, and investigate nature on many scales. Models of electromagnetic radiation as either a wave of changing electric and magnetic fields or as particles are developed and used. Students understand that combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information. Students also demonstrate
their understanding of engineering ideas by presenting information about how technological
devices use the principles of wave behavior and wave interactions with matter to transmit and
capture information and energy. The crosscutting concepts of cause and effect; systems and
system models; stability and change; interdependence of science, engineering, and technology;
and the influence of engineering, technology, and science on society and the natural world are
highlighted as organizing concepts for these disciplinary core ideas. In the PS3 performance
expectations, students are expected to demonstrate proficiency in asking questions, using
mathematical thinking, engaging in argument from evidence, and obtaining, evaluating and
communicating information; and to use these practices to demonstrate understanding of the
core ideas.
High School Life Sciences

Students in high school develop understanding of key concepts that help them make sense of life science. The ideas are building upon students’ science understanding of disciplinary core ideas, science and engineering practices, and crosscutting concepts from earlier grades. There are five life science topics in high school: 1) Structure and Function, 2) Inheritance and Variation of Traits, Matter and Energy in Organisms and Ecosystems, 4) Interdependent Relationships in Ecosystems, and 5) Natural Selection and Evolution. The performance expectations for high school life science blend core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge that can be applied across the science disciplines. While the performance expectations in high school life science couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices underlying the performance expectations. The performance expectations are based on the grade-band endpoints described in A Framework for K-12 Science Education (NRC, 2012).

The performance expectations in the topic **Structure and Function** help students formulate an answer to the question: “How do the structures of organisms enable life’s functions?” High school students are able to investigate explanations for the structure and function of cells as the basic units of life, the hierarchical systems of organisms, and the role of specialized cells for maintenance and growth. Students demonstrate understanding of how systems of cells function together to support the life processes. Students demonstrate their understanding through critical reading, using models, and conducting investigations. The crosscutting concepts of structure and function, matter and energy, and systems and system models in organisms are called out as organizing concepts.

The performance expectations in the topic **Inheritance and Variation of Traits** help students in pursuing an answer to the question: “How are the characteristics from one generation related to the previous generation?” High school students demonstrate understanding of the relationship of DNA and chromosomes in the processes of cellular division that pass traits from one generation to the next. Students can determine why individuals of the same species vary in how they look, function, and behave. Students can develop conceptual models for the role of DNA in the unity of life on Earth and use statistical models to explain the importance of variation within populations for the survival and evolution of species. Ethical issues related to genetic modification of organisms and the nature of science can be described. Students can explain the mechanisms of genetic inheritance and describe the environmental and genetic causes of gene mutation and the alteration of gene expression. Crosscutting concepts of structure and function, patterns, and cause and effect developed in this topic help students to generalize understanding of inheritance of traits to other applications in science.

The performance expectations in the topic **Matter and Energy in Organisms and Ecosystems** help students answer the questions: “How do organisms obtain and use energy they need to live and grow? How do matter and energy move through ecosystems?” High school students can construct explanations for the role of energy in the cycling of matter in organisms and ecosystems. They can apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respiration and develop
models to communicate these explanations. They can relate the nature of science to how explanations may change in light of new evidence and the implications for our understanding of the tentative nature of science. Students understand organisms’ interactions with each other and their physical environment, how organisms obtain resources, change the environment, and how these changes affect both organisms and ecosystems. In addition, students can utilize the crosscutting concepts of matter and energy and Systems and system models to make sense of ecosystem dynamics.

The performance expectations in the topic *Interdependent Relationships in Ecosystems* help students answer the question, “How do organisms interact with the living and non-living environment to obtain matter and energy?” This topic builds on the other topics as high school students demonstrate an ability to investigate the role of biodiversity in ecosystems and the role of animal behavior on survival of individuals and species. Students have increased understanding of interactions among organisms and how those interactions influence the dynamics of ecosystems. Students can generate mathematical comparisons, conduct investigations, use models, and apply scientific reasoning to link evidence to explanations about interactions and changes within ecosystems.

The performance expectations in the topic *Natural Selection and Evolution* help students answer the questions: “How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms? How does biodiversity affect humans?” High school students can investigate patterns to find the relationship between the environment and natural selection. Students demonstrate understanding of the factors causing natural selection and the process of evolution of species over time. They demonstrate understanding of how multiple lines of evidence contribute to the strength of scientific theories of natural selection and evolution. Students can demonstrate an understanding of the processes that change the distribution of traits in a population over time and describe extensive scientific evidence ranging from the fossil record to genetic relationships among species that support the theory of biological evolution. Students can use models, apply statistics, analyze data, and produce scientific communications about evolution. Understanding of the crosscutting concepts of patterns, scale, structure and function, and cause and effect supports the development of a deeper understanding of this topic.
High School Earth and Space Sciences

Students in high school develop understanding of a wide range of topics in Earth and space science (ESS) that build upon science concepts from middle school through more advanced content, practice, and crosscutting themes. There are five ESS standard topics in high school: Space Systems, History of Earth, Earth’s Systems, Weather and Climate, and Human Sustainability. The content of the performance expectations are based on current community-based geoscience literacy efforts such as the Earth Science Literacy Principles (Wysession et al., 2012), and is presented with a greater emphasis on an Earth Systems Science approach. There are strong connections to mathematical practices of analyzing and interpreting data. The performance expectations strongly reflect the many societally relevant aspects of ESS (resources, hazards, environmental impacts) with an emphasis on using engineering and technology concepts to design solutions to challenges facing human society. While the performance expectations shown in high school ESS couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.

The performance expectations in **HS.Space Systems** help students formulate answers to the questions: “What is the universe, and what goes on in stars?” and “What are the predictable patterns caused by Earth’s movement in the solar system?” Four sub-ideas from the NRC Framework are addressed in these performance expectations: ESS1.A, ESS1.B, PS3.D, and PS4.B. High school students can examine the processes governing the formation, evolution, and workings of the solar system and universe. Some concepts studied are fundamental to science, such as understanding how the matter of our world formed during the Big Bang and within the cores of stars. Others concepts are practical, such as understanding how short-term changes in the behavior of our sun directly affect humans. Engineering and technology play a large role here in obtaining and analyzing the data that support the theories of the formation of the solar system and universe. The crosscutting concepts of patterns; scale, proportion, and quantity; energy and matter; and interdependence of science, engineering, and technology are called out as organizing concepts for these disciplinary core ideas. In the HS.Space Systems performance expectations, students are expected to demonstrate proficiency in developing and using models; using mathematical and computational thinking, constructing explanations; and obtaining, evaluating, and communicating information; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **HS.History of Earth** help students formulate answers to the questions: “How do people reconstruct and date events in Earth’s planetary history?” and “Why do the continents move?” Four sub-ideas from the NRC Framework are addressed in these performance expectations: ESS1.C, ESS2.A, ESS2.B, and PS1.C. Students can construct explanations for the scales of time over which Earth processes operate. An important aspect of Earth and space science involves making inferences about events in Earth’s history based on a data record that is increasingly incomplete that farther you go back in time. A mathematical analysis of radiometric dating is used to comprehend how absolute ages are obtained for the geologic record. A key to Earth’s history is the coevolution of the biosphere with Earth’s other systems, not only in the ways that climate and environmental changes have shaped the course of evolution but...
also in how emerging life forms have been responsible for changing Earth. The crosscutting concepts of patterns and stability and change are called out as organizing concepts for these disciplinary core ideas. In the HS.History of Earth performance expectations, students are expected to demonstrate proficiency in developing and using models, constructing explanations, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **HS.Earth’s Systems** help students formulate answers to the questions: "How do the major Earth systems interact?" and "How do the properties and movements of water shape Earth’s surface and affect its systems?" Six sub-ideas from the NRC *Framework* are addressed in these performance expectations: ESS2.A, ESS2.B, ESS2.C, ESS2.D, ESS2.E, and PS4.A. Students can develop models and explanations for the ways that feedbacks between different Earth systems control the appearance of Earth’s surface. Central to this is the tension between internal systems, which are largely responsible for creating land at Earth’s surface (e.g., volcanism and mountain building), and the sun-driven surface systems that tear down the land through weathering and erosion. Students understand the role that water plays in affecting weather. Students understand chemical cycles such as the carbon cycle. Students can examine the ways that human activities cause feedbacks that create changes to other systems. The crosscutting concepts of energy and matter; structure and function; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the HS.Earth’s Systems performance expectations, students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **HS.Weather and Climate** help students formulate an answer to the question: “What regulates weather and climate?” Four sub-ideas from the NRC *Framework* are addressed in these performance expectations: ESS1.B, ESS2.A, ESS2.D, and ESS3.D. Students understand the system interactions that control weather and climate, with a major emphasis on the mechanisms and implications of climate change. Students can understand the analysis and interpretation of different kinds of geoscience data allow students to construct explanations for the many factors that drive climate change over a wide range of time scales. The crosscutting concepts of cause and effect and stability and change are called out as organizing concepts for these disciplinary core ideas. In the HS.Weather and Climate performance expectations, students are expected to demonstrate proficiency in developing and using models and analyzing and interpreting data; and to use these practices to demonstrate understanding of the core ideas.

systems through the impacts of natural hazards, our dependencies on natural resources, and the environmental impacts of human activities. The crosscutting concepts of cause and effect; systems and system models; stability and change; and influence of engineering, technology and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the HS.Human Sustainability performance expectations, students are expected to demonstrate proficiency in using mathematics and computational thinking, constructing explanations and designing solutions, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.
High School Engineering Design

At the high school level students are expected to engage with major global issues at the interface of science, technology, society and the environment, and to bring to bear the kinds of analytical and strategic thinking that prior training and increased maturity make possible. As in prior levels, these capabilities can be thought of in three stages—defining the problem, developing possible solutions, and improving designs.

**Defining the problem** at the high school level requires both qualitative and quantitative analysis. For example, the need to provide food and fresh water for future generations comes into sharp focus when considering the speed at which world population is growing, and conditions in countries that have experienced famine. While high school students are not expected to solve these challenges, they are expected to begin thinking about them as problems that can be addressed, at least in part, through engineering.

**Developing possible solutions** for major global problems begins by breaking them down into smaller problems that can be tackled with engineering methods. To evaluate potential solutions students are expected to not only consider a wide range of criteria, but to also recognize that criteria need to be prioritized. For example, public safety or environmental protection may be more important than cost or even functionality. Decisions on priorities can then guide tradeoff choices.

**Improving designs** at the high school level may involve sophisticated methods, such as using computer simulations to model proposed solutions. Students are expected to use such methods to take into account a range of criteria and constraints, to try and anticipate possible societal and environmental impacts, and to test the validity of their simulations by comparison to the real world.

Connections with other science disciplines help high school students develop these capabilities in various contexts. For example, in the life sciences students are expected to design, evaluate, and refine a solution for reducing human impact on the environment (HS-LS2-7) and to create or revise a simulation to test solutions for mitigating adverse impacts of human activity on biodiversity (HS-LS4-6). In the physical sciences students solve problems by applying their engineering capabilities along with their knowledge of conditions for chemical reactions (HS-PS1-6), forces during collisions (HS-PS2-3), and conversion of energy from one form to another (HS-PS3-3). In the Earth and space sciences students apply their engineering capabilities to reduce human impacts on Earth systems, and improve social and environmental cost-benefit ratios (HS-ESS3-2, HS-ESS3-4).

By the end of 12th grade students are expected to achieve all four HS-ETS1 performance expectations (HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, and HS-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. These include analyzing major global challenges, quantifying criteria and constraints for solutions; breaking down a complex problem into smaller, more manageable problems, evaluating alternative solutions based on prioritized criteria and trade-offs, and using a computer simulation to model the impact of proposed solutions. While the performance expectations shown in High School Engineering Design couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.
HS. Structure and Properties of Matter

Students who demonstrate understanding can:

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole).] Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension. [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.]

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. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chain molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices

Developing and Using Models
Modeling in 9-12 builds on K-8 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.

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8)
- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

Planning and Carrying Out Investigations
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 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. (HS-PS1-3)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 9-12 builds on K-8 and progresses to evaluate the validity and reliability of the claims, methods, and designs.

- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)

Common Core State Standards Connections:

- ELA/Literacy -
  - 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. (HS-PS1-1)
  - RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3),(HS-PS2-6)

- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-PS2-6)
- WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3)

- WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, 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, avoiding plagiarism and overrelevance on any one source and following a standard format for citation. (HS-PS1-3)

- WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)

- Mathematics -
  - MP.4 Model with mathematics. (HS-PS1-8)

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### HSN-Q.A.1
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *(HS-PS1-3), (HS-PS1-8), (HS-PS2-6)*

### HSN-Q.A.2
Define appropriate quantities for the purpose of descriptive modeling. *(HS-PS1-8), (HS-PS2-6)*

### HSN-Q.A.3
Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-PS1-3), (HS-PS1-8), (HS-PS2-6)*

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HS.Chemical Reactions

Students who demonstrate understanding can:

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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]

HS-PS1-5. Apply scientific principles and evidence to provide an explanation of the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]

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.* [Clarification Statement: Emphasis is on the application of Le Chatelier’s Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students’ use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

**Science and Engineering Practices**

- Developing and Using Models
  - Modeling in 9–12 builds on K-8 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.
  - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4)

- Using Mathematics and Computational Thinking
  - Mathematical and computational thinking at the 9–12 level builds on K–8 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.
  - Use mathematical representations of phenomena to support claims. (HS-PS1-7)

- Constructing Explanations and Designing Solutions
  - Constructing explanations and designing solutions in 9–12 builds on K-8 experiences and progresses to explanations that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
  - Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)
  - 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. (HS-PS1-2)
  - Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized sources of evidence, critical tradeoffs, and considered options. (HS-PS1-6)

**Disciplinary Core Ideas**

PS1A: Structure and Properties of Matter
- The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-2) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1)
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

PS1B: Chemical Reactions
- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-5)
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2), (HS-PS1-7)

ETS1C: Optimizing the Design Solution
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)

**Crosscutting Concepts**

- Patterns
  - 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. (HS-PS1-5)

- Energy and Matter
  - The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
  - 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. (HS-PS1-4)

- Stability and Change
  - Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

**Connections to Nature of Science**

- Scientific Knowledge Assumes an Order and Consistency in Natural Systems
  - Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7)

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


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### HS.Chemical Reactions

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<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>WHST.9-12.2</strong></td>
<td>Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2)</td>
</tr>
<tr>
<td><strong>WHST.9-12.5</strong></td>
<td>Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2)</td>
</tr>
<tr>
<td><strong>WHST.9-12.7</strong></td>
<td>Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-6)</td>
</tr>
<tr>
<td><strong>SL.11-12.5</strong></td>
<td>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 and to add interest. (HS-PS1-4)</td>
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**Mathematics -**

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<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>MP.2</strong></td>
<td>Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)</td>
</tr>
<tr>
<td><strong>MP.4</strong></td>
<td>Model with mathematics. (HS-PS1-4)</td>
</tr>
<tr>
<td><strong>HSN-Q.A.1</strong></td>
<td>Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7)</td>
</tr>
<tr>
<td><strong>HSN-Q.A.2</strong></td>
<td>Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4),(HS-PS1-7)</td>
</tr>
<tr>
<td><strong>HSN-Q.A.3</strong></td>
<td>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7)</td>
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HS.Forces and Interactions

Students who demonstrate understanding can:

**HS-PS2-1.** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.  
[Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.]  
[Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]

**HS-PS2-2.** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.  
[Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.]  
[Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.]

**HS-PS2-3.** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*  
[Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.]  
[Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]

**HS-PS2-4.** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.  
[Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.]  
[Assessment Boundary: Assessment is limited to systems with two objects.]

**HS-PS2-5.** Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.  
[Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.]

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education.*

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### Disciplinary Core Ideas

**PS2.A: Forces and Motion**  
- Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)  
- Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2)  
- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3)

**PS2.B: Types of Interactions**  
- Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)  
- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5)

**PS2.C: Definitions of Energy**  
- “Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5)

---

### Crosscutting Concepts

**Patterns**  
- 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. (HS-PS2-4)

**Cause and Effect**  
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-4)

**Systems and System Models**  
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)

---

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### HS.Forces and Interactions

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RST.11-12.1</td>
<td>Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS2-1)</td>
</tr>
<tr>
<td>RST.11-12.7</td>
<td>Integrate and 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. (HS-PS2-1)</td>
</tr>
<tr>
<td>WHST.9-12.7</td>
<td>Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-3),(HS-PS2-5)</td>
</tr>
<tr>
<td>WHST.11-12.8</td>
<td>Gather relevant information from multiple authoritative print and digital sources, 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, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS2-5)</td>
</tr>
<tr>
<td>WHST.9-12.9</td>
<td>Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)</td>
</tr>
<tr>
<td><strong>Mathematics -</strong></td>
<td></td>
</tr>
<tr>
<td>MP.2</td>
<td>Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)</td>
</tr>
<tr>
<td>MP.4</td>
<td>Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)</td>
</tr>
<tr>
<td>HSN-Q.A.1</td>
<td>Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)</td>
</tr>
<tr>
<td>HSN-Q.A.2</td>
<td>Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)</td>
</tr>
<tr>
<td>HSN-Q.A.3</td>
<td>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)</td>
</tr>
<tr>
<td>HSA-SSE.A.1</td>
<td>Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)</td>
</tr>
<tr>
<td>HSA-SSE.B.3</td>
<td>Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)</td>
</tr>
<tr>
<td>HSA-CED.A.1</td>
<td>Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)</td>
</tr>
<tr>
<td>HSA-CED.A.2</td>
<td>Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-PS2-1),(HS-PS2-2)</td>
</tr>
<tr>
<td>HSA-CED.A.4</td>
<td>Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)</td>
</tr>
<tr>
<td>HSF-IF.C.7</td>
<td>Graph functions expressed symbolically and show key features of the graph, by in hand in simple cases and using technology for more complicated cases. (HS-PS2-1)</td>
</tr>
<tr>
<td>HSS-ID.A.1</td>
<td>Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-PS2-1)</td>
</tr>
</tbody>
</table>

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HS. Energy

Students who demonstrate understanding can:

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, and electromagnetic contexts.]  

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]  

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]  

HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).* [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]  

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]  

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education.

### Developing and Using Models
Modeling in 9-12 builds on K-8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables in a system and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2), (HS-PS3-5)

### Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems 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 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. (HS-PS3-4)

### Using Mathematics and Computational Thinking
Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponential and logarithmic functions, 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 a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)

### Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9-12 builds on K-8 and progresses to constructing explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Design, evaluate, and/or refine a solution to a problem. (HS-PS3-3)

### Disciplinary Core Ideas

#### PS3.A: Definitions of Energy
- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. Toward this end, there is a single quantity called energy due to the fact that a system’s total energy is conserved, even as within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1), (HS-PS3-2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2), (HS-PS3-3)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)

#### PS3.B: Conservation of Energy and Energy Transfer
- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4)
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)
- The availability of energy limits what can occur in any system. (HS-PS3-1)
- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

#### PS3.C: Relationship Between Energy and Forces
- When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)

#### PS3.D: Energy in Chemical Processes
- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the

### Crosscutting Concepts

#### Cause and Effect
- 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. (HS-PS3-5)

#### Systems and System Models
- 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. (HS-PS3-4)
- 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. (HS-PS3-1)

#### Energy and Matter
- 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. (HS-PS3-3)
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)

### Connections to Engineering, Technology, and Applications of Science

#### Influence of Science, Engineering, and Technology on Society and the Natural World
- Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3)

### Connections to Nature of Science

#### Scientific Knowledge Assumes an Order and Consistency in Natural Systems

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**HS.Energy**

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**ETS1.A: Defining and Delimiting Engineering Problems**

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS3-3)

**Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)**

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**Connections to other DCIs in this grade-band:**


**Articulation to DCIs across grade-bands:**


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**Common Core State Standards Connections:**

**ELA/Literacy –**

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS3-4)

- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS3-3), (HS-PS3-4), (HS-PS3-5)

- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, 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, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS3-4), (HS-PS3-5)

- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4), (HS-PS3-5)

- **SL.11-12.5** 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 and to add interest. (HS-PS3-1), (HS-PS3-2), (HS-PS3-5)

**Mathematics –**

- **MP.2** Reason abstractly and quantitatively. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-PS3-5)

- **MP.4** Model with mathematics. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-PS3-5)

- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS3-1), (HS-PS3-3)

- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS3-1), (HS-PS3-3)

- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS3-1), (HS-PS3-3)

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HS.Waves and Electromagnetic Radiation

Students who demonstrate understanding can:

**HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

**HS-PS4-2. Evaluate questions about the advantages and disadvantages of a digital transmission and storage of information.** [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]

**HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]

**HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]

**HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.** [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

### Science and Engineering Practices

**Asking Questions and Defining Problems**
- Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating explanatory accounts of observable phenomena in the natural world.

**Using Mathematics and Computational Thinking**
- Mathematical and computational thinking at the 9–12 level builds on K–8 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.
- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.

**Engaging in Argument from Evidence**
- Engaging in argument from evidence in grades 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 natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.
- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in grades 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.
- Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)
- Communicate 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). (HS-PS4-5)

### Disciplinary Core Ideas

**PS3.D: Energy in Chemical Processes**
- Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy. (secondary to HS-PS4-5)

**PS4.A: Wave Properties**
- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)
- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2),(HS-PS4-5)
- From the 3–5 band endpoints Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)

**PS4.B: Electromagnetic Radiation**
- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)
- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)
- Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)

**PS4.C: Information Technologies and Instrumentation**
- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)

### Crosscutting Concepts

**Cause and Effect**
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1)
- 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. (HS-PS4-4)
- Systems can be designed to cause a desired effect. (HS-PS4-5)

### Connections to Engineering, Technology, and Applications of Science

**Interdependence of Science, Engineering, and Technology**
- Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5)

**Influence of Engineering, Technology, and Science on Society and the Natural World**
- Modern civilization depends on major technological systems. (HS-PS4-2),(HS-PS4-5)
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS4-2)

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**HS.Waves and Electromagnetic Radiation**

The theory is generally modified in light of this new evidence. (HS-PS4-3)

<table>
<thead>
<tr>
<th>Connections to other DCIs in this grade-band:</th>
<th>HS.PS1.C (HS-PS4-4); HS.PS3.A (HS-PS4-4),(HS-PS4-5); HS.PS3.D (HS-PS4-3),(HS-PS4-4); HS.LS1.C (HS-PS4-4); HS.ESS1.A (HS-PS4-3); HS.ESS2.A (HS-PS4-1); HS.ESS2.D (HS-PS4-3)</th>
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</thead>
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<tr>
<td>Articulation to DCIs across grade-bands:</td>
<td>MS.PS3.D (HS-PS4-4); MS.PS4.A (HS-PS4-1),(HS-PS4-2),(HS-PS4-5); MS.PS4.B (HS-PS4-1),(HS-PS4-2),(HS-PS4-3),(HS-PS4-4),(HS-PS4-5); MS.PS4.C (HS-PS4-2),(HS-PS4-5); MS.LS1.C (HS-PS4-4); MS.ESS2.D (HS-PS4-4)</td>
</tr>
</tbody>
</table>

**Common Core State Standards Connections:**

**ELA/Literacy -**

- **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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)  
- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)  
- **RST.11-12.7** Integrate and 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. (HS-PS4-1),(HS-PS4-4)  
- **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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)  
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5)  
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, 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, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4)  

**Mathematics -**

- **MP.2** Reason abstractly and quantitatively. (HS-PS4-1),(HS-PS4-3)  
- **MP.4** Model with mathematics. (HS-PS4-1)  
- **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1),(HS-PS4-3)  
- **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1),(HS-PS4-3)  
- **HSA.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1),(HS-PS4-3)
# HS. Structure and Function

**Students who demonstrate understanding can:**

**HS-LS1-1.** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.  
(Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.)

**HS-LS1-2.** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.  
(Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.)  
(Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.)

**HS-LS1-3.** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.  
(Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.)  
(Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.)

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

- **Disciplinary Core Ideas**
  - **LS1.A: Structure and Function**
    - Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
    - All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1)  
      (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)
    - Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
    - Feedback mechanisms maintain a living system’s internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)
  - **Crosscutting Concepts**
    - **Systems and Model Systems**
      - 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. (HS-LS1-2)
    - **Structure and Function**
      - 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. (HS-LS1-1)
    - **Stability and Change**
      - Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

- **Science and Engineering Practices**
  - **Developing and Using Models**
    - 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.
    - Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
  - **Planning and Carrying Out Investigations**
    - Planning and carrying out 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 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. (HS-LS1-3)
  - **Constructing Explanations and Designing Solutions**
    - 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.
    - Construct 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. (HS-LS1-1)

- **Scientific Investigations Use a Variety of Methods**
  - Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

- **Connections to Other Disciplines in this grade-band:** HS.LS3.A (HS-LS1-1)

- **Articulation across grade-bands:** MS.LS1.A (HS-LS1-1), (HS-LS1-2), (HS-LS1-3); MS.LS3.A (HS-LS1-1); MS.LS3.B (HS-LS1-1)

- **Common Core State Standards Connections:**
  - ELA/Literacy - RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1)
  - WHST.9-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-LS1-1)
  - WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3)
  - WHST.11-12.8: Gather relevant information from multiple authoritative print and digital sources, 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, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)
  - WHST.9-12.9: Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1)
  - SL.11-12.5: Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*
Evidence generated sources of evidence consistent with scientific ideas, that are supported by multiple and independent student-on K–8 experiences and progresses to explanations and designs

Constructing Explanations and Designing Solutions

Students who demonstrate understanding can:

**HS-LS1-5.** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment does not include specific biochemical steps.]

**HS-LS1-6.** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.]

**HS-LS1-7.** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]

**HS-LS2-3.** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

**HS-LS2-4.** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they travel through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]

**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. [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]

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**Science and Engineering Practices**

**Developing and Using Models**

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.
- Use a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS1-5),(HS-LS1-7)
- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-3)

**Using Mathematics and Computational Thinking**

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, exponential and logarithmic, 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.
- Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

**Constructing Explanations and Designing Solutions**

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.
- 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. (HS-LS1-6),(HS-LS2-3)

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**Disciplinary Core Ideas**

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

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)
- The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-8)
- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The cellular elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)
- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)

**PS3.D: Energy in Chemical Processes**

- The main way that solar energy is captured and stored on Earth is through the complex chemical processes known as...
### HS.Matter and Energy in Organisms and Ecosystems

<table>
<thead>
<tr>
<th>Connections to other DCIs in this grade-band:</th>
<th>photosynthesis (secondary to HS-LS2-5)</th>
</tr>
</thead>
</table>

### Common Core State Standards Connections:

<table>
<thead>
<tr>
<th>ELA/Literacy</th>
<th>WHST.9-12.2</th>
<th>Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-6), (HS-LS2-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RST.11-12.1</td>
<td>Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-6), (HS-LS2-3)</td>
<td></td>
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<tr>
<td>WHST.9-12.5</td>
<td>Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6), (HS-LS2-3)</td>
<td></td>
</tr>
<tr>
<td>WHST.9-12.9</td>
<td>Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-6)</td>
<td></td>
</tr>
<tr>
<td>SL.11-12.5</td>
<td>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 and to add interest. (HS-LS1-5), (HS-LS1-7)</td>
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<thead>
<tr>
<th>Mathematics</th>
<th>MP.2</th>
<th>Reason abstractly and quantitatively. (HS-LS2-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP.4</td>
<td>Model with mathematics. (HS-LS2-4)</td>
<td></td>
</tr>
<tr>
<td>HSN-Q.A.1</td>
<td>Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-4)</td>
<td></td>
</tr>
<tr>
<td>HSN-Q.A.2</td>
<td>Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-4)</td>
<td></td>
</tr>
<tr>
<td>HSN-Q.A.3</td>
<td>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-4)</td>
<td></td>
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</table>

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The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

**Disciplinary Core Ideas**

- **LS2.A: Interdependent Relationships in Ecosystems**
  - Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease. Organisms would need the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1), (HS-LS2-2)

- **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
  - A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-1), (HS-LS2-6)

  - Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

- **LS2.D: Social Interactions and Group Behavior**
  - Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

- **LS4.C: Adaptation**
  - Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-6)

- **LS4.D: Biodiversity and Humans**
  - Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)
  - Humans depend on the living world for the resources and other benefits provided by biodiversity. But human

**Crosscutting Concepts**

- **Cause and Effect**
  - Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8), (HS-LS4-6)

- **Scale, Proportion, and Quantity**
  - The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)

  - Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

- **Stability and Change**
  - Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)

**Science and Engineering Practices**

- **Using Mathematics and Computational Thinking**
  - 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.

  - Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)

  - Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

  - Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

- **Constructing Explanations and Designing Solutions**
  - 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.

  - Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)

- **Engaging in Argument from Evidence**
  - Engaging in argument from evidence in 9-12 builds from 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.

  - Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)

  - Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-8)

**Connections to Nature of Science**

- **Scientific Knowledge is Open to Revision in Light of New Evidence**
  - Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-7)

  - Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and

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

**Interdependent Relationships in Ecosystems**

<table>
<thead>
<tr>
<th>Connections to other DCIs in this grade-band:</th>
<th>(HS-LS2-1); (HS-LS2-2); (HS-LS2-6); (HS-LS2-7); (HS-LS4-6)</th>
<th>(secondary to HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-7), (HS-LS4-6); (HS-LS2-8); (HS-LS4-6)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common Core State Standards Connections:</strong></td>
<td><strong>ELA/Literacy</strong> -</td>
<td><strong>Mathematics</strong> -</td>
</tr>
<tr>
<td>RST.9-10.8</td>
<td>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. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)</td>
<td>Reason abstractly and quantitatively. (HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-7)</td>
</tr>
<tr>
<td>RST.11-12.1</td>
<td>Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-8)</td>
<td>Model with mathematics. (HS-LS2-1), (HS-LS2-2)</td>
</tr>
<tr>
<td>RST.11-12.7</td>
<td>Integrate and 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. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)</td>
<td>Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1), (HS-LS2-2), (HS-LS2-7)</td>
</tr>
<tr>
<td>RST.11-12.8</td>
<td>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. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)</td>
<td>Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-7)</td>
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<tr>
<td>WHST.9-12.2</td>
<td>Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1), (HS-LS2-2)</td>
<td>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-7)</td>
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<tr>
<td>WHST.9-12.5</td>
<td>Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS2-6), (HS-LS2-7)</td>
<td>Represent data with plots on the real number line. (HS-LS2-6)</td>
</tr>
<tr>
<td>WHST.9-12.7</td>
<td>Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7), (HS-LS4-6)</td>
<td>Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6)</td>
</tr>
<tr>
<td>Evaluating reports based on data. (HS-LS2-6)</td>
<td>Evaluate reports based on data. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)</td>
<td>Evaluate reports based on data. (HS-LS2-6)</td>
</tr>
</tbody>
</table>

The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
HS.Inheritance and Variation of Traits

Students who demonstrate understanding can:

HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. [Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]

HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

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. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]

Science and Engineering Practices

Ask questions and define problems. When constructing explanations and designing solutions, ask questions about data and current technology to refined the design. Use the structured nature of the scientific method to ask and answer questions. (HS-LS1-1)

Analyze and interpret data. Analyze and interpret data from sources such as tables, charts, and graphs to identify and explain trends and patterns. (HS-LS1-2)

Engage in argument from evidence. Support claims within an argument with data and evidence. (HS-LS1-3)

Disciplinary Core Ideas

LS1.A: Structure and Function
- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)
- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS1-1)
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS1-1)

LS3.A: Inheritance of Traits
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-1)
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2)

Common Core State Standards Connections:
- ELA/Literacy - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1), (HS-LS1-2)
- 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. (HS-LS2-1)
- WHST.9-10.1 - Write arguments focused on discipline-specific content. (HS-LS2-1)
- SL.11-12.5 - 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 and to add interest. (HS-LS4-1)
- MP.2 - Reason abstractly and quantitatively. (HS-LS3-2), (HS-LS3-3)

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<table>
<thead>
<tr>
<th>MP.4</th>
<th>Model with mathematics. (HS-LS1-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSF-IF.C.7</td>
<td>Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-LS1-4)</td>
</tr>
<tr>
<td>HSF-BF.A.1</td>
<td>Write a function that describes a relationship between two quantities. (HS-LS1-4)</td>
</tr>
</tbody>
</table>
HS.Natural Selection and Evolution

Students who demonstrate understanding can:

**HS-LS4-1.** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. [Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.]

**HS-LS4-2.** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

**HS-LS4-3.** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical analysis and interpretation. Assessment does not include allele frequency analysis.]

**HS-LS4-4.** Construct an explanation based on evidence for how natural selection leads to adaptation of populations. [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

**HS-LS4-5.** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

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### Science and Engineering Practices

**Analyzing and Interpreting Data**
- 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.
- 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. (HS-LS4-3)

**Constructing Explanations and Designing Solutions**
- 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.
- Construct 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. (HS-LS4-1)

**Engaging in Argument from Evidence**
- 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 or historical episodes in science.
- Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)

**Obtaining, Evaluating, and Communicating Information**
- 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.
- Communicate scientific information (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). (HS-LS4-1)

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### Disciplinary Core Ideas

**LS4.A: Evidence of Common Ancestry and Diversity**
- Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)

**LS4.B: Natural Selection**
- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3)
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)

**LS4.C: Adaptation**
- Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)
- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-4)
- Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species’ evolution is lost. (HS-LS4-5)

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### Crosscutting Concepts

**Patterns**
- 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. (HS-LS4-1), (HS-LS4-3)
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2), (HS-LS4-4), (HS-LS4-5)

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### Connections to Nature of Science

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (HS-LS4-1), (HS-LS4-4)

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*The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education: Applying Concepts of Statistics and Probability to Support Explanations that Organisms With a Advantageous Heritable Trait Tend to Increase in Proportion to Organisms Lacking This Trait. The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education: Patterns 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. The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education: Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems. The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education: Patterns 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. The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education: Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems.*
evidence is discovered that the theory does not accommodate, the
theory is generally modified in light of this new evidence. (HS-LS4-1)

Connections to other DCIs in this grade-band:  
HS.LS2.A (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5);  
HS.LS2.D (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5);  
HS.LS3.A (HS-LS4-1);  
HS.LS3.B (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-5);  
HS.ESS1.E (HS-LS4-2),(HS-LS4-3),(HS-LS4-5);  
HS.ESS2.E (HS-LS4-2),(HS-LS4-3),(HS-LS4-5);  
HS.ESS3.A (HS-LS4-2),(HS-LS4-3),(HS-LS4-5)

Articulation across grade-bands:  
MS.LS2.A (HS-LS4-2),(HS-LS4-3),(HS-LS4-5);  
MS.LS2.C (HS-LS4-5);  
MS.LS3.A (HS-LS4-1);  
MS.LS3.B (HS-LS4-1),(HS-LS4-2),(HS-LS4-3);  
MS.LS4.A (HS-LS4-1);  
MS.LS4.B (HS-LS4-2),(HS-LS4-3),(HS-LS4-4);  
MS.LS4.C (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5);  
MS.ESS1.C (HS-LS4-1);  
MS.ESS3.C (HS-LS4-5)

Common Core State Standards Connections:
ELA/Literacy –
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)
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. (HS-LS4-5)
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)
WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5)
SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-LS4-1),(HS-LS4-2)
Mathematics –
MP.2 Reason abstractly and quantitatively. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5)
MP.4 Model with mathematics. (HS-LS4-2)
Constructing Explanations and Designing Solutions

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-1)
- Using Mathematical and Computational Thinking

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.
- Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)
- Constructing Explanations and Designing Solutions

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.
- Construct 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. (HS-ESS1-2)

Obtaining, Evaluating, and Communicating Information

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.
- Communicate scientific 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). (HS-ESS1-3)

Connections to Nature of Science

Science Models, Laws, and Mechanisms, and Theories Explain Natural Phenomena

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-2)

Disciplinary Core Ideas

ESS1A: The Universe and Its Stars
- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1)
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2), (HS-ESS1-3)
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2)
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2), (HS-ESS1-3)

ESS1B: Earth and the Solar System
- Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4)

PS3D: Energy in Chemical Processes and Everyday Life
- Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary to HS-ESS1-1)

PS4B Electromagnetic Radiation
- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2)

Crosscutting Concepts

Scale, Proportion, and Quantity
- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1)
- Energy cannot be created or destroyed—only moved between one place and another, between objects and/or fields, or between systems. (HS-ESS1-2)

Connection to Engineering, Technology, and Applications of Science

Connection to Engineering
- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2), (HS-ESS1-4)

Connection to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (HS-ESS1-2)
- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-ESS1-2)
### HS.Space Systems

**Common Core State Standards Connections:**

**ELA/Literacy -**

RST.11-12.1  
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-ESS1-1),(HS-ESS1-2)*

WHST.9-12.2  
Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-ESS1-2),(HS-ESS1-3)*

SL.11-12.4  
Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(HS-ESS1-3)*

**Mathematics -**

MP.2  
Reason abstractly and quantitatively. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4)*

MP.4  
Model with mathematics. *(HS-ESS1-1),(HS-ESS1-4)*

HSN-Q.A.1  
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*

HSN-Q.A.2  
Define appropriate quantities for the purpose of descriptive modeling. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*

HSN-Q.A.3  
Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*

HSA-SSE.A.1  
Interpret expressions that represent a quantity in terms of its context. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*

HSA-CED.A.2  
Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*

HSA-CED.A.4  
Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*

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### WHST.9-12.1
Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions.

### WHST.9-12.2
Articulation of DCIs across grade bands and consortia.

### HSN-Q.A.1
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the most relevant units or scales for use.

### Engaging in Argument from Evidence
Engaging in argument from evidence 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.

### Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions 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.

### Science and Engineering Practices
Developing and Using Models
Modeling in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS-1)

### Crosscutting Concepts
- Stability and Change
  - Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS-1)
  - Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS-1)

### Science, Engineering, and Construction
- Science and Engineering Practices
- Disciplinary Core Ideas
- Crosscutting Concepts

### Disciplinary Core Ideas

#### ESS1.C: The History of Planet Earth
- Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS-1)

#### ESS2.A: Earth Materials and Systems
- Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS-2)

#### ESS2.B: Plate Tectonics and Large-Scale System Interactions
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth’s surface and provides a framework for understanding its geologic history. (ESS2.B Grade 8 GBE) (secondary to HS-ESS1.5), (HS-ESS2.1)

#### PS1.C: Nuclear Processes
- Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1.5), (secondary to HS-ESS1.6)

### Connections to Nature of Science

#### Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1.6)

- Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. (HS-ESS1.6)

### Articulation of DCIs across grade bands

#### MS.PS2.A
- Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. (HS-ESS1.6)

#### MS.PS2.B
- Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. (HS-ESS1.6)

#### MS.ESS1.B
- Energy in systems can be conserved in simple cases. (HS-ESS1.6)

#### MS.ESS1.C
- The History of Planet Earth

#### MS.ESS2.C
- Ocean processes can redistribute heat on the Earth by changing the distribution of sea surface temperature and by transporting heat across the surface and into the ocean. (HS-ESS2.1)

#### MS.ESS2.D
- Ocean processes can redistribute heat on the Earth by changing the distribution of sea surface temperature and by transporting heat across the surface and into the ocean. (HS-ESS2.1)

### Common Core State Standards Connections:

#### ELA/Literacy -

- **RST.11-12.1**
  - **RST.11-12.8**
  - **WHST.9-12.1**
  - **WHST.9-12.2**
  - **SL.11-12.5**

#### Mathematics -

- **MP.2**
- **MP.4**
- **HSN-Q.A.1**

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


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HS. History of Earth

Interpret the scale and the origin in graphs and data displays. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)

Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)

Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. (HS-ESS1-6)

Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. (HS-ESS1-6)

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

HS.Earth’s Systems

Students who demonstrate understanding can:

**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems.  
[Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth’s surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

**HS-ESS2-3.** Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection.  
[Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth’s three-dimensional structure obtained from seismic waves, records of the rate of change of Earth’s magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth’s layers from high-pressure laboratory experiments.]

**HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.  
[Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

**HS-ESS2-6.** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.  
[Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

**HS-ESS2-7.** Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.  
[Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth’s other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth’s surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms. [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth’s other systems.]
### HS.Earth’s Systems

- **Science knowledge is based on empirical evidence.** (HS-ESS2-3)
- **Science disciplines share common rules of evidence used to evaluate explanations about natural systems.** (HS-ESS2-3)
- **Science includes the process of coordinating patterns of evidence with current theory.** (HS-ESS2-3)

#### Connections to other DCIs in this grade-band:

- **PS4.A: Wave Properties**
  - Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)

#### Articulation of DCIs across grade-bands:

- **MS.PS1.A** (HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6); **MS.PS1.B** (HS-ESS2-3); **MS.PS2.B** (HS-ESS2-3);
- **MS.PS3.A** (HS-ESS2-3),(HS-ESS2-6); **MS.PS3.B** (HS-ESS2-3); **MS.PS3.C** (HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6);
- **MS.PS3.D** (HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6); **MS.PS4.B** (HS-ESS2-2); **MS.PS4.D** (HS-ESS2-2),(HS-ESS2-6);
- **HS.PS1.A** (HS-ESS2-5),(HS-ESS2-6); **HS.PS1.B** (HS-ESS2-3); **HS.PS2.B** (HS-ESS2-2); **HS.PS2.D** (HS-ESS2-6); **HS.PS3.B** (HS-ESS2-2); **HS.PS3.C** (HS-ESS2-2), (HS-ESS2-5),(HS-ESS2-6);
- **HS.PS4.B** (HS-ESS2-2); **HS.PS4.C** (HS-ESS2-7);
- **HS.LS1.C** (HS-ESS2-6); **HS.LS2.B** (HS-ESS2-2), (HS-ESS2-6); **HS.LS2.C** (HS-ESS2-2), (HS-ESS2-6);
- **HS.LS4.B** (HS-ESS2-7);
- **HS.LS4.C** (HS-ESS2-7); **HS.LS4.D** (HS-ESS2-2),(HS-ESS2-7); **HS.ESS3.C** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6); **HS.ESS3.D** (HS-ESS2-2),(HS-ESS2-6);
- **HS.ESS3.A** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6);
- **HS.ESS3.B** (HS-ESS2-2),(HS-ESS2-6);
- **HS.ESS3.C** (HS-ESS2-2),(HS-ESS2-6);
- **HS.ESS3.D** (HS-ESS2-2),(HS-ESS2-6);

#### Common Core State Standards Connections:

- **ELA/Literacy –**
  - RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS2-2),(HS-ESS2-3)
  - RST.11-12.2: Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2)
  - WHST.9-12.1: Write arguments focused on discipline-specific content. (HS-ESS2-7)
  - WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)
  - SL.11-12.5: 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 and to add interest. (HS-ESS2-3)

- **Mathematics –**
  - MP.2: Reason abstractly and quantitatively. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6)
  - MP.4: Model with mathematics. (HS-ESS2-3),(HS-ESS2-6)
  - HSN-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6)
  - HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-2),(HS-ESS2-6)
  - HSN-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6)

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HS.Weather and Climate

Students who demonstrate understanding can:

**HS-ESS2-4.** Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100 years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperature, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]

**HS-ESS3-5.** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition.)] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education.*

### Science and Engineering Practices

**Developing and Using Models**

Modeling in 9–12 builds on K–8 experiences and progresses to components in the natural and designed world(s).

- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

**Analyzing and Interpreting Data**

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 computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

### Disciplinary Core Ideas

**ESS1.B: Earth and the Solar System**

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

**ESS2.A: Earth Materials and Systems**

- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term (tectonic cycles). (HS-ESS2-4)

**ESS2.D: Weather and Climate**

- The foundation for Earth's global climate system is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-4, secondary to HS-ESS2-2)

**ESS3.D: Global Climate Change**

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)

### Crosscutting Concepts

**Cause and Effect**

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4)

**Stability and Change**

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-5)

### Connections to Nature of Science

**Scientific Investigations Use a Variety of Methods**

- Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)

**Scientific Knowledge is Based on Empirical Evidence**

- New technologies advance scientific knowledge. (HS-ESS3-5)

**Science arguments are strengthened by multiple lines of evidence supporting a single explanation.** (HS-ESS2-4, HS-ESS3-5)

**The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term (tectonic cycles).**

**The foundation for Earth's global climate system is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.**

**Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.**

### Common Core State Standards Connections:

**ELA/Literacy -**

<table>
<thead>
<tr>
<th><strong>RST.11-12.1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>RST.11-12.2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS3-5)</td>
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</tbody>
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<table>
<thead>
<tr>
<th><strong>RST.11-12.7</strong></th>
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<tbody>
<tr>
<td>Integrate and 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. (HS-ESS3-5)</td>
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</table>

<table>
<thead>
<tr>
<th><strong>SL.11-12.5</strong></th>
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</thead>
<tbody>
<tr>
<td>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 and to add interest. (HS-ESS2-4)</td>
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</tbody>
</table>

**Mathematics -**

<table>
<thead>
<tr>
<th><strong>MP.2</strong></th>
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<tbody>
<tr>
<td>Reason abstractly and quantitatively. (HS-ESS2-4, HS-ESS3-5)</td>
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<table>
<thead>
<tr>
<th><strong>MP.4</strong></th>
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<tbody>
<tr>
<td>Model with mathematics. (HS-ESS2-4)</td>
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<table>
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<tr>
<th><strong>HSN-Q.A.1</strong></th>
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<tr>
<td>Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-4, HS-ESS3-5)</td>
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<table>
<thead>
<tr>
<th><strong>HSN-Q.A.2</strong></th>
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</thead>
<tbody>
<tr>
<td>Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-4, HS-ESS3-5)</td>
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</table>

<table>
<thead>
<tr>
<th><strong>HSN-Q.A.3</strong></th>
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<tbody>
<tr>
<td>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-4, HS-ESS3-5)</td>
</tr>
</tbody>
</table>

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas.* Integrated and reprinted with permission from the National Academy of Sciences.

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Students who demonstrate understanding can:

**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

**Clarification Statement:** Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types and crops and livestock that can be raised.

**HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*

**Clarification Statement:** Examples of design solutions for energy resources include extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning. [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

**HS-ESS3-3.** Create a computational simulation to illustrate the relationships among management of natural resources, technology, sustainability of human populations, and biodiversity.

**Clarification Statement:** Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning. [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

**HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*

**Clarification Statement:** Examples of the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoenineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).

**HS-ESS3-5.** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.*

**Clarification Statement:** Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations. [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

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**Science and Engineering Practices**

**Using Mathematics and Computational Thinking**
- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to algebraic thinking and analysis, a range of linear and nonlinear functions, trigonometric functions, exponential and logarithmic functions, 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 a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

**Constructing Explanations and Designing Solutions**
- 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 knowledge, principles, and theories.
- Construct 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. (HS-ESS3-1)
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)

**Engaging in Argument from Evidence**
- 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 natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding

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**Disciplinary Core Ideas**

**ESS2.D: Weather and Climate**
- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the oceans and biosphere. (secondary to HS-ESS3-6)

**ESS3.A: Natural Resources**
- Resource availability has guided the development of human society. (HS-ESS3-1)
- All forms of energy production and other resource extraction have associated economic, social, environmental, and/or geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

**ESS3.B: Natural Hazards**
- Natural hazards and other geologic events have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)

**ESS3.C: Human Impacts on Earth Systems**
- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that prevent ecosystem degradation. (HS-ESS3-4)

**ESS3.D: Global Climate Change**
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

**ETS1.B: Developing Possible Solutions**
- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-ESS3-2)/(secondary to HS-ESS3-4)

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**Crosscutting Concepts**

**Cause and Effect**
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)

**Systems and System Models**
- 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. (HS-ESS3-6)

**Stability and Change**
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3)
- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

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**Connections to Engineering, Technology, and Applications of Science**

**Influence of Engineering, Technology, and Science on Society and the Natural World**
- Modern civilization depends on major technological systems. (HS-ESS3-1), (HS-ESS3-3)
- Engineers continuously modify these systems to increase benefits while decreasing costs and risks. (HS-ESS3-2), (HS-ESS3-4)
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-2)
- Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2)
relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

Connections to Nature of Science

Science is a Human Endeavor
- Scientific knowledge is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Science Addresses Questions About the Natural and Material World
- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2)
- Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

Connections to other DCIs in this grade-band:
- HS.PS1.B (HS-ESS3-3); HS.PS3.B (HS-ESS3-2); HS.PS3.D (HS-ESS3-2); HS.LS2.A (HS-ESS3-2),(HS-ESS3-3); HS.LS2.B (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-6); HS.LS2.C (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); HS.LS4.D (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); HS.ESS2.A (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-6); HS.ESS2.E (HS-ESS3-3)

Articulation of DCI’s across grade-bands:
- MS.PS1.B (HS-ESS3-3); MS.PS3.B (HS-ESS3-2); MS.LS2.A (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); MS.LS2.B (HS-ESS3-2),(HS-ESS3-3); MS.LS2.C (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); MS.LS4.C (HS-ESS3-3); MS.LS4.D (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); MS.ESS2.A (HS-ESS3-1),(HS-ESS3-3),(HS-ESS3-6); MS.ESS3.A (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); MS.ESS3.B (HS-ESS3-1),(HS-ESS3-4); MS.ESS3.C (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); MS.ESS3.D (HS-ESS3-4),(HS-ESS3-6)

Common Core State Standards Connections:
- ELA/Literacy –
  - RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-4)
  - 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. (HS-ESS3-2),(HS-ESS3-4)
  - WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)
- Mathematics –
  - MP.2 Reason abstractly and quantitatively. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6)
  - MP.4 Model with mathematics. (HS-ESS3-3),(HS-ESS3-6)
  - HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6)
  - HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6)
  - HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6)
HS.Engineering Design

Students who demonstrate understanding can:

**HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

**HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

**HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

**HS-ETS1-4.** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**Science and Engineering Practices**

**Asking Questions and Defining Problems**

- 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.
  - Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

**Using Mathematics and Computational Thinking**

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.

- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

**Constructing Explanations and Designing Solutions**

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.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)

- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

**Disciplinary Core Ideas**

**ETS1.A: Defining and Delimiting Engineering Problems**

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)

- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

**ETS1.B: Developing Possible Solutions**

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

**ETS1.C: Optimizing the Design Solution**

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)

**Crosscutting Concepts**

**Systems and System 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. (HS-ETS1-4)

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