Table of Contents

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The Three Dimensions

Dimension 1: Science and Engineering Practices

What the students will do.

This dimension describes (a) the major practices that scientists employ as they investigate and build models and theories about the world and (b) a key set of engineering practices that engineers use as they design and build systems. We use the term "practices" instead of a term such as "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Similarly, because the term "inquiry," extensively referred to in previous standards documents, has been interpreted over time in many different ways throughout the science education community, part of our intent in articulating the practices in Dimension 1 is to better specify what is meant by inquiry in science and the range of cognitive, social and physical practices that it requires. As in all inquiry-based approaches to science teaching, our expectation is that students will themselves engage in the practices and not merely learn about them secondhand. Students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves.

Dimension 2: Crosscutting Concepts

How the students will organize and connect their knowledge.

The crosscutting concepts have application across all domains of science. As such, they provide one way of linking across the domains in Dimension 3. There is a need to consider not only content but also the ideas and practices that cut across the science disciplines.

Dimension 3: Disciplinary Core Ideas

What the students will understand.

The continuing expansion of scientific knowledge makes it impossible to teach all the ideas related to a given discipline in exhaustive detail during the K-12 years. But given the cornucopia of information available today virtually at a touch– people live, after all, in an information age—an important role of science education is not to teach "all the facts" but rather to prepare students with sufficient core knowledge so that they can later acquire additional information on their own. An education focused on a limited set of ideas and practices in science and engineering should enable students to evaluate and select reliable sources of scientific information and allow them to continue their development well beyond their K-12 school years as science learners, users of scientific knowledge, and perhaps also as producers of such knowledge.

EIGHT SCIENCE AND ENGINEERING PRACTICES

PRACTICE	SCIENCE	ENGINEERING
Asking Questions and Defining Problems	Science begins with a question about a phenomenon, such as "Why is the sky blue?" or "What causes cancer?," and seeks to develop theories that can provide explanatory answers to such questions. A basic practice of the scientist is formulating empirically answerable questions about phenomena, establishing what is already known, and determining what questions have yet to be satisfactorily answered.	Engineering begins with a problem, need, or desire that suggests an engineering problem that needs to be solved. A societal problem such as reducing the nation's dependence on fossil fuels may engender a variety of engineering problems, such as designing more efficient transportation systems, or alternative power generation devices such as improved solar cells. Engineers ask questions to define the engineering problem, determine criteria for a successful solution, and identify constraints.
Developing and Using Models	Science often involves the construction and use of a wide variety of models and simulations to help develop explanations about natural phenomena. Models make it possible to go beyond observables and imagine a world not yet seen. Models enable predictions of the form "if . . .then . . . therefore" to be made in order to test hypothetical explanations.	Engineering makes use of models and simulations to analyze existing systems so as to see where flaws might occur or to test possible solutions to a new problem. Engineers also call on models of various sorts to test proposed systems and to recognize the strengths and limitations of their designs.
Planning and Carrying Out Investigations	Scientific **investigation** may be conducted in the field or the laboratory. A major practice of scientists is planning and carrying out a systematic investigation, which requires the identification of what is to be recorded and, if applicable, what are to be treated as the dependent and independent variables (control of variables). Observations and data collected from such work are used to test existing theories and explanations or to revise and develop new ones.	Engineers use investigation both to gain data essential for specifying design criteria or parameters and to test their designs. Like scientists, engineers must identify relevant variables; decide how they will be measured, and collect data for analysis. Their investigations help them to identify how effective, efficient, and durable their designs may be under a range of conditions.
Analyzing and Interpreting Data	Scientific **investigations** produce data that must be analyzed in order to derive meaning. Because data usually do not speak for themselves, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Sources of error are identified and the degree of certainty calculated. Modern technology makes the collection of large data sets much easier, thus providing many secondary sources for analysis.	Engineers analyze data collected in the tests of their designs and investigations; this allows them to compare different solutions and determine how well each one meets specific design criteria—that is, which design best solves the problem within the given constraints. Like scientists, engineers require a range of tools to identify the major patterns and interpret the results.

Using Mathematics and Computational Thinking	In **science,** mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks, such as constructing simulations, statistically analyzing data, and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable predictions of the behavior of physical systems, along with the testing of such predictions. Moreover, statistical techniques are invaluable for assessing the significance of patterns or correlations.	In **engineering,** mathematical and computational representations of established relationships and principles are an integral part of design. For example, structural engineers create mathematically based analyses of designs to calculate whether they can stand up to the expected stresses of use and if they can be completed within acceptable budgets. Moreover, simulations of designs provide an effective test bed for the development of designs and their improvement.
Constructing Explanations and Designing Solutions	The goal of **science** is the construction of theories that can provide explanatory accounts of features of the world. A theory becomes accepted when it has been shown to be superior to other explanations in the breadth of phenomena it accounts for and in its explanatory coherence and parsimony. Scientific explanations are explicit applications of theory to a specific situation or phenomenon, perhaps with the intermediary of a theory-based model for the system under study. The goal for students is to construct logically coherent explanations of phenomena that incorporate their current understanding of science, or a model that represents it, and are consistent with the available evidence.	**Engineering design,** a systematic process for solving engineering problems, is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technological feasibility, cost, safety, esthetics, and compliance with legal requirements. There is usually no single best solution but rather a range of solutions. Which one is the optimal choice depends on the criteria used for making evaluations.
Engaging in Argument from Evidence	In **science,** reasoning and argument are essential for identifying the strengths and weaknesses of a line of reasoning and for finding the best explanation for a natural phenomenon. Scientists must defend their explanations, formulate evidence based on a solid foundation of data, examine their own understanding in light of the evidence and comments offered by others, and collaborate with peers in searching for the best explanation for the phenomenon being investigated.	In **engineering,** reasoning and argument are essential for finding the best possible solution to a problem. Engineers collaborate with their peers throughout the design process, with a critical stage being the selection of the most promising solution among a field of competing ideas. Engineers use systematic methods to compare alternatives, formulate evidence based on test data, make arguments from evidence to defend their conclusions, evaluate critically the ideas of others, and revise their designs in order to achieve the best solution to the problem at hand.
Obtaining, Evaluating, and Communicating Information	**Science** cannot advance if scientists are unable to communicate their findings clearly and persuasively or to learn about the findings of others. A major practice of science is thus the communication of ideas and the results of inquiry—orally, in writing, with the use of tables, diagrams, graphs, and equations, and by engaging in extended discussions with scientific peers. Science requires the ability to derive meaning from scientific texts (such as papers, the Internet, symposia, and lectures), to evaluate the scientific validity of the information thus acquired, and to integrate that information.	**Engineers** cannot produce new or improved technologies if the advantages of their designs are not communicated clearly and persuasively. Engineers need to be able to express their ideas, orally and in writing, with the use of tables, graphs, drawings, or models and by engaging in extended discussions with peers. Moreover, as with scientists, they need to be able to derive meaning from colleagues' texts, evaluate the information, and apply it usefully. In engineering and science alike, new technologies are now routinely available that extend the possibilities for collaboration and communication.

SEVEN CROSSCUTTING CONCEPTS OF THE FRAMEWORK

The organizational framework that connects knowledge into a coherent and scientifically based view of the world

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

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

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

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

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

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

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

FIFTH GRADE OVERVIEW

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.

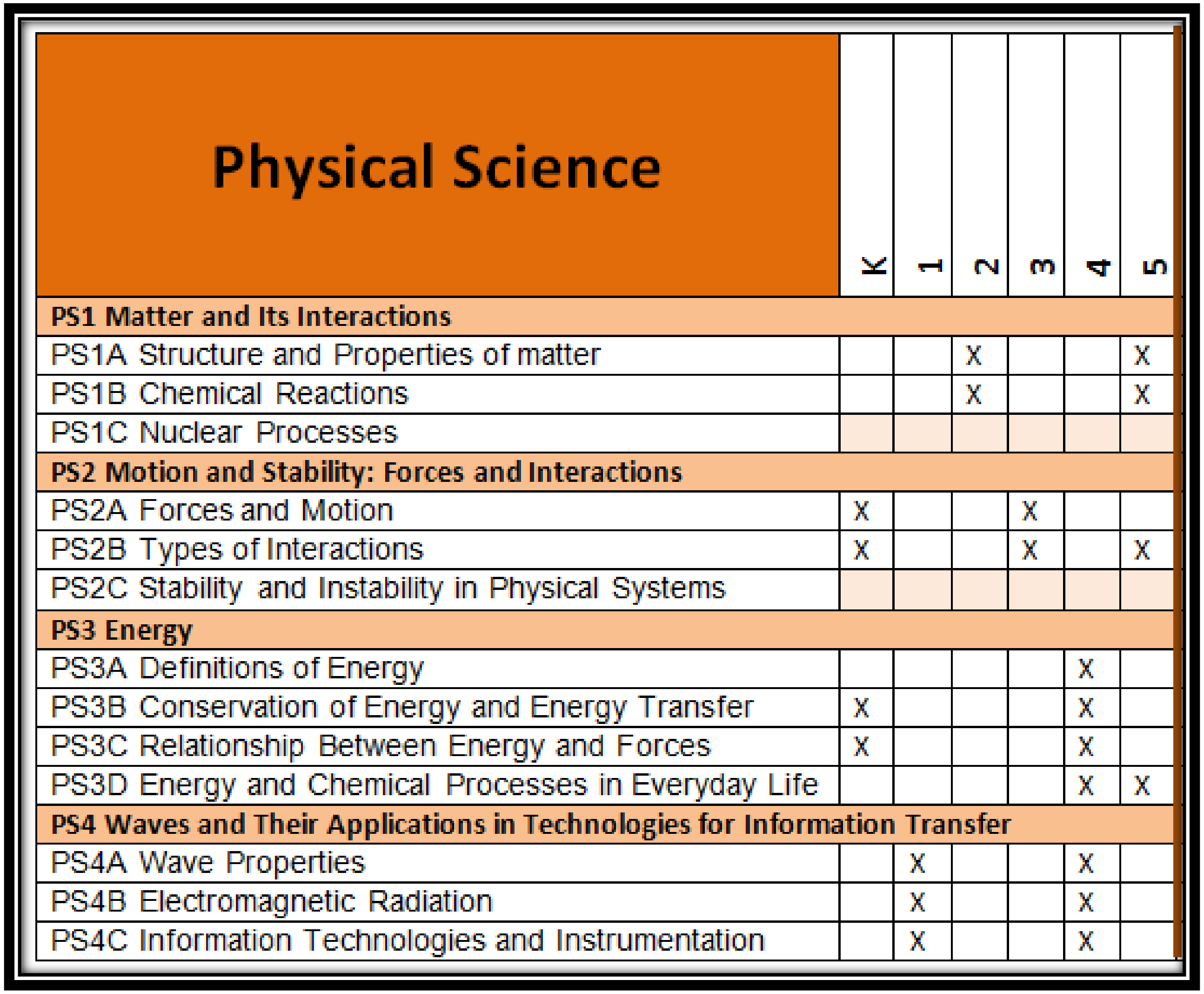
PS = Physical Science

LS = Life Science

ESS = Earth Space Science

ETS = Engineering, Technology, and Application of Science

Physical Science K-5 Progression



Physical Science	K	1	2	3	4	5
PS1 Matter and Its Interactions						
PS1A Structure and Properties of matter			X			X
PS1B Chemical Reactions			X			X
PS1C Nuclear Processes						
PS2 Motion and Stability: Forces and Interactions						
PS2A Forces and Motion	X			X		
PS2B Types of Interactions	X			X		X
PS2C Stability and Instability in Physical Systems						
PS3 Energy						
PS3A Definitions of Energy					X	
PS3B Conservation of Energy and Energy Transfer	X				X	
PS3C Relationship Between Energy and Forces	X				X	
PS3D Energy and Chemical Processes in Everyday Life					X	X
PS4 Waves and Their Applications in Technologies for Information Transfer						
PS4A Wave Properties		X			X	
PS4B Electromagnetic Radiation		X			X	
PS4C Information Technologies and Instrumentation		X			X	

Core Idea PS1

Matter and Its Interactions

Essential Question: How can one explain the structure, properties, and interactions of matter?

The existence of atoms, now supported by evidence from modern instruments, was first postulated as a model that could explain both qualitative and quantitative observations about matter (e.g., Brownian motion, ratios of reactants and products in chemical reactions). Matter can be understood in terms of the types of atoms present and the interactions both between and within them. The states (i.e., solid, liquid, gas, or plasma), properties (e.g., hardness, conductivity), and reactions (both physical and chemical) of matter can be described and predicted based on the types, interactions, and motions of the atoms within it. Chemical reactions, which underlie so many observed phenomena in living and nonliving systems alike, conserve the number of atoms of each type but change their arrangement into molecules. Nuclear reactions involve changes in the types of atomic nuclei present and are key to the energy release from the sun and the balance of isotopes in matter.

PS1.A: STRUCTURE AND PROPERTIES OF MATTER

Essential Question: How do particles combine to form the variety of matter one observes?

While too small to be seen with visible light, atoms have substructures of their own. They have a small central region or nucleus—containing protons and neutrons—surrounded by a larger region containing electrons. The number of protons in the atomic nucleus (atomic number) is the defining characteristic of each element; different isotopes of the same element differ in the number of neutrons only. Despite the immense variation and number of substances, there are only some 100 different stable elements.

Each element has characteristic chemical properties. The periodic table, a systematic representation of known elements, is organized horizontally by increasing atomic number and vertically by families of elements with related chemical properties. The development of the periodic table (which occurred well before atomic substructure was understood) was a major advance, as its patterns suggested and led to the identification of additional elements with particular properties. Moreover, the table's patterns are now recognized as related to the atom's outermost electron patterns, which play an important role in explaining chemical reactivity and bond formation, and the periodic table continues to be a useful way to organize this information.

The substructure of atoms determines how they combine and rearrange to form all of the world's substances. Electrical attractions and repulsions between charged particles (i.e., atomic nuclei and electrons) in matter explain the structure of atoms and the forces between atoms that cause them to form molecules (via chemical bonds), which range in size from two to thousands of atoms (e.g., in biological molecules such as proteins). Atoms also combine due to these forces to form extended structures, such as crystals or metals. The varied properties (e.g., hardness, conductivity) of the materials one encounters, both natural and manufactured, can be understood in terms of the atomic and molecular constituents present and the forces within and between them. Within matter, atoms and their constituents are constantly in motion. The arrangement and motion of atoms vary in characteristic ways, depending on the substance and its current state (e.g., solid, liquid). Chemical composition, temperature, and pressure affect such arrangements and motions of atoms, as well as the ways in which they interact. Under a given set of conditions, the state and some properties (e.g., density, elasticity, viscosity) are the same for different bulk quantities of a substance, whereas other properties (e.g., volume, mass) provide measures of the size of the sample at hand.

Materials can be characterized by their intensive measureable properties. Different materials with different properties are suited to different uses. The ability to image and manipulate placement of individual atoms in tiny structures allows for the design of new types of materials with particular desired functionality (e.g., plastics, nanoparticles). Moreover, the modern explanation of how particular atoms influence the properties of materials or molecules is critical to understanding the physical and chemical functioning of biological systems.

Grade Band Endpoints for PS1.A

By the end of grade 2. Different kinds of matter exist (e.g., wood, metal, water), and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties (e.g., visual, aural, textural), by its uses, and by whether it occurs naturally or is manufactured. Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces (e.g., blocks, construction sets). Objects or samples of a substance can be weighed, and their size can be described and measured. (Boundary: volume is introduced only for liquid measure.)

By the end of grade 5. Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means (e.g., by weighing or by its effects on other objects). For example, a model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects (e.g., leaves in wind, dust suspended in air); and the appearance of visible scale water droplets in condensation, fog, and, by extension, also in clouds or the contrails of a jet. The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish (e.g., sugar in solution, evaporation in a closed container). Measurements of a variety of properties (e.g., hardness, reflectivity) can be used to identify particular materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)

PS1.B: CHEMICAL REACTIONS

Essential Question: How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?

Many substances react chemically with other substances to form new substances with different properties. This change in properties results from the ways in which atoms from the original substances are combined and rearranged in the new substances. However, the total number of each type of atom is conserved (does not change) in any chemical process, and thus mass does not change either. The property of conservation can be used, along with knowledge of the chemical properties of particular elements, to describe and predict the outcomes of reactions. Changes in matter in which the molecules do not change, but their positions and their motion relative to each other do change also occur (e.g., the forming of a solution, a change of state). Such changes are generally easier to reverse (return to original conditions) than chemical changes.

“Collision theory” provides a qualitative model for explaining the rates of chemical reactions. Higher rates occur at higher temperatures because atoms are typically moving faster and thus collisions are more frequent; also, a larger fraction of the collisions have sufficient energy to initiate the process. Although a solution or a gas may have constant chemical composition—that is, be in a steady state—chemical reactions may be occurring within it that are dynamically balanced with reactions in opposite directions proceeding at equal rates.

Any chemical process involves a change in chemical bonds and the related bond energies and thus in the total chemical binding energy. This change is matched by a difference between the total kinetic energy of the set of reactant molecules before the collision and that of the set of product molecules after the collision (conservation of energy). Some reactions release energy (e.g., burning fuel in the presence of oxygen), and others require energy input (e.g., synthesis of sugars from carbon dioxide and water).

Understanding chemical reactions and the properties of elements is essential not only to the physical sciences but also is foundational knowledge for the life sciences and the earth and space sciences. The cycling of matter and associated transfers of energy in systems, of any scale, depend on physical and chemical processes. The reactivity of hydrogen ions gives rise to many biological and geophysical phenomena. The capacity of carbon atoms to form the backbone of extended molecular structures is essential to the chemistry of life. The carbon cycle involves transfers between carbon in the atmosphere—in the form of carbon dioxide—and carbon in living matter or formerly living matter (including fossil fuels). The proportion of oxygen molecules (i.e., oxygen in the form O_2) in the atmosphere also changes in this cycle.

Grade Band Endpoints for PS1.B

By the end of grade 2. Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible (e.g., melting and freezing), and sometimes they are not (e.g., baking a cake, burning fuel).

By the end of grade 5. When two or more different substances are mixed, a new substance with different properties may be formed; such occurrences depend on the substances and the temperature. No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)

Core Idea PS2

Motion and Stability: Forces and Interactions

Essential Question: How can one explain and predict interactions between objects and within systems of objects?

Interactions between any two objects can cause changes in one or both of them. An understanding of the forces between objects is important for describing how their motions change, as well as for predicting stability or instability in systems at any scale. All forces between objects arise from a few types of interactions: gravity, electromagnetism, and the strong and weak nuclear interactions.

PS2.B: TYPES OF INTERACTIONS

Essential Question: What underlying forces explain the variety of interactions observed?

All forces between objects arise from a few types of interactions: gravity, electromagnetism, and strong and weak nuclear interactions. Collisions between objects involve forces between them that can change their motion. Any two objects in contact also exert forces on each other that are electromagnetic in origin. These forces result from deformations of the objects' substructures and the electric charges of the particles that form those substructures (e.g., a table supporting a book, friction forces).

Gravitational, electric, and magnetic forces between a pair of objects do not require that they be in contact. These forces are explained by force fields that contain energy and can transfer energy through space. These fields can be mapped by their effect on a test object (mass, charge, or magnet, respectively).

Objects with mass are sources of gravitational fields and are affected by the gravitational fields of all other objects with mass. Gravitational forces are always attractive. For two human-scale objects, these forces are too small to observe without sensitive instrumentation. Gravitational interactions are nonnegligible, however, when very massive objects are involved. Thus the gravitational force due to Earth, acting on an object near Earth's surface, pulls that object toward the planet's center. Newton's law of universal gravitation provides the mathematical model to describe and predict the effects of gravitational forces between distant objects. These long-range gravitational interactions govern the evolution and maintenance of large-scale structures in the universe (e.g., the solar system, galaxies) and the patterns of motion within them.

Electric forces and magnetic forces are different aspects of a single electromagnetic interaction. Such forces can be attractive or repulsive, depending on the relative sign of the electric charges involved, the direction of current flow, and the orientation of magnets. The forces' magnitudes depend on the magnitudes of the charges, currents, and magnetic strengths as well as on the distances between the interacting objects. All objects with electrical charge or magnetization are sources of electric or magnetic fields and can be affected by the electric or magnetic fields of other such objects. Attraction and repulsion of electric charges at the atomic scale explain the structure, properties, and transformations of matter and the contact forces between material objects (link to PS1.A and PS1.B). Coulomb's law provides the mathematical model to describe and predict the effects of electrostatic forces (relating to stationary electric charges or fields) between distant objects.

The strong and weak nuclear interactions are important inside atomic nuclei. These short-range interactions determine nuclear sizes, stability, and rates of radioactive decay (see PS1.C).

Grade Band Endpoints for PS2.B

By the end of grade 2. When objects touch or collide, they push on one another and can change motion or shape.

By the end of grade 5. Objects in contact exert forces on each other (friction, elastic pushes and pulls). Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. 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. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

Core Idea PS3

Energy

Essential Question: How is energy transferred and conserved?

Interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another. The total energy within a defined system changes only by the transfer of energy into or out of the system.

PS3.D: ENERGY IN CHEMICAL PROCESSES AND EVERYDAY LIFE

Essential Questions: *How do food and fuel provide energy?*
If energy is conserved, why do people say it is produced or used?

In ordinary language, people speak of “producing” or “using” energy. This refers to the fact that energy in concentrated form is useful for generating electricity, moving or heating objects, and producing light, whereas diffuse energy in the environment is not readily captured for practical use. Therefore, to produce energy typically means to convert some stored energy into a desired form—for example, the stored energy of water behind a dam is released as the water flows downhill and drives a turbine generator to produce electricity, which is then delivered to users through distribution systems. Food, fuel, and batteries are especially convenient energy resources because they can be moved from place to place to provide processes that release energy where needed. A system does not destroy energy when carrying out any process. However, the process cannot occur without energy being available. The energy is also not destroyed by the end of the process. Most often some or all of it has been transferred to heat the surrounding environment; in the same sense that paper is not destroyed when it is written on, it still exists but is not readily available for further use.

Naturally occurring food and fuel contain complex carbon-based molecules, chiefly derived from plant matter that has been formed by photosynthesis. The chemical reaction of these molecules with oxygen releases energy; such reactions provide energy for most animal life and for residential, commercial, and industrial activities.

Electric power generation is based on fossil fuels (i.e., coal, oil, and natural gas), nuclear fission, or renewable resources (e.g., solar, wind, tidal, geothermal, and hydro power). Transportation today chiefly depends on fossil fuels, but the use of electric and alternative fuel (e.g., hydrogen, biofuel) vehicles is increasing. All forms of electricity generation and transportation fuels have associated economic, social, and environmental costs and benefits, both short and long term. Technological advances and regulatory decisions can change the balance of those costs and benefits.

Although energy cannot be destroyed, it can be converted to less useful forms. In designing a system for energy storage, for energy distribution, or to perform some practical task (e.g., to power an airplane), it is important to design for maximum efficiency—thereby ensuring that the largest possible fraction of the energy is used for the desired purpose rather than being transferred out of the system in unwanted ways (e.g., through friction, which eventually results in heat energy transfer to the surrounding environment). Improving efficiency reduces costs, waste materials, and many unintended environmental impacts.

Grade Band Endpoints for PS3.D

***By the end of grade 2*.**

When two objects rub against each other, this interaction is called friction. Friction between two surfaces can warm of both of them (e.g., rubbing hands together). There are ways to reduce the friction between two objects.

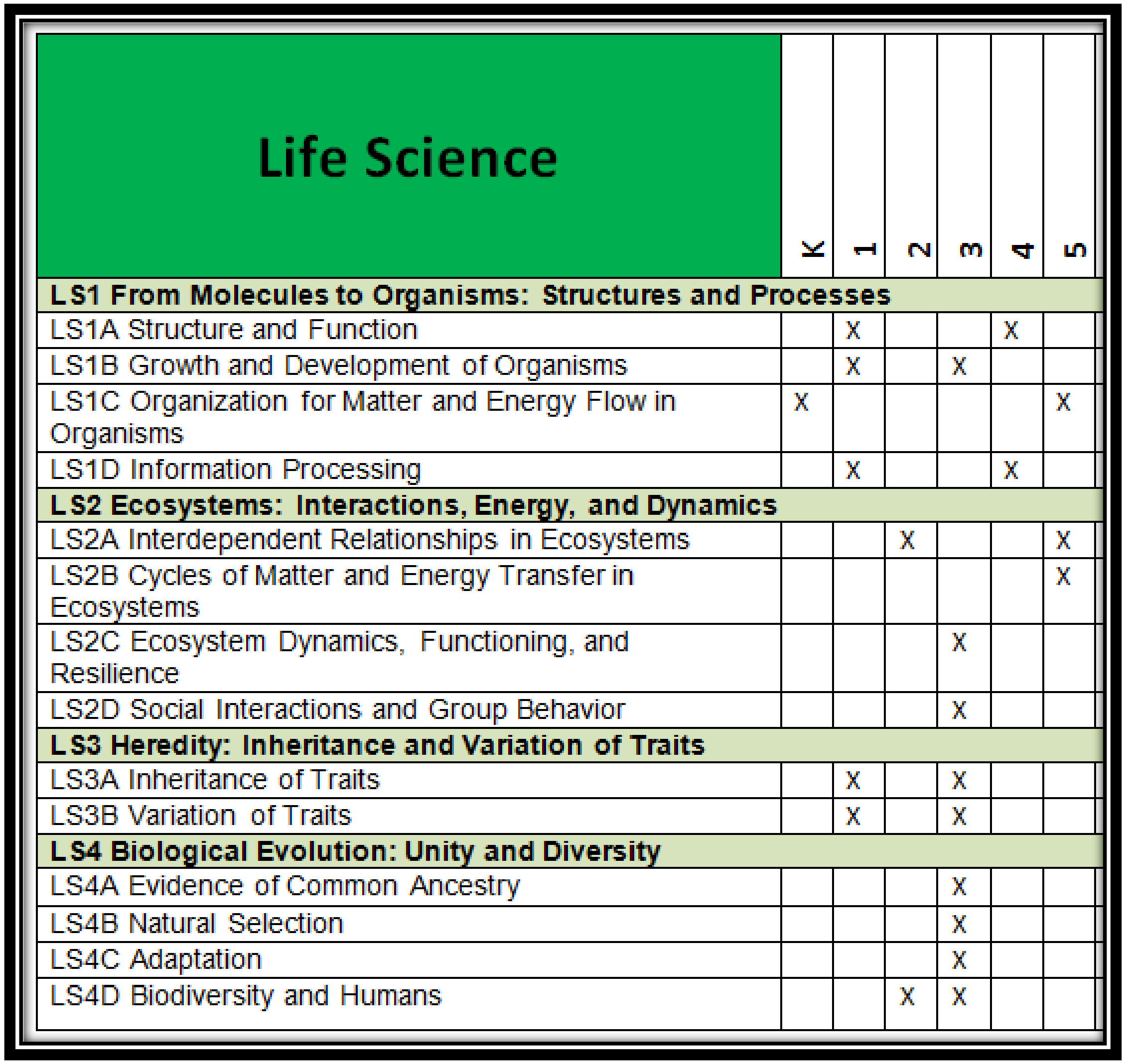
***By the end of grade 5*.**

The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use—for example, the stored energy of water behind a dam is released so that it flows downhill and drives a turbine generator to produce electricity. Food and fuel also release energy when they are digested or burned. When machines or animals “use” energy (e.g., to move around), most often the energy is transferred to heat the surrounding environment.

The energy released by burning fuel or digesting food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (Boundary: The fact that plants capture energy from sunlight is introduced at this grade level, but details of photosynthesis are not.)

It is important to be able to concentrate energy so that it is available for use where and when it is needed. For example, batteries are physically transportable energy storage devices, whereas electricity generated by power plants is transferred from place to place through distribution systems.

Life Science K-5 Progression



Life Science	K	1	2	3	4	5
LS1 From Molecules to Organisms: Structures and Processes						
LS1A Structure and Function		X			X	
LS1B Growth and Development of Organisms		X		X		
LS1C Organization for Matter and Energy Flow in Organisms	X					X
LS1D Information Processing		X			X	
LS2 Ecosystems: Interactions, Energy, and Dynamics						
LS2A Interdependent Relationships in Ecosystems			X			X
LS2B Cycles of Matter and Energy Transfer in Ecosystems						X
LS2C Ecosystem Dynamics, Functioning, and Resilience				X		
LS2D Social Interactions and Group Behavior				X		
LS3 Heredity: Inheritance and Variation of Traits						
LS3A Inheritance of Traits		X		X		
LS3B Variation of Traits		X		X		
LS4 Biological Evolution: Unity and Diversity						
LS4A Evidence of Common Ancestry				X		
LS4B Natural Selection				X		
LS4C Adaptation				X		
LS4D Biodiversity and Humans			X	X		

Core Idea LS1

From Molecules to Organisms: Structures and Processes

Essential Question: How do organisms live, grow, respond to their environment, and reproduce?

All living organisms are made of cells. Life is the quality that distinguishes living things—composed of living cells—from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things—that is to say all organisms—can be characterized by common aspects of their structure and functioning. Organisms are complex, organized, and built on a hierarchical structure, with each level providing the foundation for the next, from the chemical foundation of elements and atoms, to the cells and systems of individual organisms, to species and populations living and interacting in complex ecosystems. Organisms can be made of a single cell or millions of cells working together and include animals, plants, algae, fungi, bacteria, and all other microorganisms.

Organisms respond to stimuli from their environment and actively maintain their internal environment through homeostasis. They grow and reproduce, transferring their genetic information to their offspring. While individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes. Over generations natural selection can lead to changes in a species overall; hence, species evolve over time. To maintain all of these processes and functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun.

LS1.C: ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS

Essential Question: How do organisms obtain and use the matter and energy they need to live and grow?

Sustaining life requires substantial energy and matter inputs. The complex structural organization of organisms accommodates the capture, transformation, transport, release, and elimination of the matter and energy needed to sustain them. As matter and energy flow through different organizational levels—cells, tissues, organs, organisms, populations, communities, and ecosystems—of living systems, chemical elements are recombined in different ways to form different products. The result of these chemical reactions is that energy is transferred from one system of interacting molecules to another.

In most cases, the energy needed for life is ultimately derived from the sun through photosynthesis (although in some ecologically important cases, energy is derived from reactions involving inorganic chemicals in the absence of sunlight—e.g., chemosynthesis). Plants, algae (including phytoplankton), and other energy-fixing microorganisms use sunlight, water, and carbon dioxide to facilitate photosynthesis, which stores energy, forms plant matter, releases oxygen, and maintains plants' activities. Plants and algae—being the resource base for animals, the animals that feed on animals, and the decomposers—are energy-fixing organisms that sustain the rest of the food web.

Grade Band Endpoints for LS1.C

By the end of grade 2. 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.

By the end of grade 5. Animals and plants alike generally need to take in air and water, animals must take in food, and plants need light and minerals; anaerobic life, such as bacteria in the gut, functions without air. Food provides animals with the materials they need for body repair and growth and is digested to release the energy they need to maintain body warmth and for motion. Plants acquire their material for growth chiefly from air and water and process matter they have formed to maintain their internal conditions (e.g., at night).

Core Idea LS2

Ecosystems: Interactions, Energy, and Dynamics

Essential Question: How and why do organisms interact with their environment and what are the effects of these interactions?

Ecosystems are complex, interactive systems that include both biological communities (biotic) and physical (abiotic) components of the environment. As with individual organisms, a hierarchal structure exists; groups of the same organisms (species) form populations, different populations interact to form communities, communities live within an ecosystem, and all of the ecosystems on Earth make up the biosphere. Organisms grow, reproduce, and perpetuate their species by obtaining necessary resources through interdependent relationships with other organisms and the physical environment. These same interactions can facilitate or restrain growth and enhance or limit the size of populations, maintaining the balance between available resources and those who consume them. These interactions can also change both biotic and abiotic characteristics of the environment. Like individual organisms, ecosystems are sustained by the continuous flow of energy, originating primarily from the sun, and the recycling of matter and nutrients within the system. Ecosystems are dynamic, experiencing shifts in population composition and abundance and changes in the physical environment over time, which ultimately affects the stability and resilience of the entire system.

LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

Essential Question: How do organisms interact with the living and nonliving environments to obtain matter and energy?

Ecosystems are ever changing because of the interdependence of organisms of the same or different species and the nonliving (physical) elements of the environment. Seeking matter and energy resources to sustain life, organisms in an ecosystem interact with one another in complex feeding hierarchies of producers, consumers, and decomposers, which together represent a food web. Interactions between organisms may be predatory, competitive, or mutually beneficial. Ecosystems have carrying capacities that limit the number of organisms (within populations) they can support. Individual survival and population sizes depend on such factors as predation, disease, availability of resources, and parameters of the physical environment. Organisms rely on physical factors, such as light, temperature, water, soil, and space for shelter and reproduction. Earth's varied combinations of these factors provide the physical environments in which its ecosystems (e.g., deserts, grasslands, rain forests, and coral reefs) develop and in which the diverse species of the planet live. Within any one ecosystem, the biotic interactions between organisms (e.g., competition, predation, and various types of facilitation, such as pollination) further influence their growth, survival, and reproduction, both individually and in terms of their populations.

Grade Band Endpoints for LS2.A

By the end of grade 2. Animals depend on their surroundings to get what they need, including food, water, shelter, and a favorable temperature. Animals depend on plants or other animals for food. They use their senses to find food and water, and they use their body parts to gather, catch, eat, and chew the food. Plants depend on air, water, minerals (in the soil), and light to grow. Animals can move around, but plants cannot, and they often depend on animals for pollination or to move their seeds around. Different plants survive better in different settings because they have varied needs for water, minerals, and sunlight.

By the end of grade 5. The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Either way, they are "consumers." Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil for plants to use. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

LS2.B: CYCLES OF MATTER AND ENERGY TRANSFER IN ECOSYSTEMS

Essential Question: How do matter and energy move through an ecosystem?

The cycling of matter and the flow of energy within ecosystems occur through interactions among different organisms and between organisms and the physical environment. All living systems need matter and energy. Matter fuels the energy-releasing chemical reactions that provide energy for life functions and provides the material for growth and repair of tissue. Energy from light is needed for plants because the chemical reaction that produces plant matter from air and water requires an energy input to occur. Animals acquire matter from food, that is, from plants or other animals. The chemical elements that make up the molecules of organisms pass through food webs and the environment and are combined and recombined in different ways. At each level in a food web, some matter provides energy for life functions, some is stored in newly made structures, and much is discarded to the surrounding environment. Only a small fraction of the matter consumed at one level is captured by the next level up. As matter cycles and energy flows through living systems and between living systems and the physical environment, matter and energy are conserved in each change.

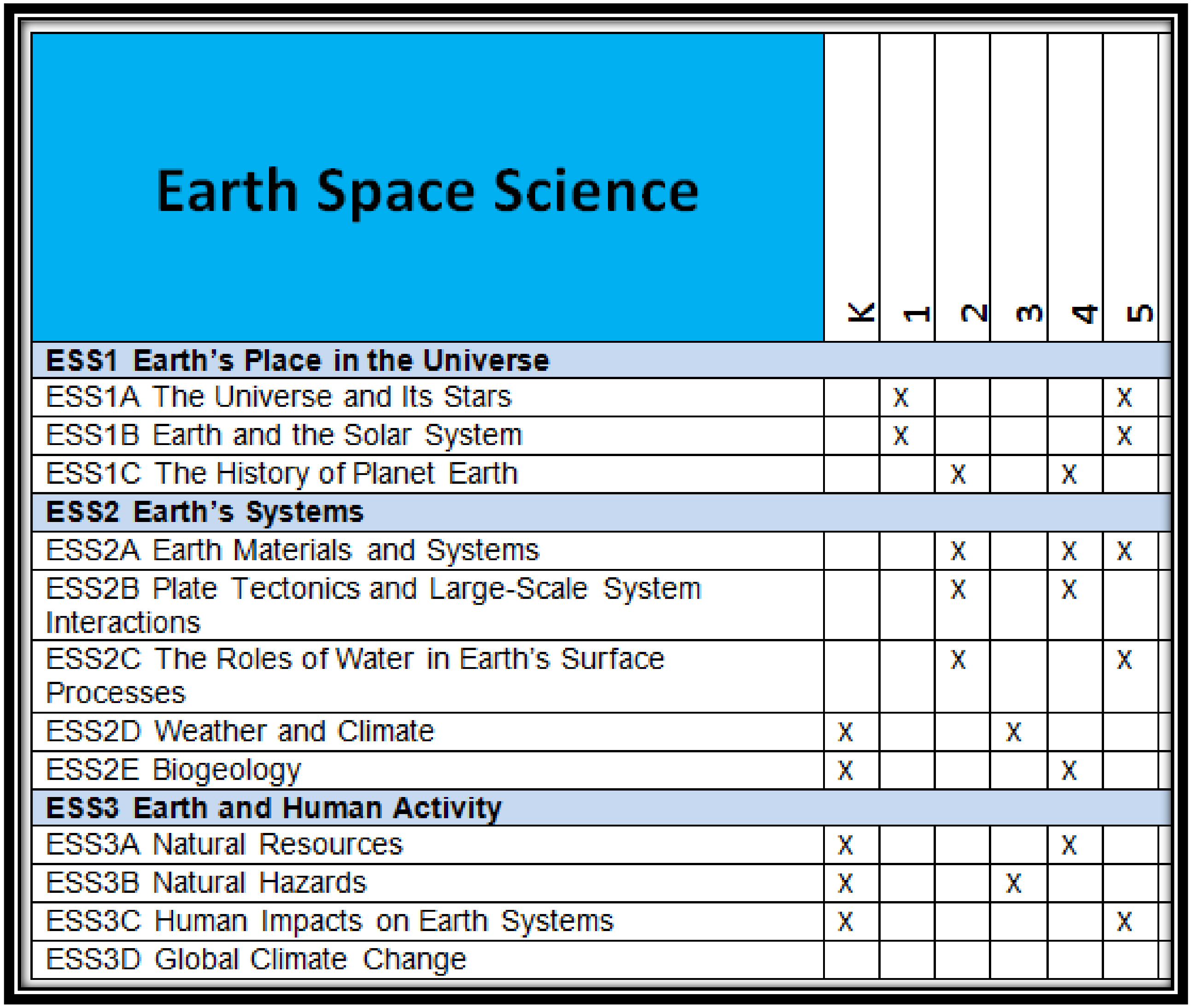
The carbon cycle provides an example of matter cycling and energy flow in ecosystems. Photosynthesis, digestion of plant matter, respiration, and decomposition are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

Grade Band Endpoints for LS2.B

By the end of grade 2. Organisms obtain the materials they need to grow and survive from the environment. Many of these materials come from organisms and are used again by other organisms.

By the end of grade 5. Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, water, and minerals from the environment and release waste matter (gas, liquid, or solid) back into the environment.

Earth Space K-5 Progression



Earth Space Science	K	1	2	3	4	5
ESS1 Earth's Place in the Universe						
ESS1A The Universe and Its Stars		X				X
ESS1B Earth and the Solar System		X				X
ESS1C The History of Planet Earth			X		X	
ESS2 Earth's Systems						
ESS2A Earth Materials and Systems			X		X	X
ESS2B Plate Tectonics and Large-Scale System Interactions			X		X	
ESS2C The Roles of Water in Earth's Surface Processes			X			X
ESS2D Weather and Climate	X			X		
ESS2E Biogeology	X				X	
ESS3 Earth and Human Activity						
ESS3A Natural Resources	X				X	
ESS3B Natural Hazards	X			X		
ESS3C Human Impacts on Earth Systems	X					X
ESS3D Global Climate Change						

Core Idea ESS1

Earth’s Place in the Universe

Essential Question: What is the universe, and what is Earth’s place in it?

The planet Earth is a tiny part of a vast universe that has developed over a huge expanse of time. The history of the universe, and of the structures and objects within it, can be deciphered using observations of their present condition together with knowledge of physics and chemistry. Similarly, the patterns of motion of the objects in the solar system can be described and predicted on the basis of observations and an understanding of gravity. Comprehension of these patterns can be used to explain many Earth phenomena, such as day and night, seasons, tides, and phases of the moon. Observations of other solar system objects and of Earth itself can be used to determine Earth’s age and the history of large-scale changes in its surface.

ESS1.A: THE UNIVERSE AND ITS STARS

Essential Question: What is the universe, and what goes on in stars?

The sun is but one of a vast number of stars in the Milky Way galaxy, which is one of a vast number of galaxies in the universe.

The universe began with a period of extreme and rapid expansion known as the Big Bang, which occurred about 13.7 billion years ago. This theory is supported by the fact that it provides explanation of observations of distant galaxies receding from our own, of the measured composition of stars and nonstellar gases, and of the maps and spectra of the primordial radiation (cosmic microwave background) that still fills the universe.

Nearly all observable matter in the universe is hydrogen or helium, which formed in the first minutes after the Big Bang. Elements other than these remnants of the Big Bang continue to form within the cores of stars. Nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases the energy seen as starlight. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

Stars' radiation of visible light and other forms of energy can be measured and studied to develop explanations about the formation, age, and composition of the universe. Stars go through a sequence of developmental stages—they are formed; evolve in size, mass, and brightness; and eventually burn out. Material from earlier stars that exploded as supernovas is recycled to form younger stars and their planetary systems. The sun is a medium-sized star about halfway through its predicted life span of about 10 billion years.

Grade Band Endpoints for ESS1.A

By the end of grade 2. Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. At night one can see the light coming from many stars with the naked eye, but telescopes make it possible to see many more and to observe them and the moon and planets in greater detail.

By the end of grade 5. The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their size and distance from Earth.

ESS1.B: EARTH AND THE SOLAR SYSTEM

Essential Question: What are the predictable patterns caused by Earth's movement in the solar system?

The solar system consists of the sun and a collection of objects of varying sizes and conditions—including planets and their moons—that are held in orbit around the sun by its gravitational pull on them. This system appears to have formed from a disk of dust and gas, drawn together by gravity.

Earth and the moon, sun, and planets have predictable patterns of movement. These patterns, which are explainable by gravitational forces and conservation laws, in turn explain many large-scale phenomena observed on Earth. Planetary motions around the sun can be predicted using Kepler's three empirical laws, which can be explained based on Newton's theory of gravity. These orbits may also change somewhat due to the gravitational effects from, or collisions with, other bodies. Gradual changes in the shape of Earth's orbit around the sun (over hundreds of thousands of years), together with the tilt of the planet's spin axis (or axis of rotation), have altered the intensity and distribution of sunlight falling on Earth. These phenomena cause cycles of climate change, including the relatively recent cycles of ice ages.

Gravity holds Earth in orbit around the sun, and it holds the moon in orbit around Earth. The pulls of gravity from the sun and the moon cause the patterns of ocean tides. The moon's and sun's positions relative to Earth cause lunar and solar eclipses to occur. The moon's monthly orbit around Earth, the relative positions of the sun, the moon, and the observer and the fact that it shines by reflected sunlight explain the observed phases of the moon.

Even though Earth's orbit is very nearly circular, the intensity of sunlight falling on a given location on the planet's surface changes as it orbits around the sun. Earth's spin axis is tilted relative to the plane of its orbit, and the seasons are a result of that tilt. The intensity of sunlight striking Earth's surface is greatest at the equator. Seasonal variations in that intensity are greatest at the poles.

Grade Band Endpoints for ESS1.B

By the end of grade 2. Seasonal patterns of sunrise and sunset can be observed, described, and predicted.

By the end of grade 5.

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 and seasonal changes in the length and direction of shadows; phases of the moon; and different positions of the sun, moon, and stars at different times of the day, month, and year.

Some objects in the solar system can be seen with the naked eye. Planets in the night sky change positions and are not always visible from Earth as they orbit the sun. Stars appear in patterns called constellations, which can be used for navigation and appear to move together across the sky because of Earth's rotation.

Core Idea ESS2

Earth’s Systems

Essential Question: How and why is Earth constantly changing?

Earth’s surface is a complex and dynamic set of interconnected systems—principally the geosphere, hydrosphere, atmosphere, and biosphere—that interact over a wide range of temporal and spatial scales. All of Earth’s processes are the result of energy flowing and matter cycling within and among these systems. For example, the motion of tectonic plates is part of the cycles of convection in Earth’s mantle, driven by outflowing heat and the downward pull of gravity, which result in the formation and changes of many features of Earth’s land and undersea surface. Weather and climate are shaped by complex interactions involving sunlight, the ocean, the atmosphere, clouds, ice, land, and life forms. Earth’s biosphere has changed the makeup of the geosphere, hydrosphere, and atmosphere over geological time; conversely, geological events and conditions have influenced the evolution of life on the planet. Water is essential to the dynamics of most earth systems, and it plays a significant role in shaping Earth’s landscape.

ESS2.A: EARTH MATERIALS AND SYSTEMS

Essential Question: How do Earth's major systems interact?

Earth is a complex system of interacting subsystems: the geosphere, hydrosphere, atmosphere, and biosphere. The geosphere includes a hot and mostly metallic inner core; a mantle of hot, soft, solid rock; and a crust of rock, soil, and sediments. The atmosphere is the envelope of gas surrounding the planet. The hydrosphere is the ice, water vapor, and liquid water in the atmosphere, ocean, lakes, streams, soils, and groundwater. The presence of living organisms of any type defines the biosphere; life can be found in many parts of the geosphere, hydrosphere, and atmosphere. Humans are of course part of the biosphere, and human activities have important impacts on all of Earth's systems.

All Earth processes are the result of energy flowing and matter cycling within and among Earth's systems. This energy originates from the sun and from Earth's interior. Transfers of energy and the movements of matter can cause chemical and physical changes among Earth's materials and living organisms.

Solid rocks, for example, can be formed by the cooling of molten rock, the accumulation and consolidation of sediments, or the alteration of older rocks by heat, pressure, and fluids. These processes occur under different circumstances and produce different types of rock. Physical and chemical interactions among rocks, sediments, water, air, and plants and animals produce soil. In the carbon, water, and nitrogen cycles, materials cycle between living and nonliving forms and among the atmosphere, soil, rocks, and ocean.

Weather and climate are driven by interactions of the geosphere, hydrosphere, and atmosphere, with inputs of energy from the sun. The tectonic and volcanic processes that create and build mountains and plateaus, for example, as well as the weathering and erosion processes that break down these structures and transport the products, all involve interactions among the geosphere, hydrosphere, and atmosphere. The resulting landforms and the habitats they provide affect the biosphere, which in turn modifies these habitats and affects the atmosphere, particularly through imbalances between the carbon capture and oxygen release that occur in photosynthesis, and the carbon release and oxygen capture that occur in respiration and in the burning of fossil fuels to support human activities.

Earth exchanges mass and energy with the rest of the solar system. It gains or loses energy through incoming solar radiation, thermal radiation to space, and gravitational forces exerted by the sun, moon, and planets. Earth gains mass from the impacts of meteoroids and comets and loses mass from the escape of gases into space.

Earth's systems are dynamic; they interact over a wide range of temporal and spatial scales and continually react to changing influences, including human activities. Components of Earth's systems may appear stable, change slowly over long periods of time, or change abruptly, with significant consequences for living organisms. Changes in part of one system can cause further changes to that system or to other systems, often in surprising and complex ways.

Grade Band Endpoints for ESS2.A

By the end of grade 2. Wind and water can change the shape of the land. The resulting landforms, together with the materials on the land, provide homes for living things.

By the end of grade 5. 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. Rainfall helps shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. Human activities affect Earth’s systems and their interactions at its surface.

ESS2.C: THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES

Essential Question: How do the properties and movements of water shape Earth's surface and affect its systems?

Earth is often called the water planet because of the abundance of liquid water on its surface and because water's unique combination of physical and chemical properties is central to Earth's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy as it changes state; to transmit sunlight; to expand upon freezing; to dissolve and transport many materials; and to lower the viscosities and freezing points of the material when mixed with fluid rocks in the mantle. Each of these properties plays a role in how water affects other Earth systems (e.g., ice expansion contributes to rock erosion, ocean thermal capacity contributes to moderating temperature variations).

Water is found almost everywhere on Earth, from high in the atmosphere (as water vapor and ice crystals) to low in the atmosphere (precipitation, droplets in clouds) to mountain snowcaps and glaciers (solid) to running liquid water on the land, ocean, and underground. Energy from the sun and the force of gravity drive the continual cycling of water among these reservoirs. Sunlight causes evaporation and propels oceanic and atmospheric circulation, which transports water around the globe. Gravity causes precipitation to fall from clouds and water to flow downward on the land through watersheds.

About 97 percent of Earth's water is in the ocean, and most fresh water is contained in glaciers or underground aquifers; only a tiny fraction of Earth's water is found in streams, lakes, and rivers. The relative availability of water is a major factor in distinguishing habitats for different living organisms.

Water participates both in the dissolution and formation of Earth's materials. The downward flow of water, both in liquid and solid form, shapes landscapes through the erosion, transport, and deposition of sediment. Shoreline waves in the ocean and lakes are powerful agents of erosion. Over millions of years, coastlines have moved back and forth over continents by hundreds of kilometers, largely due to the rise and fall of sea level as the climate changed (e.g., ice ages).

Grade Band Endpoints for ESS2.C

By the end of grade 2. Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. It carries soil and rocks from one place to another and determines the variety of life forms that can live in a particular location.

By the end of grade 5. Water is found almost everywhere on Earth: as vapor; as fog or clouds in the atmosphere; as rain or snow falling from clouds; as ice, snow, and running water on land and in the ocean; and as groundwater beneath the surface. The downhill movement of water as it flows to the ocean shapes the appearance of the land. 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.

Core Idea ESS3

Earth and Human Activity

Essential Question: How do Earth's surface processes and human activities affect each other?

Earth's surface processes affect and are affected by human activities. Humans depend on all of the planet's systems for a variety of resources, some of which are renewable or replaceable and some of which are not. Natural hazards and other geological events can significantly alter human populations and activities. Human activities, in turn, can contribute to the frequency and intensity of some natural hazards. Indeed, humans have become one of the most significant agents of change in Earth's surface systems. In particular, it has been shown that climate change—which could have large consequences for all of Earth's surface systems, including the biosphere—is driven not only by natural effects but also by human activities. Sustaining the biosphere will require detailed knowledge and modeling of the factors that affect climate, coupled with the responsible management of natural resources.

ESS3.C: HUMAN IMPACTS ON EARTH SYSTEMS

Essential Question: How do humans change the planet?

Recorded history, as well as chemical and geological evidence, indicates that human activities in agriculture, industry, and everyday life have had major impacts on the land, rivers, ocean, and air. Humans affect the quality, availability, and distribution of Earth's water through the modification of streams, lakes, and groundwater. Large areas of land, including such delicate ecosystems as wetlands, forests, and grasslands, are being transformed by human agriculture, mining, and the expansion of settlements and roads. Human activities now cause land erosion and soil movement annually that exceed all natural processes. Air and water pollution caused by human activities affect the condition of the atmosphere and of rivers and lakes, with damaging effects on other species and on human health. The activities of humans have significantly altered the biosphere, changing or destroying natural habitats and causing the extinction of many living species. These changes also affect the viability of agriculture or fisheries to support human populations. Land use patterns for agriculture and ocean use patterns for fishing are affected not only by changes in population and needs but also by changes in climate or local conditions (such as desertification due to overuse or depletion of fish populations by over extraction).

Thus humans have become one of the most significant agents of change in the near-surface Earth system. And because all of Earth's subsystems are interconnected, changes in one system can produce unforeseen changes in others.

The activities and advanced technologies that have built and maintained human civilizations clearly have large consequences for the sustainability of these civilizations and the ecosystems with which they interact. As the human population grows and per-capita consumption of natural resources increases to provide a greater percentage of people with more developed lifestyles and greater longevity, so do the human impacts on the planet.

Some negative effects of human activities are reversible with informed and responsible management. For example, communities are doing many things to help protect Earth's resources and environments. They are treating sewage, reducing the amount of materials they use, and reusing and recycling materials. Regulations regarding water and air pollution have greatly reduced acid rain and stream pollution, and international treaties on the use of certain refrigerant gases have halted the growth of the annual ozone hole over Antarctica. Regulation of fishing and the development of marine preserves can help restore and maintain fish populations. In addition, the development of alternative energy sources can reduce the environmental impacts otherwise caused by the use of fossil fuels.

The sustainability of human societies and of the biodiversity that supports them requires responsible management of natural resources not only to reduce existing adverse impacts but also to prevent such impacts to the extent possible. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

Grade Band Endpoints for ESS3.C

By the end of grade 2. 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—for example, by reducing trash through reuse and recycling.

By the end of grade 5. 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. For example, they are treating sewage, reducing the amounts of materials they use, and regulating sources of pollution such as emissions from factories and power plants or the runoff from agricultural activities.

A Closer Look at the Scope and Sequence
Fifth Grade Unit 1

This is a **performance expectation**. Performance expectations describe what students should be able to do at the end of instruction and incorporates a science and engineering practice, a disciplinary core idea (DCI) and a crosscutting concept. Performance expectations are not instructional strategies or objectives for a lesson. Instead, they are intended to guide the development of assessments. Clarification statements and assessment boundary statements are provided in the original documents to render additional support and clarification of the performance expectation.

5-PS1-1 5 = grade level
PS1 = Core Idea
1 = the number within the core idea (so this is the first performance expectation in the core idea ESS2)

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.	
Science and Engineering Practice • **Developing and Using Models –** Use models to represent events and design solutions.	what they will do
Disciplinary Core Idea • **PS1.A Structure and Properties of Matter -** Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from moving particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	what they will understand
Crosscutting Concept • **Scale, proportion, and Quantity** – Natural objects exist from the very small to the immensely large.	how they will organize and connect their knowledge

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
Matter **Bring Science Alive!** Unit 3: Changes in Matter Lessons 1- 2 Suggested Time Frame: 11 days	**5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.** Science and Engineering Practice • **Developing and Using Models –** Use models to represent events and design solutions. Disciplinary Core Idea • **PS1.A Structure and Properties of Matter -** Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from moving particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. Crosscutting Concept • **Scale, proportion, and Quantity** – Natural objects exist from the very small to the immensely large.
Materials and Their Properties **Bring Science Alive!** Unit 3: Changes in Matter Lessons 3-5 Suggested Time Frame: 18 days	**5-PS1-3 Make observations and measurements to identify materials based on their properties.** Science and Engineering Practice • **Planning and Carrying Out Investigations –** Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. Disciplinary Core Idea • **PS1.A Structure and Properties of Matter -** Measurements of a variety of properties can be used to identify materials. Crosscutting Concept • **Scale, proportion, and Quantity** – Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. **5-PS1-4 Conduct an investigation to determine whether the mixing of two or more substances results in new substances.** Science and Engineering Practice • **Planning and Carrying Out Investigations –** 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 traits considered. Disciplinary Core Idea • **PS1.B Chemical Reactions -** When two or more different substances are mixed, a new substance with different properties may be formed. Crosscutting Concept • **Cause and Effect –** Cause and effect relationships are routinely identified and used to explain change.

Conservation of Matter **Bring Science Alive!** Unit 3: Changes in Matter Lessons 6 – 7 Suggested Time Frame: 14 days	**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.** Science and Engineering Practice - **Using Mathematics and Computational Thinking –** Measure and graph quantities such as weight to address scientific and engineering questions and problems. Disciplinary Core Idea - **PS1.A Structure and Properties of Matter -** The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. - **PS1.B Chemical Reactions -** No matter what reaction or change in properties occurs, the total weight of the substances does not change. Crosscutting Concept - **Scale, Proportion, and Quantity** – Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.
Producers in an Ecosystem **Bring Science Alive!** Unit 1: Living Things and Ecosystems Lessons 1-2 Suggested Time Frame: 12 days	**5-LS1-1** Support an argument that **plants get** the materials they need **for growth chiefly from air and water.** Science and Engineering Practice - **Engaging in Argument from Evidence – Support an argument with evidence, data, or a model.** Disciplinary Core Idea - **LS1.C Organization for Matter and Energy Flow in Organisms -** Plants acquire their material for growth chiefly from air and water. Crosscutting Concept - **Energy and Matter** – Matter is transported into, out of , and within systems
Consumers in an Ecosystem **Bring Science Alive!** Unit 1: Living Things and Ecosystems Lessons 3 Suggested Time Frame: 7 days	**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. Science and Engineering Practice - **Developing and using Models –** Use models to describe phenomena. Disciplinary Core Idea - **PS3.D Energy in Chemical Processes and Everyday Life -** The energy released (from) food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). - **LS1.C Organization for Matter and Energy Flow in Organisms -** Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. Crosscutting Concept - **Energy and Matter –** Energy can be transferred in various ways and between objects.

Food Webs **Bring Science Alive!** Unit 1: Living Things and Ecosystems Lessons 4-8 Suggested Time Frame: 39 days	**5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.** **Science and Engineering Practice** - **Developing and Using Models –** Develop a model to describe a phenomena. **Disciplinary Core Idea** - **LS2.A Interdependent Relationships In Ecosystems -** The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. - **LS2.B Cycles of Matter and Energy Transfers -** Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. **Crosscutting Concept** - **Systems and System Models –** A system can be described in terms of its components and their interactions.

Interaction of Earth Systems **Bring Science Alive!** Unit 2: Earth Systems Lessons 1-3 Suggested Time Frame: 17 days	**5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and /or atmosphere interact.** **Science and Engineering Practice** - **Developing and Using Models –** Develop a model using an example to describe a scientific principle. **Disciplinary Core Idea** - **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. **Crosscutting Concept** - **Systems and System Models –** A system can be described in terms of its components and their interactions. **5-ESS2-2 Describe and graph the amount and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.** **Science and Engineering Practice** - **Using Mathematics and Computational Thinking** – Describe and graph quantities such as area and volume to address scientific questions. **Disciplinary Core Idea** - **ESS2.C: The Roles of Water in Earth's Surface Processes -** Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. **Crosscutting Concept** - **Scale, Proportion, and Quantity** – Standard units are used to measure and describe physical quantities such as weight and volume.
Human Impacts on Earth Systems **Bring Science Alive!** Unit 2: Earth Systems Lessons 4-6 Suggested Time Frame: 20 days	5-**ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment** **Science and Engineering Practice** - **Obtaining, Evaluating, and Communicating Information –** Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. **Disciplinary Core Idea** - **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. **Crosscutting Concept** - **Systems and System Models –** A system can be described in terms of its components and their interactions.

Gravity **Bring Science Alive!** Unit 4: Earth, the Moon and the Stars Lesson 1 Suggested Time Frame: 5 days	**5-PS2-1** Support an argument that **the gravitational force** exerted by Earth on objects **is directed down.** Science and Engineering Practice • **Engaging in Argument from Evidence –** Support an argument with evidence, data or a model Disciplinary Core Idea • **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. Crosscutting Concept • **Cause and Effect –** Cause and effect relationships are routinely identified and used to explain change.
Our Sun and the Stars **Bring Science Alive!** Unit 4: Earth, the Moon and the Stars Lessons 2 and 7 **STAR LAB** Suggested Time Frame: 13 days	**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.** Science and Engineering Practice • **Engaging in Argument from Evidence –** Support an argument with evidence, data or a model Disciplinary Core Idea • **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. Crosscutting Concept • **Scale, Proportion, and Quantity –** Natural objects exist from the very small to the immensely large.
Patterns in the Sky **Bring Science Alive!** Unit 4: Earth, the Moon and the Stars Lessons 3-6 **STAR LAB** Suggested Time Frame: 25 days	**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.** Science and Engineering Practice • **Analyzing and Interpreting Data –** Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Disciplinary Core Idea • **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. Crosscutting Concepts • **Cause and Effect –** Cause and effect relationships are routinely identified and used to explain change.

Materials for Investigations: It is recommended that you keep track of the materials you use throughout the year so that you can replenish the necessary materials for the following year. All expenses for materials will be paid for by the building. A unit by unit materials checklist is provided on our website.

TCI Kit Materials				**Teacher/Student Provided Materials**	
Consumables Materials		Non-Consumables Materials			
Antacid Tablets, pkg/2		Balance, triple beam		Newspaper	
Baking Powder		Beaker, 250 mL		Paper towels	
Balloons, round, pkg/35		Beakers, 250 mL, pkg/10		Garbage bag	
Batteries, size D, pkg/6		Droppers, pkg/6		Disposable gloves	
Bowl, paper		Earth Model, inflatable		Disinfectant	
Calcium Chloride		Flashlight		Making Tape	
Chalk, white		Graduated Cylinder, 100 mL		Water	
Cotton Balls, pkg/300		Gravel			
Craft Sticks, pkg/30		Hand Lenses, pkg/6		Water Bottle with Cap	
Cups, paper, 200 mL, pkg/25		Lens, double concave, FL 10 cm		Scissors	
Cups, plastic medicine, 30 mL, pkg/50		Lens, double concave, FL 5 cm		Construction paper	
Filter, coffee		Lens, double convex, FL 10 cm		Tape	
Flour		Lens, double convex, FL 15 cm		Colored Pencils/Markers	
Food Coloring, set/4		Light Socket, porcelain w/cord		Paper bowl	
Iodine Solution, 1.85%, 100 mL		Ruler		Chocolate Chip Cookies	
Jar, plastic, clear, 4 oz.		Washers, metal, 3/4", box/100		Rulers	
Lid for plastic jar		Container, plastic, 2 qt		Small rocks	
Light Bulb, 60 W		Forceps, pkg/6		Sugar	
Paper Clips, large, box/100		Bin, plastic, shoe box size		Whipping Cream	
Plates, paper, pkg/50		Poster, Owls and Owl Pellets		Stickers	
Sponge		**Non-consumables** are the materials that will be used over and over. However, sometimes things break or get lost so you may have to purchase something from this list at some point. Again, most things can be purchased at Wal-Mart or the Dollar Store but some may need to be purchased through Ward's Science at https://wardsci.com/ .		Sticky Notes	
Spoons, plastic, pkg/24				Pencils	
Talc, powder				Poster Board or Butcher Paper	
Toothpicks, flat, pkg/750				**Teacher/student provided materials** are (for the most part) things that you have in your classroom already. Highlighted items will most likely need to be purchased for the investigations. They can be purchased at Wal-Mart or a hardware store.	
Tube, cardboard					
Wood, balsa					
Yarn					
Beads, pkg/100					
Clay, modeling, pkg/4					
Cloth, cotton					
Forks, plastic, pkg/24		**Consumables** are the materials that will need to be replenished yearly or bi-yearly. The cost of these materials will be covered through your building (Instructional expenses). Most of these items can be purchased at Wal-Mart or the Dollar Store. The highlighted item(s) will need to be purchased through Ward's Science at https://wardsci.com/.			
Knives, plastic, pkg/24					
Owl pellets, pkg/6					
Seeds, Lima Bean					
Soil, potting					
Sugar, granulated					
Yeast					
Bags, plastic, sandwich-size, box/100					
Baking Soda					
Salt, non-iodized					
Sand, medium grain					
Vinegar, white					