The following are the key shifts called for by the Louisiana Student Standards for Science.

1. Apply content knowledge	Content knowledge is critical and evident in the standards in the Disciplinary Core Ideas, the key ideas in science that have broad importance within or across multiple science or engineering disciplines. However, simply having content knowledge is not enough. Students must investigate and apply content knowledge to scientific **phenomenon**.
2. Investigate, evaluate, and reason scientifically	Scientists do more than learn about science; they "do" science. Science instruction must integrate the practices, or behaviors, of scientists and engineers as they investigate real-world phenomenon and design solutions to problems.
3. Connect ideas across disciplines	For students to develop a coherent and scientifically-based view of the world, they must make connections across the domains of science (life science, physical science, earth and space science, environmental science, and engineering, technology, and applications of science). The crosscutting concepts have applications across all domains.

◆**Three Dimensional Learning**: the integration of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in science instruction◆

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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	**Physical Science:** 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. Emphasis is on one-dimensional motion and macroscopic objects moving at non-relativistic speeds. **Physics:** 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. Emphasis is on kinematics, one-dimensional motion, two-dimensional motion, and macroscopic objects moving at non-relativistic speeds.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS.PS2.A.a)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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	**Physical Science:** Emphasis is on calculating momentum and the qualitative meaning of conservation of momentum. **Physics:** Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle as well as systems of two macroscopic bodies moving in one dimension.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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 (e.g. trigonometric, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. (HS.PS2A.b) 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.PS2A.c)	**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.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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	**Physical Science:** Examples of evaluation and refinement could include determining the success of a device at protecting an object from damage such as, but not limited to, impact resistant packaging and modifying the design to improve it. Emphasis is on qualitative evaluations. **Physics:** 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 by applying the impulse-momentum theorem. Examples of a device could include a football helmet or an airbag. Emphasis is on qualitative evaluations and/or algebraic manipulations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** 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.PS2A.c) **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.ETS1A.a) **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.ETS1C.a)	**CAUSE AND EFFECT** Systems can be designed to cause a desired effect.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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 (e.g. trigonometric, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 objects not in physical contact. (HS.PS2B.a) Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS.PS2B.b)	**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.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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.
Clarification Statement	**Physical Science:** Emphasis is on designing and conducting investigations including evaluating simple series and parallel circuits. Qualitative evidence is used to explain the relationship between a current-carrying wire and a magnetic compass. **Physics:** Evidence of changes within a circuit can be represented numerically, graphically, or algebraically using Ohm's law. Emphasis is on designing and conducting investigations using qualitative evidence to determine the relationship between electric current and magnetic fields. Examples of evidence can include movement of a magnetic compass needle when placed in the vicinity of a current-carrying wire, and a magnet passing through a coil that turns on the light of a Faraday flashlight.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**TYPES OF INTERACTIONS** Forces that act over a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS.PS2B.b) **DEFINITIONS OF ENERGY** "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (HS.PS3A.d)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

ENERGY

Performance Expectation	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	**Chemistry:** Emphasis is on explaining the meaning of mathematical expressions used in the model. Focus is on basic algebraic expression or computations, systems of two or three components, and thermal energy. **Physics:** Emphasis is on explaining the meaning of mathematical expressions used in the model. Focus is on basic algebraic expression or computations; systems of two or three components; and thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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 (e.g. trigonometric, 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. • Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. That there is a single quantity called energy is 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.PS3A.a) **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.PS3B.a) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS.PS3B.b) Mathematical expressions allow the concept of conservation of energy to be used to predict and describe system behavior. These expressions 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 velocity. (HS.PS3B.c) The availability of energy limits what can occur in any system. (HS.PS3B.d)	**SYSTEMS AND SYSTEM MODELS** 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.

ENERGY

Performance Expectation	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 positions of particles (objects)
Clarification Statement	**Physical Science:** Examples of phenomena at the macroscopic scale could include the conversion of potential energy to kinetic and thermal energy. Examples of models could include diagrams, drawings, descriptions, and computer simulations. **Physics:** Examples of phenomena at the macroscopic scale could include the conversion of potential energy to kinetic and thermal energy, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s) • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. There is a single quantity called energy. 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.PS3A.a) At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b) 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.PS3A.c)	**ENERGY AND MATTER** Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

ENERGY

Performance Expectation	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
Clarification Statement	**Physical Science:** Emphasis is on qualitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Emphasis is on devices constructed with teacher approved materials. Examples of devices can be drawn from chemistry or physics clarification statements below. **Chemistry:** Emphasis is on both qualitative and quantitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Focus of quantitative evaluations is limited to total output for a given input. Emphasis is on devices constructed with teacher approved materials. Examples of devices in chemistry could include hot/cold packs and batteries. **Physics:** Emphasis is on both qualitative and quantitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Focus of quantitative evaluations is limited to total output for a given input. Emphasis is on devices constructed with teacher approved materials. Examples of devices in physics could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and electric motors.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b) **ENERGY IN CHEMICAL PROCESSES** Although energy cannot be destroyed, it can be converted to other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.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.ETS1A.a)	**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.

ENERGY

Performance Expectation	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	**Physical Science, Physics and Chemistry:** Emphasis is on analyzing data from student investigations and using mathematical thinking appropriate to the subject to describe the energy changes quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out Investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CONSERVATION OF ENERGY AND ENERGY TRANSFER** Energy cannot be created or destroyed, but it can be transported from one place to another, transformed into other forms, and transferred between systems. (HS.PS3B.b) 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.PS3B.e) **ENERGY IN CHEMICAL PROCESSES AND EVERYDAY LIFE** Although energy cannot be destroyed, it can be converted to less useful other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.a)	**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.

ENERGY

Performance Expectation	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	**Physical Science:** Examples of models could include drawings, diagrams, simulations and texts, such as what happens when two charged objects or two magnetic poles are near each other. **Physics:** 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**RELATIONSHIP BETWEEN ENERGY AND FORCES** When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS.PS3C.a)	**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.

WAVES AND THEIR APPLICATIONS IN TECHNOLOGIES FOR INFORMATION TRANSFER

Performance Expectation	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
Clarification Statement	**Physical Science:** Emphasis is on describing waves both qualitatively and quantitatively. Qualitative focus includes standard repeating waves and transmission/absorption of electromagnetic waves/radiation. **Physics:** Examples of data could include electromagnetic radiation traveling through a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth. Emphasis is on algebraic relationships and describing those relationships qualitatively.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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 (e.g. trigonometric, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.PS4A.a)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

WAVES AND THEIR APPLICATIONS IN TECHNOLOGIES FOR INFORMATION TRANSFER

Performance Expectation	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. Quantum theory is not included.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 scientific or historical episodes in science. • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. 8. Obtaining, evaluating, and communicating information	**WAVE PROPERTIES** 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. (HS.PS4A.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.PS4B.a)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	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 and the composition of the nucleus of atoms.
Clarification Statement	**Physical Science:** Examples of properties that could be predicted from patterns could include metals, nonmetals, metalloids, number of valence electrons, types of bonds formed, or atomic mass. Emphasis is on main group elements. **Chemistry:** Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, atomic radius, atomic mass, or reactions with oxygen. Emphasis is on main group elements and qualitative understanding of the relative trends of ionization energy and electronegativity.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematical and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS.PS1A.a) 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.PS1A.b) **TYPES OF INTERACTIONS** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.(HS.PS2B.c)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	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	**Physical Science:** Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or hydrogen and oxygen. Reaction classification includes synthesis, decomposition, single displacement, double displacement, and acid-base. **Chemistry:** Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or carbon and hydrogen. Reaction classification aids in the prediction of products (e.g. synthesis, decomposition, single displacement, double displacement, and acid-base).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematical and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.PS1A.b) **CHEMICAL REACTIONS** 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.PS1B.c)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
Clarification Statement	**Physical Science:** Emphasis is on using mathematical ideas to communicate the relationship between masses of reactants and products as well as balancing chemical equations. **Chemistry:** Emphasis is on using mathematical ideas as they relate to stoichiometry 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **Using mathematics and computational thinking:** 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, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CHEMICAL REACTIONS** 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.PS1B.c)	**ENERGY AND MATTER** The total amount of energy and matter in closed systems is conserved.

MATTER AND ITS INTERACTIONS

Performance Expectation	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	**Physical Science:** Emphasis is only 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. Radioactive decay focus is on its relationship to half-life. **Chemistry:** 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. Emphasis is on alpha, beta, and gamma radioactive decays.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NUCLEAR PROCESSES** Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS.PS1C.a)	**ENERGY AND MATTER** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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	**Physical Science:** 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. Emphasis is on one-dimensional motion and macroscopic objects moving at non-relativistic speeds. **Physics:** 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. Emphasis is on kinematics, one-dimensional motion, two-dimensional motion, and macroscopic objects moving at non-relativistic speeds.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS.PS2.A.a)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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	**Physical Science:** Emphasis is on calculating momentum and the qualitative meaning of conservation of momentum. **Physics:** Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle as well as systems of two macroscopic bodies moving in one dimension.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. (HS.PS2A.b) 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.PS2A.c)	**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.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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	**Physical Science:** Examples of evaluation and refinement could include determining the success of a device at protecting an object from damage such as, but not limited to, impact resistant packaging and modifying the design to improve it. Emphasis is on qualitative evaluations. **Physics:** 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 by applying the impulse-momentum theorem. Examples of a device could include a football helmet or an airbag. Emphasis is on qualitative evaluations and/or algebraic manipulations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** 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.PS2A.c) **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.ETS1A.a) **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.ETS1C.a)	**CAUSE AND EFFECT** Systems can be designed to cause a desired effect.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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.
Clarification Statement	**Physical Science:** Emphasis is on designing and conducting investigations including evaluating simple series and parallel circuits. Qualitative evidence is used to explain the relationship between a current-carrying wire and a magnetic compass. **Physics:** Evidence of changes within a circuit can be represented numerically, graphically, or algebraically using Ohm's law. Emphasis is on designing and conducting investigations using qualitative evidence to determine the relationship between electric current and magnetic fields. Examples of evidence can include movement of a magnetic compass needle when placed in the vicinity of a current-carrying wire, and a magnet passing through a coil that turns on the light of a Faraday flashlight.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**TYPES OF INTERACTIONS** Forces that act over a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS.PS2B.b) **DEFINITIONS OF ENERGY** "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (HS.PS3A.d)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

ENERGY

Performance Expectation	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 positions of particles/objects.
Clarification Statement	**Physical Science:** Examples of phenomena at the macroscopic scale could include the conversion of potential energy to kinetic and thermal energy. Examples of models could include diagrams, drawings, descriptions, and computer simulations. **Physics:** Examples of phenomena at the macroscopic scale could include the conversion of potential energy to kinetic and thermal energy, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **Developing and using models:** 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(s) • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. There is a single quantity called energy. 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.PS3A.a) At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b) 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.PS3A.c)	**ENERGY AND MATTER** Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

ENERGY

Performance Expectation	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
Clarification Statement	**Physical Science:** Emphasis is on qualitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Emphasis is on devices constructed with teacher approved materials. Examples of devices can be drawn from chemistry or physics clarification statements below. **Chemistry:** Emphasis is on both qualitative and quantitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Focus of quantitative evaluations is limited to total output for a given input. Emphasis is on devices constructed with teacher approved materials. Examples of devices in chemistry could include hot/cold packs and batteries. **Physics:** Emphasis is on both qualitative and quantitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Focus of quantitative evaluations is limited to total output for a given input. Emphasis is on devices constructed with teacher approved materials. Examples of devices in physics could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and electric motors.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b) **ENERGY IN CHEMICAL PROCESSES** Although energy cannot be destroyed, it can be converted to other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.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.ETS1A.a)	**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.

ENERGY

Performance Expectation	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	**Physical Science, Physics and Chemistry:** Emphasis is on analyzing data from student investigations and using mathematical thinking appropriate to the subject to describe the energy changes quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out Investigations:** Planning and carrying out investigations to answer questions (science) or test solutions to problems (engineering) 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CONSERVATION OF ENERGY AND ENERGY TRANSFER** Energy cannot be created or destroyed, but it can be transported from one place to another, transformed into other forms, and transferred between systems. (HS.PS3B.b) 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.PS3B.e) **ENERGY IN CHEMICAL PROCESSES AND EVERYDAY LIFE** Although energy cannot be destroyed, it can be converted to less useful other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.a)	**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.

ENERGY

Performance Expectation	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	**Physical Science:** Examples of models could include drawings, diagrams, simulations and texts, such as what happens when two charged objects or two magnetic poles are near each other. **Physics:** 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**RELATIONSHIP BETWEEN ENERGY AND FORCES** When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS.PS3C.a)	**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.

WAVES AND THEIR APPLICATIONS

Performance Expectation	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
Clarification Statement	**Physical Science:** Emphasis is on describing waves both qualitatively and quantitatively. Qualitative focus includes standard repeating waves and transmission/absorption of electromagnetic waves/radiation. **Physics:** Examples of data could include electromagnetic radiation traveling through a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth. Emphasis is on algebraic relationships and describing those relationships qualitatively.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.PS4A.a)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

WAVES AND THEIR APPLICATIONS

Performance Expectation	Evaluate the validity and reliability of claims in published materials regarding 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. Emphasis is on qualitative descriptions.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. 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. • Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.	**ELECTROMAGNETIC RADIATION** 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.PS4B.b)	**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.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	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.
Clarification Statement	Emphasis is on the conceptual understanding that DNA sequences determine the amino acid sequence and thus protein structure. Students can produce scientific writing, or presentations, and/or physical models that communicate constructed explanations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND FUNCTION** Systems of specialized cells within organisms help them perform the essential functions of life. (HS.LS1A.a) 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 the essential functions of life. (HS.LS1A.c)	**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.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	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, or 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND FUNCTION** 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.LS1A.b)	**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.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis in living organisms.
Clarification Statement	Examples of investigations could include heart rate responses to exercise, stomate responses to moisture and temperature, root development in response to water levels, or cell response to hypertonic and hypotonic environments.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND FUNCTION** Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing the organism to remain alive and functional even as external conditions change within some range. Feedback mechanisms can promote (through positive feedback) or inhibit (through negative feedback) activities within an organism to maintain homeostasis. (HS.LS1A.d)	**STABILITY AND CHANGE** Feedback (negative or positive) can stabilize or destabilize a system.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Use a model to illustrate the role of the cell cycle and differentiation in producing and maintaining complex organisms.
Clarification Statement	Emphasis is on conceptual understanding that mitosis passes on genetically identical materials via replication, not on the details of each phase in mitosis.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**GROWTH AND DEVELOPMENT OF ORGANISMS** In multicellular organisms the cell cycle is necessary for growth, maintenance and repair of multicellular organisms. Disruptions in the cell cycles of mitosis and meiosis can lead to diseases such as cancer. (HS.LS1B.a) The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. (HS.LS1B.b) Cellular division and differentiation (stem cell) produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS.LS1B.c)	**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.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	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, the transfer and transformation of energy in photosynthesis by plants, and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, conceptual models, and/or laboratory investigations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.LS1C.a)	**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.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	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 students constructing explanations for how sugar molecules are formed through photosynthesis and the components of the reaction (i.e. carbon, hydrogen, oxygen). This hydrocarbon backbone is used to make amino acids and other carbon-based molecules that can be assembled (anabolism) into larger molecules (such as proteins or DNA). Examples of models could include diagrams, chemical equations, or conceptual models.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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, 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.LS1C.a) 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.LS1C.b)	**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.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	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 processes of aerobic and anaerobic cellular respiration. Examples of models could include diagrams, chemical equations, conceptual models and/or laboratory investigations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS** As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS.LS1C.c) 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.LS1C.d)	**ENERGY AND MATTER** Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Obtain, evaluate, and communicate information about (1) viral and bacterial reproduction and adaptation, (2) the body's primary defenses against infection, and (3) how these features impact the design of effective treatment.
Clarification Statement	Emphasis is on the speed of reproduction which produces many generations in a short time, allowing for rapid adaptation, the role of antibodies in the body's immune response to infection and how vaccination protects an individual from infectious disease.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. **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. • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information by presenting them in simpler but still accurate terms.	**PUBLIC HEALTH** Viruses are obligate intracellular parasites that replicate using a cell's protein expression mechanisms. (HS.LS1E.a) Vaccines provide immunity to infections by exposing the immune system to antigens before infection which decreases the immune system's response time. Some vaccines may require more than one dose. (HS.LS1E.b) Antibiotics are effective treatments against most bacterial infections. Some bacteria may develop resistance to these treatments. (HS.LS1E.c) Microorganisms can cause diseases and can provide beneficial services. Microorganisms live in a variety of environments as both parasites and free-living organisms. (HS.LS1E.d) Microorganisms can reproduce quickly. (HS.LS1E.e)	**SCALE, PROPORTION, AND QUANTITY** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

Performance Expectation	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity, biodiversity and populations of ecosystems at different scales.
Clarification Statement	Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, or population changes gathered from simulations or historical data sets.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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 (e.g. trigonometric, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 that affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem. Organisms would have 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.LS2A.a) Human activity directly and indirectly affect biodiversity and ecosystem health (e.g., habitat fragmentation, introduction of nonnative or invasive species, overharvesting, pollution and climate change). (HS.LS2A.b)	**SCALE, PROPORTION, AND QUANTITY** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

Performance Expectation	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 move through an ecosystem.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data **5. 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 (e.g. trigonometric, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CYCLES OF MATTER AND ENERGY TRANSFER IN ECOSYSTEMS** Energy is inefficiently transferred from one trophic level to another that affect the relative number of organisms that can be supported at each trophic level and necessitates a constant input of energy from sunlight or inorganic compounds from the environment. (HS.LS2B.b) Photosynthesis, cellular respiration, decomposition and combustion are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes. (HS.LS2B.c) Photosynthesis, chemosynthesis, aerobic and anaerobic respiration and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Environmental conditions restrict which and when reactions can occur. (HS.LS2B.a) (suggested extension)	**ENERGY AND MATTER: FLOWS, CYCLES, AND CONSERVATION** Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

Performance Expectation	Evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
Clarification Statement	Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood and extreme changes, such as volcanic eruption or sea level rise. Emphasis should be on describing drivers of ecosystem stability and change, not on the organismal mechanisms of responses and interactions.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 scientific or historical episodes in science. • Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. 8. Obtaining, evaluating, and communicating information	**ECOSYSTEM DYNAMICS, FUNCTIONING, AND RESILIENCE** The dynamic 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 and may result in new ecosystems. (HS.LS2C.a)	**STABILITY AND CHANGE** Much of science deals with constructing explanations of how things change and how they remain stable.

ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

Performance Expectation	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
Clarification Statement	Examples of human activities can include urbanization, building dams, or dissemination of invasive species.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ECOSYSTEM DYNAMICS, FUNCTIONING, AND RESILIENCE** Ecosystems with a greater biodiversity tend to have a greater resistance and resilience to change. 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.LS2C.b) **BIODIVERSITY AND HUMANS** Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS.LS4D.a) **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.ETS1B.a)	**STABILITY AND CHANGE** Much of science deals with constructing explanations of how things change and how they remain stable.

HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Performance Expectation	Formulate, refine, and evaluate questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
Clarification Statement	Emphasis should be on traits including completely dominant, codominant, incompletely dominant, and sex-linked traits (e.g., pedigrees, karyotypes, genetic disorders, Punnett squares). Examples do not need to include dihybrid crosses.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 which carry out the essential functions of life. (HS.LS1A.c) **INHERITANCE OF TRAITS** 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.LS3A.a) In Mendel's model of inheritance an organism's phenotype is determined by the combined expression of two inherited versions they have for each gene. However, most traits follow more complex patterns of inheritance such as traits that are codominant, incomplete dominant, and polygenic. (HS.LS3A.b)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Performance Expectation	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. Claims should not include the phases of meiosis or the biochemical mechanisms of specific steps in the process.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 scientific or historical episodes in science. • Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence. 8. Obtaining, evaluating, and communicating information	**VARIATION OF TRAITS** In sexual reproduction, chromosomes can sometimes swap sections or cross over 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.LS3B.a) Mutations may occur due to errors during DNA replication and/or environmental factors. In general, only mutations that occur in gametes (sperm and egg) can be passed to offspring. Genes have variations (alleles) that code for specific variants of a protein (or RNA), and therefore specific traits of an individual. (HS.LS3B.b) 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.LS3B.c)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Performance Expectation	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
Clarification Statement	Emphasis is on distribution and variation of traits in a population and the use of mathematics (e.g., calculations of frequencies in Punnett squares, graphical representations) to describe the distribution.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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. • Apply concepts of statistics and probability (e.g., determining function fits to data and correlation coefficient for linear or nonlinear fits) to scientific and engineering questions and problems, using digital tools when feasible. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**VARIATION OF TRAITS** In sexual reproduction, chromosomes can sometimes swap sections or cross over 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.LS3B.a) Mutations may occur due to errors during DNA replication and/or caused by environmental factors. In general, only mutations that occur in gametes (sperm and egg) can be passed to offspring. Genes have variations (alleles) that code for specific variants of a protein (or RNA), and therefore specific traits of an individual. (HS.LS3B.b)	**SCALE, PROPORTION AND QUANTITY** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Analyze and interpret 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 (e.g., similarities in DNA sequences, order of appearance of structure during embryological development, cladograms, homologous and vestigial structures, fossil records) demonstrates as related to common ancestry and biological evolution.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **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. • Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 observable anatomical and embryological evidence. (HS.LS4A.a)	**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.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Construct an explanation based on evidence that biological diversity is influenced by (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 or proportional reasoning.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL SELECTION** Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population e.g. mutations and sexual reproduction and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. Natural selection leads to populations that have more individuals with behavioral, anatomical, and physiological adaptations. (HS.LS4B.a) The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS.LS4B.c)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Apply concepts of statistics and probability to support explanations that populations of organisms adapt when an advantageous heritable trait increases 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 for adaptations. Explanations could include basic statistical or graphical analysis.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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. • Apply concepts of statistics and probability (e.g., determining function fits to data and correlation coefficient for linear or nonlinear fits) to scientific and engineering questions and problems, using digital tools when feasible. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL SELECTION** Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population e.g. mutations and sexual reproduction and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. Natural selection leads to populations that have more individuals with behavioral, anatomical, and physiological adaptations. (HS.LS4B.a) The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS.LS4B.c) **ADAPTATION** 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.LS4C.a) Adaptation also means that the distribution of traits in a population can change when conditions change. (HS.LS4C.b)	**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.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Construct an explanation based on evidence for how natural selection and other mechanisms lead to genetic changes in 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL SELECTION** Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population e.g. mutations and sexual reproduction and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. Natural selection leads to populations that have more individuals with behavioral, anatomical, and physiological adaptations. (HS.LS4B.a) Genetic drift and gene flow can lead to genetic changes in populations, not adaptations. (HS.LS4B.b) **ADAPTATION** 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.LS4C.a) 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.LS4C.c)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Evaluate evidence supporting claims that changes in environmental conditions can affect the distribution of traits in a population causing: (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, overfishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 scientific or historical episodes in science. • Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. 8. Obtaining, evaluating, and communicating information	**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.LS4C.c) 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.LS4C.d)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

RESOURCES AND RESOURCE MANAGEMENT

Performance Expectation	Analyze and interpret data to identify the factors that affect sustainable development and natural resource management in Louisiana.
Clarification Statement	Evidence of Louisiana's natural resource wealth is found in understanding functions and values of varied ecosystems and environments, supply of non-renewable mining products and profitable agricultural commodities. Examples of key natural resources include state waterways (such as rivers, lakes, and bayous) and the aquatic life found in them, regions of agriculture (pine forests, sugar cane and rice fields) and high concentrations of minerals and fossil fuels on and off shore. Factors to consider in reviewing the management of natural resources include a review of historical practices, costs of resource extraction and waste management, consumption of natural resources, ongoing research and the advancements in technology.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**LOUISIANA'S NATURAL RESOURCES** Ecosystem capital can be characterized as goods (removable products) and services such as the functions and values of wetlands. (HS.EVS1A.a)	**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.

RESOURCES AND RESOURCE MANAGEMENT

Performance Expectation	Obtain, evaluate and communicate information on the effectiveness of management or conservation practices for one of Louisiana's natural resources with respect to common considerations such as social, economic, technological, and influencing political factors over the past 50 years.
Clarification Statement	The rate of land loss and habitat conversion from a variety of forces results in stresses and constraints that influence decisions and carry consequences that affect quality of life and have a bearing on sustainability. Increases in commercial and recreational uses may result in the need for environmental policies and call for changes in long established practices. Community efforts to address changes to secure growth while preserving the resources depend on education and collaboration between groups. Examples may include ground water conservation, erosion/flood control, forestry stewardship, game and wildlife, commercial fishing, oil and gas industry, dredging, or regulatory factors.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. **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. • Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. • Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.	**RESOURCE MANAGEMENT FOR LOUISIANA** Population growth along with cultural and economic factors impact resource availability, distribution and use. (HS.EVS1B.a) **RESOURCE MANAGEMENT FOR LOUISIANA** Some changes to our natural environment such as the building of levees and hydrological modification have provided for economic and social development but have resulted in unintended negative impacts. (HS.EVS1.B.b)	**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.

RESOURCES AND RESOURCE MANAGEMENT

Performance Expectation	Analyze and interpret data about the consequences of environmental decisions to determine the risk-benefit values of actions and practices implemented for selected issues.
Clarification Statement	Examples could be taken from system interactions: (1) loss of ground vegetation causing an increase in water runoff and soil erosion. (2) dammed rivers increasing ground-water recharge, decreasing sediment transport, and increasing coastal erosion. (3) loss of wetlands reducing storm protection buffer zones allowing further wetland reduction. (4) hydrological modification such as levees providing protection to infrastructure at a cost to ecosystems.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**RESOURCE MANAGEMENT FOR LOUISIANA** Some changes to our natural environment such as the building of levees and hydrological modification have provided for economic and social development but have resulted in unintended negative impacts. (HS.EVS1B.b)	**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.

ENVIRONMENTAL AWARENESS AND PROTECTION

Performance Expectation	Design and evaluate a solution to limit the introduction of non-point source pollution into state waterways.
Clarification Statement	Examples of non-point source water pollution could include nitrogen and phosphorus compounds from agricultural activities and sediments from poor land-use practices. Nitrogen and phosphorus contribute to eutrophication and are anthropegenic drivers of the Gulf of Mexico hypoxic area known as the dead zone.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria and trade-off considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**POLLUTION AND THE ENVIRONMENT** Pollution includes both natural and man-made substances which occur at rates or levels which incur harm (i.e. combustion of fossil fuels, agricultural waste, and industrial byproducts). Pollution can be categorized as point-source pollution and non-point source pollution. (HS.EVS2A.a) **ENVIRONMENTAL CHOICES** Different approaches can be used to manage impacts to our environment. Generally speaking, we can change human activities to limit negative impacts. Alternately, we can use technologies that reduce impact or we can perform restoration work to recover natural functions and values. (HS.EVS2C.a) Trade-offs occur when we make environmental choices. (HS.EVS2C.b) **DEFINING AND DELIMITING ENGINEERING PROBLEMS** 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.ETS1A.b)	**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.

ENVIRONMENTAL AWARENESS AND PROTECTION

Performance Expectation	Use a model to predict the effects that pollution as a limiting factor has on an organism's population density.
Clarification Statement	The law of limiting factors is often illustrated as a graphic tolerance curve and can be used to infer the range of tolerance a species has for specific pollution hazards. When combined with real-world data such as field measurements of abiotic factors, these models can be used to help predict the suitability of an ecosystem for a particular species.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s) • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems and/or solve problems 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**POLLUTION AND THE ENVIRONMENT** Different organisms have unique tolerances to pollution hazards. Many of the organisms most tolerant of pollution are the least desirable to humans (e.g., for food, for recreation, for ecosystem services). (HS.EVS2A.b)	**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.

ENVIRONMENTAL AWARENESS AND PROTECTION

Performance Expectation	Use multiple lines of evidence to construct an argument addressing the negative impacts that introduced organisms have on Louisiana's native species.
Clarification Statement	The exotic organisms introduced in Louisiana include plants such as Chinese tallow, kudzu and water hyacynth and animals including nutria, Asian tiger mosquitoes and zebra mussels. These organisms can have impacts on scales ranging from the level of the individual (e.g. competition) to that of the landscape (e.g. the destruction of coastal marshes by nutria).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 • Construct, use, and/or present an oral and written argument or counterarguments based on data and evidence 8. Obtaining, evaluating, and communicating information	**ECOSYSTEM CHANGE** The introduction of exotic/invasive species causes a disruption in natural ecosystems and can lead to the loss of native species (i.e. threatened/endangered). (HS.EVS2B.a) Changes in ecosystems impact the availability of natural resources (e.g. sediment starvation, climate change). (HS.EVS2B.b)	**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.

PERSONAL RESPONSIBILITIES

Performance Expectation	Construct and evaluate arguments about the positive and negative consequences of using disposable resources versus reusable resources.
Clarification Statement	Resources can be both natural or man-made and may include renewable and non-renewable energy sources, soil, ecosystems, forestry, fisheries, plastic, paper, or aluminum products. Energy used to create and dispose of products may also be considered.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • Construct, use, and/or present an oral and written argument or counterarguments based on data and evidence. 8. Obtaining, evaluating, and communicating information	**STEWARDSHIP** Ecosystem sustainability can be used as a model for a sustainable society (e.g. recycling, energy efficiency, diversity). (HS.EVS3A.a) Louisiana citizens are responsible for conserving our state's natural resources. Personal actions can have a positive or negative impact. (HS.EVS3A.b)	**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.

EARTH'S SYSTEMS

Performance Expectation	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.
Clarification Statement	Examples could 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 damned rivers increase ground water 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH MATERIALS AND SYSTEMS** Earth's systems, being dynamic and interacting, include feedback effects that can increase or decrease the original changes. (HS.ESS2A.a) **WEATHER AND CLIMATE** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere, and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)	**STABILITY AND CHANGE** Feedback (negative or positive) can stabilize or destabilize a system.

EARTH'S SYSTEMS

Performance Expectation	Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems result in changes in atmosphere and climate.
Clarification Statement	Changes differ by timescale, from sudden (large volcanic eruption, hydrosphere circulation) to intermediate (hydrosphere circulation, solar output, human activity) and long-term (Earth's orbit and the orientation of its axis and changes in atmospheric composition). Examples of human activities could include fossil fuel combustion, cement production, or agricultural activity and natural processes such as changes in incoming solar radiation or volcanic activity. Examples of data can include tables, graphs, maps of global and regional temperatures, and atmospheric levels of gases.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 Earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (HS.ESS1B.b) **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, hydrosphere 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.ESS2A.d) **WEATHER AND CLIMATE** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere and land systems, and this energy's re-radiation into space. (HS.ESS2D.a) Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

EARTH'S SYSTEMS

Performance Expectation	Plan and conduct an investigation on 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)

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 an investigation (science) or test a design (engineering) individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE ROLE OF WATER IN EARTH'S SURFACE PROCESSES** The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks (HS.ESS2C.a)	**STRUCTURE AND FUNCTION** The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

EARTH'S SYSTEMS

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**WEATHER AND CLIMATE** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	**ENERGY AND MATTER** The total amount of energy and matter in closed systems is conserved.

HUMAN SUSTAINABILITY

Performance Expectation	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). Natural hazards and other geologic events exhibit some non-random patterns of occurrence. 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, or the types of crops and livestock that can be raised.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL RESOURCES** Resource availability has guided the development of human society. (HS.ESS3A.a) **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.ESS3B.a)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

HUMAN SUSTAINABILITY

Performance Expectation	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
Clarification Statement	Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural, soil use, forestry, and mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems--not what should happen.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL RESOURCES** All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS.ESS3A.b) **DESIGNING SOLUTIONS TO ENGINEERING PROBLEMS** 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.ETS1B.a)	**SYSTEMS AND SYSTEM MODELS** Systems can be designed to do specific tasks.

HUMAN SUSTAINABILITY

Performance Expectation	Create a computational simulation to illustrate the relationships among management of natural resources, the 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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 (e.g. trigonometric, 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. • Create a computational model or simulation of a phenomenon, designed device, process, or system 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**HUMAN IMPACTS ON EARTH SYSTEMS** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS.ESS3C.a)	**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.

HUMAN SUSTAINABILITY

Performance Expectation	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
Clarification Statement	Examples of data on 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 geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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 or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**HUMAN IMPACTS ON EARTH SYSTEMS** Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS.ESS3C.b) **DESIGNING SOLUTIONS TO ENGINEERING PROBLEMS** 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.ETS1B.a)	**STABILITY AND CHANGE** Feedback (negative or positive) can stabilize or destabilize a system.

HUMAN SUSTAINABILITY

Performance Expectation	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, geosphere, 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data **5. 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 (e.g. trigonometric, 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 a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 ocean and biosphere. (HS.ESS2D.d) **GLOBAL CLIMATE CHANGE** Important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities (e.g., through computer simulations and other discoveries satellite imagery). (HS.ESS3D.b)	**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.

ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

Performance Expectation	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity, biodiversity and populations of ecosystems at different scales.
Clarification Statement	Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, or population changes gathered from simulations or historical data sets.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data **5. 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 (e.g. trigonometric, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 that affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem. Organisms would have 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.LS2A.a) Human activity directly and indirectly affect biodiversity and ecosystem health (e.g., habitat fragmentation, introduction of nonnative or invasive species, over-harvesting, pollution and climate change). (HS.LS2A.b)	**SCALE, PROPORTION, AND QUANTITY** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

Performance Expectation	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 move through an ecosystem.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data **5. 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 (e.g. trigonometric, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CYCLES OF MATTER AND ENERGY TRANSFER IN ECOSYSTEMS** Energy is inefficiently transferred from one trophic level to another that affect the relative number of organisms that can be supported at each trophic level and necessitates a constant input of energy from sunlight or inorganic compounds from the environment. (HS.LS2B.b) Photosynthesis, cellular respiration, decomposition and combustion are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes.(HS.LS2B.c) Photosynthesis, chemosynthesis, aerobic and anaerobic respiration and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Environmental conditions restrict which and when reactions can occur. (HS.LS2B.a) (suggested extension)	**ENERGY AND MATTER: FLOWS, CYCLES, AND CONSERVATION** Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

Performance Expectation	Evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
Clarification Statement	Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood and extreme changes, such as volcanic eruption or sea level rise. Emphasis should be on describing drivers of ecosystem stability and change, not on the organismal mechanisms of responses and interactions.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 scientific or historical episodes in science. • Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. 8. Obtaining, evaluating, and communicating information	**ECOSYSTEM DYNAMICS, FUNCTIONING, AND RESILIENCE** The dynamic 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 and may result in new ecosystems. (HS.LS2C.a)	**STABILITY AND CHANGE** Much of science deals with constructing explanations of how things change and how they remain stable.

ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

Performance Expectation	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
Clarification Statement	Examples of human activities can include urbanization, building dams, and dissemination of invasive species.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ECOSYSTEM DYNAMICS, FUNCTIONING, AND RESILIENCE** Ecosystems with a greater biodiversity tend to have a greater resistance and resilience to change. 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.LS2C.b) **BIODIVERSITY AND HUMANS** Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS.LS4D.a) **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.ETS1B.a)	**STABILITY AND CHANGE** Much of science deals with constructing explanations of how things change and how they remain stable.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
Clarification Statement	Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE UNIVERSE AND ITS STARS** All stars, such as our sun, are evolving. The star called Sol, our sun, will burn out over a lifespan of approximately 10 billion years. (HS.ESS1A.a) 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.ESS1A.c) **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. (HS.PS3D.c)	**SCALE, PROPORTION, AND QUANTITY** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

EARTH'S SYSTEMS

Performance Expectation	Plan and conduct an investigation on 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)

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 an investigation (science) or test a design (engineering) individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE ROLE OF WATER IN EARTH'S SURFACE PROCESSES** The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks (HS.ESS2C.a)	**STRUCTURE AND FUNCTION** The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

SPACE SYSTEMS

Performance Expectation	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
Clarification Statement	Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and intersellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by Big Bang theory.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE UNIVERSE AND ITS STARS** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS.ESS1A.b) 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.ESS1A.c) 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.ESS1A.d) **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. (HS.PS4B.d)	**ENERGY AND MATTER** Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
Clarification Statement	Emphasis is on the way nucleosynthesis, and therefore the different elements created, depends on the mass of a star and the stage of its lifetime.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. **Obtaining, evaluating, and communicating information:** Obtaining, evaluating and communicating information in 9-12 builds on K-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).	**THE UNIVERSE AND ITS STARS** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS.ESS1A.b) 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.ESS1A.d) **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. (HS.PS3D.c)	**ENERGY AND MATTER** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
Clarification Statement	Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages of oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient continental center (a result of past plate interactions).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 scientific or historical episodes in science. • Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. 8. Obtaining, evaluating, and communicating information	**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.ESS1C.b) Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS.ESS1C.c) **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. (HS.ESS2B.a) **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. (HS.PS1C.b)	**PATTERNS** Empirical evidence is needed to identify patterns.

HISTORY OF EARTH

Performance Expectation	Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
Clarification Statement	Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples include the absolute age of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest materials), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. • Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE HISTORY OF PLANET EARTH** Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS.ESS1C.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. (HS.PS1C.b)	**STABILITY AND CHANGE** Much of science deals with constructing explanations of how things change and how they remain stable.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
Clarification Statement	Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as other celestial bodies (e.g. graphical representations of orbits).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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 (e.g. trigonometric, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS1B.a)	**SCALE, PROPORTIONS AND QUANTITY** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

EARTH'S SYSTEMS

Performance Expectation	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
Clarification Statement	Emphasis is on the processes by which rocks and minerals are formed and on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, erosion, and mass wasting).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH MATERIALS AND SYSTEMS** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS.ESS2A.a) **PLATE TECTONICS AND LARGE-SCALE SYSTEM INTERACTIONS** Plate tectonics is the unifying theory that explains the past and current movements of rocks at Earth's surface and provides a framework for understanding its geologic history. (HS.ESS2B.a) Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (HS.ESS2B.b)	**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.

EARTH'S SYSTEMS

Performance Expectation	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.
Clarification Statement	Examples could 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 damned rivers increase ground water 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH MATERIALS AND SYSTEMS** Earth's systems, being dynamic and interacting, include feedback effects that can increase or decrease the original changes. (HS.ESS2A.a) **WEATHER AND CLIMATE** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere, and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)	**STABILITY AND CHANGE** Feedback (negative or positive) can stabilize or destabilize a system.

EARTH'S SYSTEMS

Performance Expectation	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 the Earth's three-dimensional structure obtained from seismic wave data, 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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. • Develop a model based on evidence to illustrate the relationships between systems or components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH MATERIALS AND SYSTEMS** Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a viscous mantle and solid crust. (HS.ESS2A.b) Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS.ESS2A.c) **PLATE TECTONICS AND LARGE-SCALE SYSTEM INTERACTIONS** The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS.ESS2B.c) **WAVE PROPERTIES** Geologists use seismic waves and their reflections at interfaces between layers to probe structures deep in the planet. (HS.PS4A.c)	**ENERGY AND MATTER** Energy drives the cycling of matter within and between systems.

EARTH'S SYSTEMS

Performance Expectation	Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems result in changes in atmosphere and climate.
Clarification Statement	Changes differ by timescale, from sudden (large volcanic eruption, hydrosphere circulation) to intermediate (hydrosphere circulation, solar output, human activity) and long-term (Earth's orbit and the orientation of its axis and changes in atmospheric composition). Examples of human activities could include fossil fuel combustion, cement production, or agricultural activity and natural processes such as changes in incoming solar radiation or volcanic activity. Examples of data can include tables, graphs, maps of global and regional temperatures, and atmospheric levels of gases.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 Earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (HS.ESS1B.b) **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, hydrosphere 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.ESS2A.d) **WEATHER AND CLIMATE** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere and land systems, and this energy's re-radiation into space. (HS.ESS2D.a) Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

EARTH'S SYSTEMS

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**WEATHER AND CLIMATE** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	**ENERGY AND MATTER** The total amount of energy and matter in closed systems is conserved.

EARTH'S SYSTEMS

Performance Expectation	Construct an argument based on evidence about the simultaneous coevolution of Earth 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 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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 scientific or historical episodes in science. • Construct an oral and written argument or counterarguments based on data and evidence. 8. Obtaining, evaluating, and communicating information	**WEATHER AND CLIMATE** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b) **BIOGEOLOGY** The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS.ESS2E.a)	**STABILITY AND CHANGE** Much of science deals with constructing explanations of how things change and how they remain stable.

HUMAN SUSTAINABILITY

Performance Expectation	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). Natural hazards and other geologic events exhibit some non-random patterns of occurrence. 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 of crops and livestock that can be raised.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL RESOURCES** Resource availability has guided the development of human society. (HS.ESS3A.a) **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.ESS3B.a)	**CAUSE AND EFFECT** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

HUMAN SUSTAINABILITY

Performance Expectation	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
Clarification Statement	Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural, soil use, forestry, and mining (coal, tar sands, and oil shales), and pumping (ground water, petroleum and natural gas). Science knowledge indicates what can happen in natural systems--not what should happen.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL RESOURCES** All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS.ESS3A.b) **DESIGNING SOLUTIONS TO ENGINEERING PROBLEMS** 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.ETS1B.a)	**SYSTEMS AND SYSTEM MODELS** Systems can be designed to do specific tasks.

HUMAN SUSTAINABILITY

Performance Expectation	Create a computational simulation to illustrate the relationships among management of natural resources, the 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data **5. 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 (e.g. trigonometric, 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. • Create a computational model or simulation of a phenomenon, designed device, process, or system 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**HUMAN IMPACTS ON EARTH SYSTEMS** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS.ESS3C.a)	**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.

HUMAN SUSTAINABILITY

Performance Expectation	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
Clarification Statement	Examples of data on 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 geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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 or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**HUMAN IMPACTS ON EARTH SYSTEMS** Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS.ESS3C.b) **DESIGNING SOLUTIONS TO ENGINEERING PROBLEMS** 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.ETS1B.a)	**STABILITY AND CHANGE** Feedback (negative or positive) can stabilize or destabilize a system.

HUMAN SUSTAINABILITY

Performance Expectation	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).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 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 tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS3D.a)	**STABILITY AND CHANGE** Change and rates of change can be quantified and modeled over very short or long periods of time. Some system changes are irreversible.

HUMAN SUSTAINABILITY

Performance Expectation	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, geosphere, 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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 (e.g. trigonometric, 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 a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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 ocean and biosphere. (HS.ESS2D.d) **GLOBAL CLIMATE CHANGE** Important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities (e.g., through computer simulations and other discoveries satellite imagery). (HS.ESS3D.b)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	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 and the composition of the nucleus of atoms.
Clarification Statement	**Physical Science:** Examples of properties that could be predicted from patterns could include metals, nonmetals, metalloids, number of valence electrons, types of bonds formed, or atomic mass. Emphasis is on main group elements. **Chemistry:** Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, atomic radius, atomic mass, or reactions with oxygen. Emphasis is on main group elements and qualitative understanding of the relative trends of ionization energy and electronegativity.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematical and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS.PS1A.a) 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.PS1A.b) **TYPES OF INTERACTIONS** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.(HS.PS2B.c)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	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	**Physical Science:** Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or hydrogen and oxygen. Reaction classification includes synthesis, decomposition, single displacement, double displacement, and acid-base. **Chemistry:** Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or carbon and hydrogen. Reaction classification aids in the prediction of products (e.g. synthesis, decomposition, single displacement, double displacement, and acid-base).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematical and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.PS1A.b) **CHEMICAL REACTIONS** 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.PS1B.c)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	Plan and conduct an investigation to gather evidence to compare the structure of substances at the macroscale 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 network solids (such as graphite). Examples of macro-properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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/or 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. 4. Analyzing and interpreting data 5. Using mathematical and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** The structure and interactions of matter at the macro scale are determined by electrical forces within and between atoms. (HS.PS1A.c) **TYPES OF INTERACTIONS** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (secondary) (HS.PS2B.c)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematical and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** 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.PS1A.d) **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.PS1B.a)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
Clarification Statement	Student reasoning should focus on the number and energy of collisions between molecules. Emphasis is on simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematical and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. • Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.PS1B.a)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematical and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CHEMICAL REACTIONS** 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.PS1B.b) **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) (HS.ETS1C.a)	**STABILITY AND CHANGE** Much of science deals with constructing explanations of how things change and how they remain stable.

MATTER AND ITS INTERACTIONS

Performance Expectation	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
Clarification Statement	**Physical Science:** Emphasis is on using mathematical ideas to communicate the relationship between masses of reactants and products as well as balancing chemical equations. **Chemistry:** Emphasis is on using mathematical ideas as they relate to stoichiometry 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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, 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CHEMICAL REACTIONS** 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.PS1B.c)	**ENERGY AND MATTER** The total amount of energy and matter in closed systems is conserved.

MATTER AND ITS INTERACTIONS

Performance Expectation	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	**Physical Science:** Emphasis is only 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. Radioactive decay focus is on its relationship to half-life. **Chemistry:** 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. Emphasis is on alpha, beta, and gamma radioactive decays.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NUCLEAR PROCESSES** Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS.PS1C.a)	**ENERGY AND MATTER** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	Communicate scientific and technical information about why the atomic-level, subatomic-level, and/or 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, fireworks and neon signs are made of certain elements, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. **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 and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e.,orally, graphically, textually, mathematically).	**STRUCTURE AND PROPERTIES OF MATTER** The structure and interactions of matter at the macro scale are determined by electrical forces within and between atoms. (HS.PS1A.c) **TYPES OF INTERACTIONS** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS.PS2B.c) **ELECTROMAGNETIC RADIATION** Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS.PS4B.c) 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. (HS.PS4B.d)	**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.

ENERGY

Performance Expectation	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	**Chemistry:** Emphasis is on explaining the meaning of mathematical expressions used in the model. Focus is on basic algebraic expression or computations, systems of two or three components, and thermal energy. **Physics:** Emphasis is on explaining the meaning of mathematical expressions used in the model. Focus is on basic algebraic expression or computations; systems of two or three components; and thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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, computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. That there is a single quantity called energy is 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.PS3A.a) **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.PS3B.a) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS.PC3B.b) Mathematical expressions allow the concept of conservation of energy to be used to predict and describe system behavior. These expressions 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 velocity. (HS.PC3B.c) The availability of energy limits what can occur in any system. (HS.PC3B.d)	**SYSTEMS AND SYSTEM MODELS** 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.

ENERGY

Performance Expectation	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
Clarification Statement	**Physical Science:** Emphasis is on qualitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Emphasis is on devices constructed with teacher approved materials. Examples of devices can be drawn from chemistry or physics clarification statements below. **Chemistry:** Emphasis is on both qualitative and quantitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Focus of quantitative evaluations is limited to total output for a given input. Emphasis is on devices constructed with teacher approved materials. Examples of devices in chemistry could include hot/cold packs and batteries. **Physics:** Emphasis is on both qualitative and quantitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Focus of quantitative evaluations is limited to total output for a given input. Emphasis is on devices constructed with teacher approved materials. Examples of devices in physics could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and electric motors.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b) **ENERGY IN CHEMICAL PROCESSES** Although energy cannot be destroyed, it can be converted to other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.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.ETS1A.a)	**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.

ENERGY

Performance Expectation	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	**Physical Science, Physics and Chemistry:** Emphasis is on analyzing data from student investigations and using mathematical thinking appropriate to the subject to describe the energy changes quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out Investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CONSERVATION OF ENERGY AND ENERGY TRANSFER** Energy cannot be created or destroyed, but it can be transported from one place to another, transformed into other forms, and transferred between systems. (HS.PS3B.b) 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.PS3B.e) **ENERGY IN CHEMICAL PROCESSES AND EVERYDAY LIFE** Although energy cannot be destroyed, it can be converted to less useful other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.a)	**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.

ENERGY

Performance Expectation	Evaluate the validity and reliability of claims in published materials about the viability of nuclear power as a source of alternative energy relative to other forms of energy (e.g., fossil fuels, wind, solar, geothermal).
Clarification Statement	Emphasis is on the trade-offs existing between the amount of energy produced, the types and amounts of pollution produced, safety, and cost . Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. **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. • Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.	**NUCLEAR PROCESSES** Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS.PS1C.a) **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.ETS1B.a) **NATURAL RESOURCES** All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS.ESS3A.b)	**ENERGY AND MATTER** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Appendix B details the connections between the Louisiana Student Standards for Science and the Louisiana Student Standards for Math and ELA.

Kindergarten

K-PS2-1 Motion and Stability: Forces and Interactions 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.	ELA	W.K.7 With guidance and support from adults, participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).
K-PS2-2 Motion and Stability: Forces and Interactions 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.	ELA	RI.K.1. With prompting and support, ask and answer questions about key details in a text. SL.K.3. Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood.
K-PS3-1 Energy Make observations to determine the effect of sunlight on Earth's surface.	ELA	W.K.7 With guidance and support from adults, participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).
K-PS3-2 Energy Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.		
K-LS1-1 From Molecules to Organisms: Structures and Processes Use observations to describe patterns of what plants and animals (including humans) need to survive	ELA	W.K.7 With guidance and support from adults, 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).

K-ESS2-1 Earth's Systems Use and share observations of local weather conditions to describe patterns over time.	ELA	W.K.7 With guidance and support from adults, 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). SL.K.6 Speak audibly and express thoughts, feelings, and ideas clearly.
K-ESS2-2 Earth's System Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.	ELA	RI.K.1 With prompting and support, ask and answer questions about key details in a text 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 (e.g., My favorite book is . . .). 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-ESS3-1 Earth and Human Activity Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.	ELA	SL.K.5 Add drawings or other visual displays to descriptions as desired to provide additional detail.
	MATH	K.CC.C.6. Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies (counting is limited to groups no larger than 10).
K-ESS3-2 Earth and Human Activity Ask questions to obtain information about the purpose of weather forecasting to prepare for and respond to severe weather.	ELA	RI.K.1 With prompting and support, ask and answer questions about key details in a text SL.K.3. Ask and answer questions in order to seek help, get information, or clarify something that is not understood.
K-ESS3-3 Earth and Human Activity Communicate solutions that will reduce the impact of	ELA	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. SL.K.6 Speak audibly and express thoughts, feelings, and ideas

humans on the land, water, air, and/or other living things in the local environment.	clearly.

1st Grade

1-PS4-1 Waves and Their Applications Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.	ELA	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). W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. 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-PS4-2 Waves and Their Applications Make observations to construct an evidence-based account that objects can be seen only when illuminated.	ELA	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. 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). W.1.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
1-PS4-3 Waves and Their Applications Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.	ELA	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). W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. 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-PS4-4 Waves and Their Applications Use tools and materials to design and build a device that uses light or sound to	ELA	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).

solve the problem of communicating over a distance.	Math	K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. 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. *For example, directly compare the heights of two children and describe one child as taller/shorter.* 1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. 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. *Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps* (Students do not begin measuring with rulers and the like until grade 2).
1-LS1-1 From Molecules to Organisms: Structures and Processes Use tools and 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.	ELA	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-LS1-2 From Molecules to Organisms: Structures and Processes Read grade-appropriate texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.	ELA	RI.1.1 Ask and answer questions about key details in a text. RI.1.2 Identify the main topic and retell key details of a text. RI.1.10 With prompting and support read informational texts appropriately complex for grade. RI.1.7 Use the illustrations and details in a text to describe its key ideas.
1-LS3-1 Heredity: Inheritance and Variation of Traits Make observations to	ELA	RL.1.1 Ask and answer questions about key details in a text. 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

construct an evidence-based account that young plants and animals are similar, but not exactly like, their parents.		to write a sequence of instructions). W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
	MATH	K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. 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. *For example, directly compare the heights of two children and describe one child as taller/shorter.* 1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object.
1-ESS1-1 Earth's Place in the Universe Use observations of the sun, moon, and stars to describe patterns that can be predicted.	ELA	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). W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
1-ESS1-2 Earth's Place in the Universe Make observations at different times of year to relate the amount of daylight to the time of year.	ELA	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). W.1.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
	MATH	K.OA.A.1 Represent addition and subtraction with objects, fingers, mental images, drawings, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations. K.OA.A.2 Solve addition and subtraction word problems, and add and subtract within 10, e.g., by using objects or drawings to represent the problem. K.OA.A.3 Decompose numbers less than or equal to 10 into pairs in more than one way, e.g., by using objects or drawings, and record each decomposition by a drawing or equation (e.g., 5 = 2 + 3 and 5 = 4 + 1).

	K.OA.A.4 For any number from 1 to 9, find the number that makes 10 when added to the given number, e.g., by using objects or drawings, and record the answer with a drawing or equation. K.OA.A.5 Fluently add and subtract within 5. 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 with a symbol for the unknown number to represent the problem). 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.

2nd Grade

2-PS1-1 Matter and Its Interactions Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.	ELA	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). W.2.8 Recall information from experiences or gather information from provided sources to answer a question. SL.2.6 Produce complete sentences when appropriate to task, audience, and situation in order to provide requested detail or clarification.
	MATH	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. 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 Matter and Its Interactions Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.	ELA	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). W.2.8 Recall information from experiences or gather information from provided sources to answer a question.
	MATH	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. 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 problems4 using information presented in a bar graph.

2-PS1-3 Matter and Its Interactions 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.	ELA	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). W.2.8 Recall information from experiences or gather information from provided sources to answer a question.
2-PS1-4 Matter and Its Interactions Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.	ELA	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. RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. R1.2.8 Describe how reasons or evidence support specific points the author makes in a text 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-LS2-1 Ecosystems: Interactions, Energy, and Dynamics Plan and conduct an investigation to determine if plants need sunlight and water to grow.	ELA	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). W.2.8 Recall information from experiences or gather information from provided sources to answer a question.
2-LS2-2 Ecosystems: Interactions, Energy, and Dynamics Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.	ELA	SL.2.5 Create audio recordings of stories or poems with the guidance and support from adults and/or peers; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings.
	MATH	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.

		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-LS4-1 Biological Evolution: Unity and Diversity Make observations of plants and animals to compare the diversity of life in different habitats.	ELA	W.1.7 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). W.1.8 Recall information from experiences or gather information from provided sources to answer a question.
	MATH	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. 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-ESS1-1 Earth's Place in the Universe Use information from several sources to provide evidence that Earth events can occur quickly or slowly.	ELA	RL.2.1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. RL2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. RI.2.8 Describe how reasons or evidence support specific points the author makes in a text. RI.2.9 Compare and contrast the most important points presented by two texts on the same topic 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. 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). W.2.8.Recall information from experiences or gather information from provided sources to answer a question. SL.2.2 Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.

	MATH	1.NBT.B.2 Understand that the two digits of a two-digit number represent amounts of tens and ones. a. 10 can be thought of as a bundle of ten ones—called a "ten." b. The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones. c. The numbers 10, 20, 30, 40, 50, 60, 70, 80, 90 refer to one, two, three, four, five, six, seven, eight, or nine tens (and 0 ones). 1.NBT.B.3 Compare two two-digit numbers based on meanings of the tens and ones digits, recording the results of comparisons with the symbols >, =, and <.
2-ESS2-1 Earth's Systems Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.	ELA	RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. RI.2.9 Compare and contrast the most important points presented by two texts on the same topic.
	MATH	1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. 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. Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps. 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-ESS2-2 Earth's System Develop a model to represent the shapes and kinds of land and bodies of water in an area.	ELA	SL.2.5 Create audio recordings of stories or poems with the guidance and support from adults and/or peers; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings.
2-ESS2-3 Earth's Systems Obtain and communicate	ELA	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.

information to identify where water is found on Earth and that it can be solid or liquid.	W.2.8 Recall information from experiences or gather information from provided sources to answer a question. SL.2.6 Produce complete sentences when appropriate to task, audience, and situation in order to provide requested detail or clarification.

3rd Grade

3-PS2-1 Motion and Stability: Forces and Interactions Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.	ELA	RL.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. W.3.7 Conduct short research projects that build knowledge about a topic. 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.
	MATH	2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes. 2.MD.A.2 Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen. 2.MD.A.3 Estimate lengths using units of inches, feet, centimeters, and meters. 2.MD.A.4 Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit. 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-PS2-2 Motion and Stability: Forces and Interactions Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.	ELA	W.3.7 Conduct short research projects that build knowledge about a topic. 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-PS2-3 Motion and Stability: Forces and Interactions Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.	ELA	RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. 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. 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). SL3.3 Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
3-PS2-4 Motion and Stability: Forces and Interactions Define a simple design problem that can be solved by applying scientific ideas about magnets.		
3-LS1-1 From Molecules to Organisms: Structures and Processes Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	ELA	RI.3.7 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). 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-LS2-1 Ecosystems: Interactions, Energy, and Dynamics Construct and support an argument that some animals form groups that help members survive.	ELA	RI.3.1. Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. 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. W.3.1. Write opinion pieces on topics or texts, supporting a point of view with reasons.

3-LS3-1 Heredity: Inheritance and Variation of Traits Analyze and interpret data to provide evidence that plants and animals have traits inherited from their parents and that variation of these traits exists in a group of similar organisms.	ELA	RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. 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. W.3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
	MATH	2.MD.D.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units. 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. 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-LS3-2 Heredity: Inheritance and Variation of Traits Use evidence to support the explanation that traits can be influenced by the environment.	ELA	RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. 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.
	MATH	2.MD.D.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.

		2.MD.D10 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 problems4 using information presented in a bar graph. 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-LS4-1 Biological Evolution: Unity and Diversity Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.	ELA	RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. R1.3.3 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. W.3.1 Write opinion pieces on topics or texts, supporting a point of view with reasons. W.3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. 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.
	MATH	2.MD.D.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units. 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. 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-LS4-2 Biological Evolution: Unity and Diversity 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.	ELA	RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. 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. W.3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. SL.3.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
	MATH	2.MD.D.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units. 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 problems4 using information presented in a bar graph. 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. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets.*
3-LS4-3 Biological Evolution: Unity and Diversity Construct and support an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	ELA	RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. 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. W.3.1 Write opinion pieces on topics or texts, supporting a point of view with reasons.

	MATH	2.MD.D.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units. 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 problems4 using information presented in a bar graph. 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. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets.*
3-LS4-4 Biological Evolution: Unity and Diversity 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.	ELA	RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. 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. W.3.1 Write opinion pieces on topics or texts, supporting a point of view with reasons. SL.3.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
3-ESS2-1 Earth's Systems Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.	MATH	2.MD.D.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units. 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.

		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.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. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets.*
3-ESS2-2 Earth's Systems Obtain and combine information to describe climates in different regions around the world.	ELA	RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. RI.3.9 Compare and contrast the most important points and key details presented in two texts on the same topic. 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-ESS3-1 Earth and Human Activity Make a claim about the merit of a design solution that reduces the impact of a weather-related hazard.	ELA	W.3.1 Write opinion pieces on topics or texts, supporting a point of view with reasons. W.3.7 Conduct short research projects that build knowledge about a topic.

4th Grade

4-PS3-1 Energy Use evidence to construct an explanation relating the speed of an object to the energy of that object.	ELA	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. 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. RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. 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. W.4.9 Draw relevant evidence from grade-appropriate literary or informational texts to support analysis, reflection, and research.
4-PS3-2 Energy Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	ELA	W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. 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-PS3-3 Energy Ask questions and predict outcomes about the changes in energy that occur when objects collide.	ELA	W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. 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-PS3-4 Energy Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	ELA	W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. 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.

	MATH	3.OA.D.8 Solve two-step word problems using the four operations. 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.OA.A.3 Solve multi-step word problems posed with whole numbers and having 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. Example: Twenty-five people are going to the movies. Four people fit in each car. How many cars are needed to get all 25 people to the theater at the same time?
4-PS4-1 Waves and Their Applications in Technologies for Information Transfer Develop a model of waves to describe patterns in terms of amplitude and wavelength and to show that waves can cause objects to move.	ELA	SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.
	MATH	4.G.A.1 Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.
4-PS4-2 Waves and Their Applications in Technologies for Information Transfer Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.	ELA	SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.
	MATH	4.G.A.1 Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.
4-LS1-1 From Molecules to Organisms: Structure and Processes Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	ELA	W.4.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
	MATH	3.G.A.2 Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. *For example, partition a shape into 4 parts with equal area, and describe the area of each part as 1/4 of the area of the shape.* 4.G.A.3 Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the

		line into matching parts. Identify line-symmetric figures and draw lines of symmetry.
4-LS1-2 From Molecules to Organisms: Structure and Processes Construct an explanation to describe how animals receive different types of information through their senses, process the information in their brains, and respond to the information in different ways.	ELA	SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.
4-ESS1-1 Earth's Place in the Universe Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in landforms over time.	ELA	W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. 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. W.4.9 Draw relevant evidence from grade-appropriate literary or informational texts to support analysis, reflection, and research. 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. 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.
	MATH	3.MD.A.1 Understand time to the nearest minute. a. Tell and write time to the nearest minute and measure time intervals in minutes, within 60 minutes, on an analog and digital clock. b. Calculate elapsed time greater than 60 minutes to the nearest quarter and half hour on a number line diagram. c. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram. 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. 4.MD.A.1 Know relative sizes of measurement units within one system of units including ft, in; 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. (Conversions are limited to one-step conversions.) *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), …*
4-ESS2-1 Earth's System Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion.	ELA	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.
	MATH	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. 4.MD.A.1 Know relative sizes of measurement units within one system of units including ft, in; 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. (Conversions are limited to one-step conversions.) *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), …* 4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving whole numbers and/or simple fractions (addition and subtraction of fractions with like denominators and multiplying a fraction times a fraction or a whole number), 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-ESS2-2 Earth's Systems Analyze and interpret data from maps to describe patterns of Earth's features.	ELA	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.
	MATH	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. 4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving whole numbers and/or simple fractions (addition and subtraction of fractions with like denominators and multiplying a fraction times a fraction3 or a whole number), 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-ESS2-3 Earth's System Ask questions that can be investigated and predict reasonable outcomes about how living things affect the physical characteristics of their environment.		
4-ESS3-1 Earth and Human Activity Obtain and combine information to describe that energy and fuels are derived from renewable and non-renewable resources and how their uses affect the environment.	ELA	W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. 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. W.4.9 Draw relevant evidence from grade-appropriate literary or informational texts to support analysis, reflection, and research. 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.

		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.
	MATH	3.OA.D.8 Solve two-step word problems using the four operations. 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.OA.A.1 Interpret a multiplication equation as a comparison and represent verbal statements of multiplicative comparisons as multiplication equations, e.g., interpret 35 = 5 x 7 as a statement that 35 is 5 times as many as 7, and 7 times as many as 5.
4-ESS3-2 Earth and Human Activity Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.	ELA	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. RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.
	MATH	3.OA.D.8 Solve two-step word problems using the four operations. Represent these problems using equations with letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. 4.OA.A.1 Interpret a multiplication equation as a comparison and represent verbal statements of multiplicative comparisons as multiplication equations, e.g., interpret 35 = 5 x 7 as a statement that 35 is 5 times as many as 7, and 7 times as many as 5.

5th Grade

5-PS1-1 Matter and Its Interactions Develop a model to describe that matter is made of particles too small to be seen.	ELA	RI.5.7 Utilize information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. 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-PS1-2 Matter and Its Interactions Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total amount of matter is conserved.	ELA	W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. 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.
	MATH	4.MD.A.1. Know relative sizes of measurement units within one system of units including ft, in; 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. (Conversions are limited to one-step conversions.) *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), …* 4.MD.A.2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving whole numbers and/or simple fractions (addition and subtraction of fractions with like denominators and multiplying a fraction times a fraction3 or a whole number), 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. 5.MD.A.1. Convert among different-sized standard measurement units within a given measurement system, and use these conversions in solving multi-step, real-world problems (e.g., convert 5 cm to 0.05 m; 9 ft to 108 in). 5.MD.B.2 Make a line plot to display a set of measurements in fractions of a unit (½, ¼, $^1/_8$). Use operations on fractions for this grade to solve problems involving information presented in line plots.

		For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.
5-PS1-3 Matter and Its Interactions Make observations and measurements to identify materials based on their properties.	ELA	W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. 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. W.5.9 Draw relevant evidence from grade-appropriate literary or informational texts to support analysis, reflection, and research.
5-PS1-4 Matter and Its Interactions Conduct an investigation to determine whether the mixing of two or more substances results in new substances.	ELA	W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. 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. W.5.9 Draw relevant evidence from grade-appropriate literary or informational texts to support analysis, reflection, and research.
5-PS2-1 Motion and Stability: Forces and Interactions Support an argument that the gravitational force exerted by the Earth is directed down.	ELA	RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. W.5.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
5-PS3-1 Matter and Energy in Organisms and Ecosystems 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.	ELA	RI.5.7 Utilize information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. 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-LS1-1 From Molecules to Organisms: Structures and Processes Ask questions about how air and water affect the growth of plants.	ELA	RI.5.1. Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. RI.5.9. Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. W.5.1. Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
	MATH	4.MD.A.1. Know relative sizes of measurement units within one system of units including ft, in; 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. (Conversions are limited to one-step conversions.) *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), …* 4.MD.A.2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving whole numbers and/or simple fractions (addition and subtraction of fractions with like denominators and multiplying a fraction times a fraction3 or a whole number), 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. 5.MD.A.1. Convert among different-sized standard measurement units within a given measurement system, and use these conversions in solving multi-step, real-world problems (e.g., convert 5 cm to 0.05 m; 9 ft to 108 in).
5-LS2-1 Ecosystems Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	ELA	RI.5.7 Utilize information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. 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-ESS1-1 Earth's Place in the Universe Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from the Earth.	ELA	RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. RI.5.7 Utilize information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. 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). RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. W.5.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
	MATH	4.NBT.A.1 Recognize that in a multi-digit whole number less than or equal to 1,000,000, a digit in one place represents ten times what it represents in the place to its right. *For example, (1) recognize that 700 ÷ 70 = 10; (2) in the number 7,246, the 2 represents 200, but in the number 7,426 the 2 represents 20, recognizing that 200 is ten times as large as 20, by applying concepts of place value and division.* 4.NBT.A.2 Read and write multi-digit whole numbers less than or equal to 1,000,000 using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons. 4.NBT.A.3 Use place value understanding to round multi-digit whole numbers, less than or equal to 1,000,000, to any place. 5.NBT.A.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. 5.NBT.A.2 Explain and apply patterns in the number of zeros of the product when multiplying a number by powers of 10. Explain and apply patterns in the values of the digits in the product or the quotient, when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. *For example,* $10^0 = 1$, $10^1 = 10$ *... and* $2.1 \times 10^2 = 210$.

5-ESS1-2 Earth's Place in the Universe 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.	ELA	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.
	MATH	4.MD.A.1. Know relative sizes of measurement units within one system of units including ft, in; 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. (Conversions are limited to one-step conversions.) *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), …* 4.MD.A.2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving whole numbers and/or simple fractions (addition and subtraction of fractions with like denominators and multiplying a fraction times a fraction3 or a whole number), 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. 5.MD.A.1. Convert among different-sized standard measurement units within a given measurement system, and use these conversions in solving multi-step, real-world problems (e.g., convert 5 cm to 0.05 m; 9 ft to 108 in). 5.MD.B.2 Make a line plot to display a set of measurements in fractions of a unit (½, ¼, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. *For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.*
5-ESS2-1 Earth's Systems Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.	ELA	RI.5.7 Utilize information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. 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-ESS2-2 Earth's Systems 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.	ELA	RI.5.7 Utilize information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. 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. 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.
	MATH	4.MD.A.1. Know relative sizes of measurement units within one system of units including ft, in; 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. (Conversions are limited to one-step conversions.) *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), …* 4.MD.A.2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving whole numbers and/or simple fractions (addition and subtraction of fractions with like denominators and multiplying a fraction times a fraction3 or a whole number), 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. 5.MD.A.1. Convert among different-sized standard measurement units within a given measurement system, and use these conversions in solving multi-step, real-world problems (e.g., convert 5 cm to 0.05 m; 9 ft to 108 in). 5.MD.B.2 Make a line plot to display a set of measurements in fractions of a unit (½, ¼, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. *For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.* *Percentages are not addressed until grade 6.*

5-ESS3-1 Earth and Human Activity Generate and compare multiple solutions about ways individual communities can use science to protect the Earth's resources and environment.	ELA	RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. RI.5.7 Utilize information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. 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. W.5.9 Draw relevant evidence from grade-appropriate literary or informational texts to support analysis, reflection, and research.

6^{th} Grade

6-MS-PS1-1 Matter and Its Interactions Develop models to describe the atomic composition of simple molecules and extended structures.	ELA	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). SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
	MATH	5.OA.A.1 Use parentheses or brackets in numerical expressions, and evaluate expressions with these symbols. 5.OA.A.2 Write simple expressions that record calculations with whole numbers, fractions, and decimals, and interpret numerical expressions without evaluating them. *For example, express the calculation "add 8 and 7, then multiply by 2" as 2 × (8 + 7). Recognize that 3 x (18,932 + 9.21) is three times as large as 18,932 + 9.21, without having to calculate the indicated sum or product.* 5.NBT.A.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. 5.NBT.A.2 Explain and apply patterns in the number of zeros of the product when multiplying a number by powers of 10. Explain and apply patterns in the values of the digits in the product or the quotient, when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. *For example,* $10^0 = 1$, $10^1 = 10$ *... and* $2.1 \times 10^2 = 210$. 5.NBT.A.3 Read, write, and compare decimals to thousandths. a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., 347.392 = 3 × 100 + 4 × 10 + 7 × 1 + 3 × (1/10) + 9 × (1/100) + 2 × (1/1000). b. Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons. 5.NBT.A.4 Use place value understanding to round decimals to any place. 6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote*

		candidate A received, candidate C received nearly three votes." 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.
6-MS-PS2-1 Motion and Stability: Forces and Interactions Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
	MATH	5.NF.B.3 Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret 3/4 as the result of dividing 3 by 4, noting that 3/4 multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size 3/4. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?*

5.NBT.B.5 Fluently multiply multi-digit whole numbers using the standard algorithm.

5.NBT.B.6 Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, subtracting multiples of the divisor, and/or the relationship between multiplication and division. Illustrate and/or explain the calculation by using equations, rectangular arrays, area models, or other strategies based on place value.

5.NBT.B.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; justify the reasoning used with a written explanation.

6.RP.A.3b Solve unit rate problems including those involving unit pricing and constant speed. *For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed?*

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.

6.EE.A.1 Write and evaluate numerical expressions involving whole-number exponents.

6.EE.A.2 Write, read, and evaluate expressions in which letters stand for numbers.

a. Write expressions that record operations with numbers and with letters standing for numbers. For example, express the calculation "Subtract y from 5" as $5 - y$.
b. Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); view one or more parts of an expression as a single entity. For example, describe the expression 2 (8 + 7) as a product of two factors; view (8 + 7) as both a single entity and a sum of two terms.
c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas $V = s^3$ and $A = 6s^2$ to find the volume and surface area of a cube with sides of length $s = 1/2$.

		6.EE.B.5 Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true. 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. 6.EE.B.7 Solve real-world and mathematical problems by writing and solving equations and inequalities of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers. Inequalities will include <, >, ≤, and ≥. 6.EE.B.8 Write an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; represent solutions of such inequalities on number line diagrams.
6-MS-PS2-2 Motion and Stability: Forces and Interactions 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.	ELA	RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. 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.
	MATH	5,NBT.B.5 Fluently multiply multi-digit whole numbers using the standard algorithm. 5.NBT.5.6 Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, subtracting multiples of the divisor, and/or the relationship between multiplication and division. Illustrate and/or explain the calculation by using equations, rectangular arrays, area models, or other strategies based on place value. 5.NBT.5.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; justify the reasoning used with a written explanation.

	6.EE.A.1 Write and evaluate numerical expressions involving whole-number exponents. 6.EE.A.2 Write, read, and evaluate expressions in which letters stand for numbers. a. Write expressions that record operations with numbers and with letters standing for numbers. For example, express the calculation "Subtract y from 5" as 5 – y. b. Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); view one or more parts of an expression as a single entity. For example, describe the expression 2 (8 + 7) as a product of two factors; view (8 + 7) as both a single entity and a sum of two terms. c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas $V = s^3$ and $A = 6s^2$ to find the volume and surface area of a cube with sides of length s = 1/2. 6.EE.B.5 Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true. 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. 6.EE.B.7 Solve real-world and mathematical problems by writing and solving equations and inequalities of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers. Inequalities will include <, >, ≤, and ≥. 6.EE.B.8 Write an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; represent solutions of such inequalities on number line diagrams. 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.

6-MS-PS2-3 Motion and Stability: Forces and Interactions Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.
6-MS-PS2-4 Motion and Stability: Forces and Interactions Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.	ELA	WHST.6-8.1. Write arguments focused on discipline-specific content.
6-MS-PS2-5 Motion and Stability: Forces and Interactions Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.	ELA	RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. 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.
6-MS-PS3-1 Energy 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.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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).
	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1,*

		because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes." 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.
6-MS-PS3-2 Energy 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.	ELA	SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
6-MS-PS4-1 Waves and Their Applications in Technologies for Information Transfer Use mathematical representations to describe a simple model for waves that includes how the	ELA	SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1,*

amplitude of a wave is related to the energy in a wave and how the frequency and wavelength change the expression of the wave.		*because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."* 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. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A 3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.
6-MS-PS4-2 Waves and Their Applications in Technologies for Information Transfer Develop and use a model to describe that waves are refracted, reflected, absorbed, transmitted, or scattered through various materials.	ELA	SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
6-MS-ESS1-1 Earth's Place in the Universe Develop and use a model of the Earth-sun-moon system to describe the reoccurring patterns of lunar phases, eclipses of the sun and moon, and seasons.	ELA	SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."*
6-ESS1-2 Earth's Place in the Universe Use a model to describe the role of gravity in the motions within galaxies and the solar system.	ELA	SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."*

		6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. 6.EE.B.5 Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true. 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. 6.EE.B.7 Solve real-world and mathematical problems by writing and solving equations and inequalities of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers. Inequalities will include <, >, ≤, and ≥.
6-MS-ESS1-3 Earth's Place in the Universe Analyze and interpret data to determine scale properties of objects in the solar system.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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).

	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes." 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.
6-MS-ESS3-4 Earth and Human Activity Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. WHST.6-8.1 Write arguments focused on discipline-specific content. WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.
	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."* 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio

		relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. 6.EE.B.5 Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true. 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. 6.EE.B.7 Solve real-world and mathematical problems by writing and solving equations and inequalities of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers. Inequalities will include $<$, $>$, $\leq$, and $\geq$. 6.EE.B.8 Write an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; represent solutions of such inequalities on number line diagrams.
6-MSLS1-1 From Molecules to Organisms: Structures and Processes	ELA	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.

Conduct an investigation to provide evidence that living things are made of cells, either one or many different numbers and types.	MATH	5.NBT.A.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. 5.NBT.A.2 Explain and apply patterns in the number of zeros of the product when multiplying a number by powers of 10. Explain and apply patterns in the values of the digits in the product or the quotient, when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. *For example,* $10^0 = 1$, $10^1 = 10$ *... and* $2.1 \times 10^2 = 210$. 5.NBT.A.3 Read, write, and compare decimals to thousandths. a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$. b. Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons. 6.EE.C.9 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. *For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time.*
6- MS-LS1-2 From Molecules to Organisms: Structures and Processes Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	ELA	SL.6.5. Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
6-MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics Analyze and interpret data	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. WHST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually

to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.		(e.g., in a flowchart, diagram, model, graph, or table).
6-MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	ELA	RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts. WHST.6-8.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.6-8.9. Draw evidence from informational texts to support analysis, reflection, and research. SL.6.1. 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, building on others' ideas and expressing their own clearly. SL.6.4. 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.
	MATH	5.MD.A.1. Convert among different-sized standard measurement units within a given measurement system, and use these conversions in solving multi-step, real-world problems (e.g., convert 5 cm to 0.05 m; 9 ft to 108 in). 5.MD.B.2. Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. *For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.* 6.SP.B.5 Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations. b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement. c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range) as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. d. Relating the choice of measures of center and variability to

		the shape of the data distribution and the context in which the data were gathered.
6-MS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	ELA	SL.6.5. Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

7th Grade

7-MS-PS1-2 Matter and Its Interactions Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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).
	MATH	6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. 6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots. 6.SP.B.5 Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations. b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement. c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range) as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered. 7.RP.A.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas, and other quantities measured in like or different units. *For example, if a person walks ½ mile in each ¼ hour, compute the unit rate as the complex fraction ½/¼ miles per*

		hour, equivalently 2 miles per hour. 7.RP.A.2 Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as $t = pn$. d. Explain what a point (x, *y*) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, *r*) where r is the unit rate.
7-MS-PS1-4 Matter and Its Interactions Develop a model that predicts and describes changes in particle motion, temperature, and the state of a pure substance when thermal energy is added or removed.	ELA	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). SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
	MATH	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. 7.NS.A.1 Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram. a. Describe situations in which opposite quantities combine to make 0. For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged. b. Understand p + q as the number located a distance |q| from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts. c. Understand subtraction of rational numbers as adding the additive inverse, p – q = p + (–q). Show that the distance between two rational numbers on the number line is the

		absolute value of their difference, and apply this principle in real-world contexts. d. Apply properties of operations as strategies to add and subtract rational numbers.
7-MS-PS1-5 Matter and Its Interactions Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.	ELA	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). SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
	MATH	6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. 7.RP.A.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas, and other quantities measured in like or different units. *For example, if a person walks ½ mile in each ¼ hour, compute the unit rate as the complex fraction ½/¼ miles per hour, equivalently 2 miles per hour.* 7.RP.A.2 Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship

		between the total cost and the number of items can be expressed as $t = pn$. d. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.
7-MS-PS3-4 Energy 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.	ELA	RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. 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.
	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes." 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. 7.RP.A.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas, and other quantities measured in like or different units. *For example, if a person walks ½ mile in each ¼*

		hour, compute the unit rate as the complex fraction ½/¼ miles per hour, equivalently 2 miles per hour. 7.RP.A.2 Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as $t = pn$. d. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.
7-MS-ESS2-4 Earth's Systems Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.	ELA	SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
7-MS-ESS2-5 Earth's Systems Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	ELA	RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts. 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. 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.
	MATH	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. 7.NS.A.1 Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram. a. Describe situations in which opposite quantities combine to make 0. For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged. b. Understand p + q as the number located a distance |q| from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts. c. Understand subtraction of rational numbers as adding the additive inverse, p – q = p + (–q). Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts. d. Apply properties of operations as strategies to add and subtract rational numbers.
7-MS-ESS2-6 Earth's Systems Develop and use a model to describe how unequal heating and rotation of the Earth causes patterns of atmospheric and oceanic circulation that determine regional climates.	ELA	SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
7-MS-ESS3-5 Earth and Human Activity Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.
	MATH	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. 6.EE.C.9 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. *For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time.* 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. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, and describe the solutions. .
7-MS-LS1-3 From Molecules to Organisms: Structures and Processes Use an argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. RI.7.8 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. WHST.6-8.1 Write arguments focused on discipline-specific content.
	MATH	6.EE.C.9 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. *For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time.*

7- MS-LS1-6 From Molecules to Organisms: Structures and Processes Construct a scientific explanation based on evidence for the role of photosynthesis and cellular respiration in the cycling of matter and flow of energy into and out of organisms.	ELA	RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts. 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. WHST.6-8.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.6-8.9. Draw evidence from informational texts to support analysis, reflection, and research.
	MATH	6.EE.C.9 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. *For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time.* 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. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.
7-MS-LS1-7 From Molecules to Organisms: Structures and Processes	ELA	SL.7.5. Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

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.	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."* 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.
7-MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. RI.7.8 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. WHST.6-8.1 Write arguments focused on discipline-specific content. WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.
7-MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics	ELA	RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

Undertake a design project that assists in maintaining diversity and ecosystem services.		RST.6-8.8 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.
	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."* 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."* 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.
7-MS-LS3-2 Heredity: Inheritance and Variation of Traits Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of primary and secondary sources. RST.6-8.4 Determine the meaning of words and phrases as they are used in a text, including vocabulary specific to domains related to history/social studies. RST.6-8.7 Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts. SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize

		salient points.
	MATH	6.SP.B.5 Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations. b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement. c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range) as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.
7-MS-LS4-4 Biological Evolution: Unity and Diversity 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.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of primary and secondary sources. 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. WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
	MATH	6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."* 6.SP.B.5 Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations.

		b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement. c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range) as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered. 7.RP.A.2 Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as $t = pn$. d. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.
7-MS-LS4-5 Biological Evolution: Unity and Diversity Gather, read, and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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.

8th Grade

8-MS-PS1-1 Matter and Its Interactions Develop models to describe the atomic composition of simple molecules and extended structures.	ELA	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). SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.
	MATH	8.EE.A.3 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. *For example, estimate the population of the United States as 3 × 108 and the population of the world as 7 × 109, and determine that the world population is more than 20 times larger.*
8-MS-PS1-3 Matter and Its Interactions Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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.
8-MS-PS1-6 Matter and Its Interactions Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.	ELA	RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. 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.
8-MS-PS3-3 Energy Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.	ELA	RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. 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.

8-MS-PS3-5 Energy 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.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. WHST.6-8.1 Write arguments focused on discipline-specific content.
	MATH	7.RP.A.2 Recognize and represent proportional relationships between quantities. e. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. f. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. g. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as $t = pn$. h. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate. 8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; categorize functions as linear or nonlinear when given equations, graphs, or tables. *For example, the function* $A = s^2$ *giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.*
8-MS-ESS-1-4 Earth's Place in the Universe Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's geologic history.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
	MATH	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. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54

		cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.
8-MS-ESS-2-1 Earth's Systems Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.	ELA	SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.
8-MS-ESS2-2 Earth's System Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.
	MATH	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. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.

8-MS-ESS2-3 Earth's Systems Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). RST.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.
	MATH	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. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.
8-MS-ESS3-1 Earth and Human Activity 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.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.
	MATH	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. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently.

		Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.
8-MS-ESS3-2 Earth and Human Activity Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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).
	MATH	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. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.
8-MS-ESS3-3 Earth and Human Activity Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.	ELA	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. 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.
	MATH	7.RP.A.2 Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as $t = pn$. d. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and $(1, r)$ where r is the unit rate. 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. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.
8-MS-LS1-4 From Molecules to Organisms: Structures and Processes Construct and use argument(s) based on empirical evidence and scientific reasoning to support an explanation for	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. RST.6-8.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced. WHST.6-8.1 Write arguments focused on discipline-specific content.

how characteristic animal behaviors and specialized plant structures affect the probability of survival and successful reproduction of animals and plants respectively.		
	MATH	8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.
8-MS-LS1-5 From Molecules to Organisms: Structures and Processes Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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. WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.
	MATH	8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.
8-MS-LS3-1 Heredity: Inheritance and Variation of Traits 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.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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. 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). SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.
8-MS-LS4-1 Biological Evolution: Unity and Diversity Analyze and interpret data for patterns in the fossil	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually

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.		(e.g., in a flowchart, diagram, model, graph, or table).
8-MS-LS4-2 Biological Evolution: Unity and Diversity Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. SL.8.1 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, building on others' ideas and expressing their own clearly. 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.
8-MS-LS4-3 Biological Evolution: Unity and Diversity 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.	ELA	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. 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).
8-MS-LS4-6 Biological Evolution: Unity and Diversity Use mathematical representations to support explanations of how natural	MATH	7.RP.A.2 Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. b. Identify the constant of proportionality (unit rate) in tables,

selection may lead to increases and decreases of specific traits in populations of species over time.	graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as $t = pn$. d. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and $(1, r)$ where r is the unit rate.

Physical Science

HS-PS1-1 Matter and Its Interactions 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 and the composition of the nucleus of atoms.	ELA	RST.9-10.7 Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
HS-PS1-2 Matter and Its Interactions 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.	ELA	WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.5 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.
	MATH	A1: N-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. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS1-7 Matter and Its Interactions Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

HS-PS1-8 Matter and Its Interactions 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.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS2-1 Motion and Stability: Forces and Interactions 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.	ELA	RST.9-10.7 Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text. 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. 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. WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
	MATH	8. EE.C.7 Solve linear equations in one variable. a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a, a = a$, or $a = b$ results (where a and b are different numbers). b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms. 8. SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

8.F.B.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

A1: N-Q.A1 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.

A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.

a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.*

A1: A-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

a. Factor a quadratic expression to reveal the zeros of the function it defines.
b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
c. Use the properties of exponents to transform expressions for exponential functions emphasizing integer exponents. *For example, the growth of bacteria can be modeled by either* $f(t) = 3^{(t+2)}$ *or* $g(t) = 9(3^t)$ *because the expression* $3^{(t+2)}$ *can be rewritten as* $(3^t)(3^2) = 9(3^t)$.

A1: A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions.

A1: A-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*

A1: F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology

		for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima. b. Graph piecewise linear (to include absolute value) and exponential functions. A1: S-ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
HS-PS2-2 Motion and Stability: Forces and Interactions 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.	MATH	8. EE.C.7 Solve linear equations in one variable. A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A1: A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions. A1: A-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*
HS-PS2-3 Motion and Stability: Forces and Interactions Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.	ELA	WHST.11-12.7 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. 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. WHST.11-12.9 Draw evidence from informational texts to support

		analysis, reflection, and research.
HS-PS2-5 Motion and Stability: Forces and Interactions 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.	ELA	WHST.11-12.7 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. 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. WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS3-2 Energy 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 positions of particles/objects.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

HS-PS3-3 Energy Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	ELA	WHST.11-12.7 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-PS3-4 Energy 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).	ELA	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. WHST.11-12.7 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. 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. WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
HS-PS3-5 Energy 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.	ELA	WHST.11-12.7 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. 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. WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research. 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-PS4-1 Waves and Their Applications Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	ELA	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.
	MATH	8. EE.C.7 Solve linear equations in one variable. a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a, a = a$, or $a = b$ results (where a and b are different numbers). b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms. A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.* A1: A-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. c. Use the properties of exponents to transform expressions for exponential functions emphasizing integer exponents. *For example, the growth of bacteria can be modeled by either* $f(t) = 3^{(t+2)}$ *or* $g(t) = 9(3^t)$ *because the expression* $3^{(t+2)}$ *can be rewritten as* $(3^t)(3^2) = 9(3^t)$. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*
HS-PS4-4 Waves and Their Applications Evaluate the validity and reliability of claims in	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.1 Cite specific textual evidence to support analysis of

published materials regarding the effects that different frequencies of electromagnetic radiation have when absorbed by matter.	science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. 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. 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. 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.

Life Science

HS-LS1-1 From Molecules to Organisms: Structures and Processes 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.	ELA	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. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
HS-LS1-2 From Molecules to Organisms: Structures and Processes Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.	ELA	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-LS1-3 From Molecules to Organisms: Structures and Processes Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis in living organisms.	ELA	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. WHST.9-12.8 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-LS1-4 From Molecules to Organisms: Structures and Processes Use a model to illustrate the role of the cell cycle and differentiation in producing and maintaining complex organisms.	ELA	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.
	MATH	A1: F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima. b. Graph piecewise linear (to include absolute value) and exponential functions. A1: F-BF.A.1 Write a linear, quadratic, or exponential function that describes a relationship between two quantities.
HS-LS1-5 From Molecules to Organisms: Structures and Processes Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	ELA	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-LS1-6 From Molecules to Organisms: Structures and Processes 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.	ELA	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. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.5 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. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

HS-LS1-7 From Molecules to Organisms: Structures and Processes 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.	ELA	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-LS1-8 From Molecules to Organisms: Structures and Processes Obtain, evaluate, and communicate information about (1) viral and bacterial reproduction and adaptation, (2) the body's primary defenses against infection, and (3) how these features impact the design of effective treatment.	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.1 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. 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. 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. 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-LS2-1 Ecosystems: Interactions, Energy and Dynamics Use mathematical and/or computational representations to support	ELA	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. WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

explanations of factors that affect carrying capacity, biodiversity and populations of ecosystems at different scales.		
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-LS2-4 Ecosystems: Interactions, Energy and Dynamics Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-LS2-6 Ecosystems: Interactions, Energy and Dynamics Evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.1 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. 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. 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.
	MATH	A2: S-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. A2: S-IC.B.6 Evaluate reports based on data.

HS-LS2-7 Ecosystems: Interactions, Energy and Dynamics Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.7 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. 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. WHST.9-10.7 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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-LS3-1 Heredity: Inheritance and Variation of Traits Formulate, refine, and evaluate questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.	ELA	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. 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-LS3-2 Heredity: Inheritance and Variation of Traits	ELA	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.

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.		WHST.9-12.1 Write arguments focused on discipline-specific content.
HS-LS3-3 Heredity: Inheritance and Variation of Traits Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.		
HS-LS4-2 Biological Evolution: Unity and Diversity Construct an explanation based on evidence that biological diversity is influenced by (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.	ELA	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. WHST.9-12.1 Write arguments focused on discipline-specific content.
HS-LS4-3 Biological Evolution: Unity and Diversity Apply concepts of statistics	ELA	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.

and probability to support explanations that populations of organisms adapt when an advantageous heritable trait increases in proportion to organisms lacking this trait.		WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
HS-LS4-4 Biological Evolution: Unity and Diversity Construct an explanation based on evidence for how natural selection and other mechanisms lead to genetic changes in populations.	ELA	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. WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Chemistry

HS-PS1-1 Matter and Its Interactions 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 and the composition of the nucleus of atoms.	ELA	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-PS1-2 Matter and Its Interactions 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.	ELA	RST.9-10.7 Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes WHST.9-12.5 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.
	MATH	A1: N-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. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS1-3 Matter and Its Interactions Plan and conduct an investigation to gather evidence to compare the structure of substances at the macroscale to infer the strength of electrical forces between particles.	ELA	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. 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. 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. WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
	MATH	A1: N-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. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS1-4 Matter and Its Interactions 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.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS1-5 Matter and Its Interactions Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.	ELA	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. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
	MATH	A1: N-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.

		A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS1-6 Matter and Its Interactions Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.	ELA	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-PS1-7 Matter and Its Interactions Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS1-8 Matter and Its Interactions 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.	ELA MATH	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. A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS2-6 Motion and Stability: Forces and Interactions Communicate scientific	ELA	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. WHST.11-12.2 Write informative/explanatory texts, including the

and technical information about why the atomic-level, subatomic-level, and/or molecular level structure is important in the functioning of designed materials.		narration of historical events, scientific procedures/ experiments, or technical processes.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS3-1 Energy 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.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS3-3 Energy Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on

		measurement when reporting quantities.
HS-PS3-4 Energy 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).	ELA	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. 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. 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. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
HS-PS3-6 Energy Evaluate the validity and reliability of claims in published materials about the viability of nuclear power as a source of alternative energy relative to other forms of energy (e.g., fossil fuels, wind, solar, geothermal).	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.7 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. 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. 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.

Physics

HS-PS2-1 Motion and Stability: Forces and Interactions

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.

ELA

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.

RST.11-127 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.

WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

MATH

A1: N-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.

A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.

a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.*

A1: A-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

a. Factor a quadratic expression to reveal the zeros of the function it defines.
b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
c. Use the properties of exponents to transform expressions for exponential functions emphasizing integer exponents. *For example, the growth of bacteria can be modeled by either $f(t) = 3^{(t+2)}$ or $g(t) = 9(3^t)$ because the expression $3^{(t+2)}$ can be rewritten as $(3^t)(3^2) = 9(3^t)$.*

A1: A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions.

		A1: A-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.* A1: F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima. b. Graph piecewise linear (to include absolute value) and exponential functions. A1: S-D.B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
HS-PS2-2 Motion and Stability: Forces and Interactions 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.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A1: A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions. A1: A-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*
HS-PS2-3 Motion and Stability: Forces and Interactions Apply scientific and engineering ideas to design,	ELA	WHST.11-12.7 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.

evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.		
HS-PS2-4 Motion and Stability: Forces and Interactions Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.* A1: A-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. c. Use the properties of exponents to transform expressions for exponential functions emphasizing integer exponents. *For example, the growth of bacteria can be modeled by either $f(t) = 3^{(t+2)}$ or $g(t) = 9(3^t)$ because the expression $3^{(t+2)}$ can be rewritten as $(3^t)(3^2) = 9(3^t)$.*
HS-PS2-5 Motion and Stability: Forces and Interactions 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	ELA	WHST.11-12.7 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. 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

current.		overreliance on any one source and following a standard format for citation. WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS3-1 Energy 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.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS3-2 Energy 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 positions of particles (objects).	ELA	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-PS3-3 Energy Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-PS3-4 Energy 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).	ELA	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. 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. WHST.9-12.8 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. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
HS-PS3-5 Energy Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects	ELA	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. WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess

and the changes in energy of the objects due to the interaction.		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. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. 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-PS4-1 Waves and Their Applications in Technologies for Information Transfer Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	ELA	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.
	MATH	A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.* A1: A-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. c. Use the properties of exponents to transform expressions for exponential functions emphasizing integer exponents. *For example, the growth of bacteria can be modeled by either* $f(t) = 3^{(t+2)}$ *or* $g(t) = 9(3^t)$ *because the expression* $3^{(t+2)}$ *can be rewritten as* $(3^t)(3^2) = 9(3^t)$. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*
HS-PS4-3 Waves and Their Applications in Technologies for Information Transfer	ELA	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.

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.		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. 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.
	MATH	A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.* A1: A-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. c. Use the properties of exponents to transform expressions for exponential functions emphasizing integer exponents. *For example, the growth of bacteria can be modeled by either* $f(t) = 3^{(t+2)}$ *or* $g(t) = 9(3^t)$ *because the expression* $3^{(t+2)}$ *can be rewritten as* $(3^t)(3^2) = 9(3^t)$. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*

Earth and Space Science

HS-ESS1-1 Earth's Place in the Universe Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.	ELA	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. 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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.* A1: A-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*
HS-ESS1-2 Space Systems Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.	ELA	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. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.* A1: A-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*
HS-ESS1-3 Earth's Place in the Universe Communicate scientific ideas about the way stars, over their life cycle, produce elements.	ELA	WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. SL.11-12.4 Present information, findings, and supporting evidence, while respecting intellectual property; convey a clear and distinct perspective, such that listeners can follow the line of reasoning, address alternative or opposing perspectives, and use organization, development, substance, and style that are appropriate to purpose, audience, and a range of formal and informal tasks.
HS-ESS1-4 Earth's Place in the Universe Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

		A1: A-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.* A1: A-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A1: A-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*
HS-ESS1-5 Earth's Place in the Universe Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.	ELA	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. 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. WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS1-6 History of Earth Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an	ELA	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. 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

account of Earth's formation and early history.		information. WHST.9-12.1 Write arguments focused on discipline-specific content.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A1: F-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.* A1: S-ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. *Use given functions or choose a function suggested by the context. Emphasize linear and quadratic models.* b. Informally assess the fit of a function by plotting and analyzing residuals.
HS-ESS2-1 Earth's Systems Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

HS-ESS2-2 Earth's Systems Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.	ELA	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. 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.
	MATH	A1: N-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. A1: N-Q.A3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS2-3 Earth's Systems Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.	ELA	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. 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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS2-4 Earth's Systems Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems result in changes in atmosphere and climate.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS2-5 Earth's Systems Plan and conduct an investigation on the properties of water and its effects on Earth materials and surface processes.	ELA	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.
	MATH	A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS2-6 Earth's Systems Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS2-7 Earth's Systems Construct an argument based on evidence about the simultaneous coevolution of Earth systems and life on Earth.	ELA	WHST.A.1 Write arguments focused on discipline-specific content.
HS-ESS3-1 Human Sustainability Construct an explanation	ELA	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.

based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.		WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS3-2 Human Sustainability Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.		
HS-ESS3-3 Human Sustainability Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.		
HS-ESS3-4 Human Sustainability Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	ELA	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. 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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS3-5 Human Sustainability 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.	ELA	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. 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. 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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS3-6 Human Sustainability Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Environmental Science

HS-EVS1-1 Resources and Resource Management Analyze and interpret data to identify the factors that affect sustainable development and natural resource management in Louisiana.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-EVS1-2 Resources and Resource Management Obtain, evaluate and communicate information on the effectiveness of management or conservation practices for one of Louisiana's natural resources with respect to common considerations such as social, economic, technological, and influencing political factors over the past 50 years.	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.1 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. 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. 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. 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-EVS1-3 Resources and Resource Management	ELA	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

Analyze and interpret data about the consequences of environmental decisions to determine the risk-benefit values of actions and practices implemented for selected issues.		add interest.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-EVS2-1 Environmental Awareness and Protection Design and evaluate a solution to limit the introduction of non-point source pollution into state waterways.	ELA	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. 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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-EVS2-2 Environmental Awareness and Protection Use a model to predict the effects that pollution as a limiting factor has on an organism's population density.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-EVS2-3 Environmental Awareness and Protection	ELA	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

Use multiple lines of evidence to construct an argument addressing the negative impacts that introduced organisms have on Louisiana's native species.		scientific or technical problem. 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. 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. 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.
	MATH	A2: S-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. A2: S-IC.B.6 Evaluate reports based on data.
HS-EVS3-1 Personal Responsibilities Construct and evaluate arguments about the positive and negative consequences of using disposable resources versus reusable resources.	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.1 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. 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. 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. 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-ESS2-2 Earth's Systems Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.	ELA	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. 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.
	MATH	A1: N-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. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS2-4 Earth's Systems Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems result in changes in atmosphere and climate.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS2-5 Earth's Systems Plan and conduct an investigation on the properties of water and its effects on Earth materials and surface processes.	ELA	WHST.11-12.7 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.
	MATH	A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

HS-ESS2-6 Earth's Systems Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	ELA	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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS3-1 Human Sustainability 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.	ELA	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. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS3-2 Human Sustainability Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.	ELA	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. 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-ESS3-3 Human Sustainability Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.		
HS-ESS3-4 Human Sustainability Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	ELA	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. 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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-ESS3-6 Human Sustainability Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

HS-LS2-1 Ecosystems: Interactions, Energy and Dynamics Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity, biodiversity and populations of ecosystems at different scales.	ELA	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. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
	MATH	A1: N-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. A1: N-Q .A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q .A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-LS2-4 Ecosystems: Interactions, Energy and Dynamics Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HS-LS2-6 Ecosystems: Interactions, Energy and Dynamics Evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.1 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. 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. 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.
	MATH	A2: S-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. A2: S-IC.B.6 Evaluate reports based on data.
HS-LS2-7 Ecosystems: Interactions, Energy and Dynamics Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	ELA	RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.11-12.7 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. 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. 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.
	MATH	A1: N-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. A1: N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. A1: N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Appendix A: Learning Progression

Science and Engineering Practices

	K-2	3-5	Middle School	High School
1. Asking Questions and Defining Problems	Asking questions (science) and defining problems (engineering) in K-2 builds on prior experiences and progresses to simple descriptive questions that can be tested. Ask questions based on observations to find more information about the natural and or designed world(s). Ask and/or identify questions that can be answered by an investigation. Define a simple problem that can be solved through the development of a new or improved object or tool.	Asking questions (science) and defining problems (engineering) in 3-5 builds on K-2 experiences and progresses to specifying qualitative relationships. Ask questions about what would happen if a variable is changed. Identify scientific (testable) and non-scientific (nontestable) questions. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Use prior knowledge to describe problems that can be solved. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	Asking questions (science) and defining problems (engineering) in 6-8 builds on K-5 experiences and progresses to specifying relationships between variables, clarifying arguments and making models. Ask questions • that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. • to identify and/or clarify evidence and/or the premise(s) of an argument. • to determine relationships between independent and dependent variables and relationships in models. • to clarify and/or refine a model, an explanation, or an engineering problem. • that require sufficient and appropriate empirical evidence to answer. • that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. • that challenge the premise(s) of an argument or the interpretation of a data set. Define a problem 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.	Asking questions (science) and defining problems (engineering) in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. Ask questions • that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. • that arise from examining models or a theory, to clarify and/or seek additional information and relationships. • to determine relationships, including quantitative relationships, between independent and dependent variables. • to clarify and refine a model, an explanation, or an engineering problem. Evaluate a question to determine if it is testable and relevant. Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

	K-2	3-5	Middle School	High School
2. Developing and Using Models	Modeling in K-2 builds on prior experiences and progresses to include using and developing models (e.g., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. Distinguish between a model and the actual object, process, and/or events the model represents. Compare models to identify common features and differences. Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). Develop a simple model based on evidence to represent a proposed object or tool.	Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Identify limitations of models. Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequently and regularly occurring events. Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. Develop and/or use models to describe and/or predict phenomena. Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Evaluate limitations of a model for a proposed object or tool. Develop or modify a model— based on evidence – to match what happens if a variable or component of a system is changed. Use and/or develop a model of simple systems with uncertain and less predictable factors. Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. Develop and/or use a model to predict and/or describe phenomena. Develop a model to describe unobservable mechanisms. Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales	Modeling in 9-12 builds on K-8 experiences and progresses to synthesizing and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Evaluate merits and limitations of multiple models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria. Design a test of a model to ascertain its reliability. Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. Develop a complex model that allows for manipulation and testing of a proposed process or system. Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

	K-2	3-5	Middle School	High School
3. Planning and Carrying Out Investigations	Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. With guidance, plan and conduct an investigation in collaboration with peers (for K). Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question. Make observations and/or measurements to collect data that can be used to make comparisons. Make observations and/or measurements of a proposed object, tool, or solution to determine if it solves a problem or meets a goal. Make predictions based on prior experiences.	Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Evaluate appropriate methods and/or tools for collecting data. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Make predictions about what would happen if a variable changes. Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 solutions. Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. Evaluate the accuracy of various methods for collecting data. Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. Collect data about the performance of a proposed object, tool, process or system under a range of conditions.	Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 an investigation (science) or test a design (engineering) individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

	K-2	3-5	Middle School	High School
4. Analyzing and Interpreting Data	Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Record information (observations, thoughts, and ideas). Use and share pictures, drawings, and/or writings of observations. Use observations to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. Compare predictions (based on prior experiences) to what occurred (observable events). Analyze data from tests of an object or tool to determine if it works as intended.	Analyzing data in 3-5 builds on K-2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. Analyze data to refine a problem statement or the design of a proposed object, tool, or process. Use data to evaluate and refine design solutions.	Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. Distinguish between causal and correlational relationships in data. Analyze and interpret data to provide evidence for phenomena. Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials). Analyze and interpret data to determine similarities and differences in findings. Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.	Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. Apply concepts of statistics and probability (e.g., determining function fits to data, and correlation coefficient for linear or nonlinear fits) to scientific and engineering questions and problems, using digital tools when feasible. Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. Evaluate the impact of new data on a working explanation and/or model of a proposed process, product, or system. Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

	K-2	3-5	Middle School	High School
5. Using Mathematics and Computational Thinking	Mathematical and computational thinking in K-2 builds on prior experiences and progresses to recognizing that mathematics can be used to describe the natural and designed world(s). Decide when to use qualitative vs. quantitative data. Use counting and numbers to identify and describe patterns in the natural and designed world(s). Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs. Use quantitative data to compare two alternative solutions to a problem.	Mathematical and computational thinking in 3-5 builds on K-2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success. Organize simple data sets to reveal patterns that suggest relationships. Describe, measure, estimate, and/or graph quantities (e.g., area, volume, time) to address scientific and engineering questions and problems. Create and/or use graphs and/or charts generated from simple algorithm (computation) to compare alternative solutions to an engineering problem.	Mathematical and computational thinking in 6-8 builds on K-5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends. Use mathematical representations to describe and/or support scientific conclusions and design solutions. Create algorithms (a series of ordered steps) to solve a problem. Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems. Use digital tools and/or mathematical concepts and arguments to test and compare proposed solutions to an engineering design problem.	Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions (e.g. trigonometric, 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. Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. Apply techniques of algebra and functions to represent and solve scientific and engineering problems. Use simple limit cases to test mathematical expressions (e.g., computer programs, algorithms, or simulations) of a process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world. Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

	K-2	3-5	Middle School	High School
6. Constructing Explanations and Designing Solutions	Constructing explanations (science) and designing solutions (engineering) 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 to construct an evidence-based account for natural phenomena. Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. Generate and/or compare multiple solutions to a problem.	Constructing explanations (science) and designing solutions (engineering) in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. Identify the evidence that supports particular points in an explanation. Apply scientific ideas to solve design problems. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	Constructing explanations (science) and designing solutions (engineering) in 6–8 builds on K– 5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. Construct an explanation using models or representations. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion. Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system. Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and retesting.	Constructing explanations (science) and designing solutions (engineering) in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer reviews) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Apply scientific reasoning, theory, and/or models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion. Design, evaluate, and/or refine a solution to a complex real-world, problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

	K-2	3-5	Middle School	High School
7. 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). Identify arguments that are supported by evidence. Distinguish between explanations that account for all gathered evidence and those that do not. Analyze why some evidence is relevant to a scientific question and some is not. Distinguish between opinions and evidence in one's own explanations. Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument. Construct an argument with evidence to support a claim. Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Compare and refine arguments based on an evaluation of the evidence presented. Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation. Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions. Construct and/or support an argument with evidence, data, and/or a model. Use data to evaluate claims about cause and effect. Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints. Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, design limitations, constraints, and societal concerns. Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions. Construct, use, and/or present an oral and written argument or counterarguments based on data and evidence. Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

	K-2	3-5	Middle School	High School
8. 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 and/or technical information to determine patterns in and/or evidence about the natural and designed world(s). Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea. Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim. Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.	Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. Read and comprehend grade appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence. Compare and/or combine ideas across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices. Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices. Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s). Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings. Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts. Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Critically read scientific literature adapted for classroom use to determine central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information by presenting them in simpler but still accurate terms. Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, and mathematically).

Crosscutting Concepts

Crosscutting Concept	K-2	3-5	Middle School	High School
1. Patterns **Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.**	Patterns in the natural and human-designed world can be observed, used to describe phenomena, and used as evidence.	Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products. Patterns of change can be used to make predictions. Patterns can be used as evidence to support an explanation.	Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs, charts, and images can be used to identify patterns in data.	Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced, thus requiring improved investigations and experiments. Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system. Mathematical representations are needed to identify some patterns. Empirical evidence is needed to identify patterns.
2. Cause and Effect: Mechanism and Prediction **Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.**	Events have causes that generate observable patterns. Simple tests can be designed to gather evidence to support or refute student ideas about causes.	Cause and effect relationships are routinely identified, tested, and used to explain change. Events that occur together with regularity might or might not be a cause and effect relationship.	Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects.

Crosscutting Concept	K-2	3-5	Middle School	High School
3. Scale, Proportion, and Quantity **In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.**	Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; heavier and lighter; faster and slower). Standard units are used to measure length.	Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. Standard units are used to measure and describe physical quantities such as mass, time, temperature, and volume.	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. The observed function of natural and designed systems may change with scale. Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. Scientific relationships can be represented through the use of algebraic expressions and equations. Phenomena that can be observed at one scale may not be observable at another scale.	The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Patterns observable at one scale may not be observable or exist at other scales. Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
4. Systems and System Models **A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.**	Objects and organisms can be described in terms of their parts. Systems in the natural and designed world have parts that work together.	A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions.	Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study.	Systems can be designed to do specific tasks. When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flow—within and between systems at different scales.

Crosscutting Concept	K-2	3-5	Middle School	High School
				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.
5. Energy and Matter: Flows, Cycles, and Conservation **Tracking energy and matter flows, into, out of, and within systems helps one understand the system's behavior.**	Objects may break into smaller pieces, be put together into larger pieces, or change shapes.	Matter is made of particles. Matter flows and cycles can be tracked in terms of the mass of the substances before and after a process occurs. The total mass of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems. Energy can be transferred in various ways and between objects.	Matter is conserved because atoms are conserved in physical and chemical processes. Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. Energy may take different forms (e.g. energy in fields, thermal energy, and energy of motion). The transfer of energy can be tracked as energy flows through a natural or designed system.	The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
6. Structure and Function **The way an object is shaped or structured determines many of its properties and functions.**	The shape and stability of structures of natural and designed objects are related to their function(s).	Different materials have different substructures, which can sometimes be observed. Substructures have shapes and parts that serve functions.	Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and the connections of components to reveal their function and/or solve a problem. The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials.

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

Disciplinary Core Ideas: Physical Science - Matter and Its Interactions (PS1)

	K-2	3-5	6-8	High School
PS1.A: Structure and Properties of Matter	**Grade 2:** LE.PS1A.a Different properties are suited to different purposes. LE.PS1A.b A great variety of objects can be built up from a small set of pieces. LE.PS1A.c 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.	**Grade 5:** UE.PS1A.a Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including boiling water, the inflation and shape of a balloon and the effects of air on larger particles or objects. UE.PS1A.b The amount of mass in matter is conserved when it changes form, even in transitions in which it seems to vanish. UE.PS1A.c Measurements of a variety of properties can be used to identify materials.	**Grades 6 and 8:** MS.PS1A.a 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. **Grades 7 and 8:** MS.PS1A.b Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) under normal conditions that can be used to identify it. **Grade 7:** MS.PS1A.c Gases and liquids are made of molecules or inert atoms (the noble gases) that are moving about relative to each other. **Grade 7:** MS.PS1A.d In a liquid, the molecules are constantly in motion and in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. **Grades 6 and 8:** MS.PS1A.e Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).	HS.PS1A.a Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. HS.PS1A.b 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.PS1A.c The structure and interactions of matter at the macro scale are determined by electrical forces within and between atoms. HS.PS1A.d 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.

	K-2	3-5	6-8	High School
			Grade 7: MS.PS1A.f The changes of state that occur with variations in temperature or pressure can be described and predicted using temperature and pressure models of matter.	
PS1.B: Chemical Reactions	**Grade 2:** LE.PS1B.a Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.	**Grade 5:** UE.PS1B.a When two or more different substances are mixed, a new substance with different properties may be formed. UE.PS1.B.b No matter what reaction or change in properties occurs, the total mass of the substances does not change.	**Grades 7and 8:** MS.PS1B.a 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. **Grade 7:** MS.PS1B.b The total number of each type of atom is conserved, and thus the mass does not change. **Grade 8:** MS.PS1B.c Some chemical reactions release energy (exothermic reactions); others store energy (endothermic reactions).	HS.PS1B.a 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.PS1B.b 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.PS1B.c 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.
PS1.C: Nuclear Processes				HS.PS1C.a Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. HS.PS1C.b 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.

Disciplinary Core Ideas: Physical Science – Motion and Stability: Forces and Interactions (PS2)

	K-2	3-5	6-8	High School
PS2.A: Forces and Motion	**Kindergarten:** LE.PS2A.a Pushes and pulls can have different strengths and directions. LE.PS2A.b Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.	**Grade 3:** UE.PS2A.a 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. UE.PS2A.b Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Qualitative and conceptual, but not quantitative addition of forces are used at this level.) UE.PS2A.c 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. (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.)	**Grade 6:** MS.PS2A.a 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.PS2A.b 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 (acceleration). MS.PS2A.c 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.PS2A.d The motion of an object is dependent upon the reference frame of the observer. The reference frame must be shared when discussing the motion of an object.	HS.PS2.A.a Newton's second law accurately predicts changes in the motion of macroscopic objects. HS.PS2.A.b Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. HS.PS2.A.c 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.

	K-2	3-5	6-8	High School
PS2.B: Types of Interactions	**Kindergarten:** LE.PS2B.a When objects touch or collide, they push on one another and can change motion.	**Grade 3:** UE.PS2B.a Objects in contact exert forces on each other. UE.PS2B.b 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, their orientation relative to each other. **Grade 5:** UE.PS2B.c The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	**Grade 6:** MS.PS2B.a Electric and magnetic (electromagnetic) forces can be attractive (opposite charges) or repulsive (like charges), have polar charges (north and south poles), and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. MS.PS2B.b 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.PS2B.c 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).	HS.PS2B.a 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 objects not in physical contact. HS.PS2B.b Forces that act over a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. HS.PS2B.c Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Disciplinary Core Ideas: Physical Science – Energy (PS3)

	K-2	3-5	6-8	High School
PS3.A: Definitions of Energy		**Grade 4:** UE.PS3A.a The faster a given object is moving, the more energy it possesses. UE.PS.3A.b Energy can be moved from place to place by moving objects or through sound, light, or electric currents.	**Grade 6:** MS.PS.3A.a 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.PS.3A.b An object or a system of objects may also contain stored (potential) energy, depending on their relative positions. **Grade 7:** MS.PS.3A.c 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. **Grades 7 and 8:** MS.PS3A.d Temperature is a measure of the average kinetic energy; the relationship between the temperature and the total energy of the system depends on the types, states, and amounts of matter present.	HS.PS3A.a Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. There is a single quantity called energy. 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.PS3A.b At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. HS.PS3A.c 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.PS3A.d "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.

	K-2	3-5	6-8	High School
			Grade 7: MS.PS3A.e The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.	
PS3.B: Conservation of Energy and Energy Transfer	**Kindergarten:** LE.PS3B.a Sunlight warms Earth's surface.	**Grade 4:** UE.PS3B.a Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. UE.PS3B.b Light also transfers energy from place to place. UE.PS3B.c Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.	**Grade 8:** MS.PS3B.a When the kinetic energy of an object changes, there is inevitably some other change in energy at the same time. **Grade 7:** MS.PS3B.b The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the mass of the sample, and the environment. **Grades 7 and 8:** MS.PS3B.c Energy is spontaneously transferred out of hotter regions or objects and into colder ones.	HS.PS3B.a 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.PS3B.b Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. HS.PS3B.c Mathematical expressions allow the concept of conservation of energy to be used to predict and describe system behavior. These expressions 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 velocity. HS.PS3B.d The availability of energy limits what can occur in any system. HS.PS3B.e 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).

	K-2	3-5	6-8	High School
PS3.C: Relationship Between Energy and Forces	**Kindergarten:** LE.PS3C.a A bigger push or pull makes things speed up or slow down more quickly.	**Grade 4:** UE.PS3C.a When objects collide, the contact forces transfer energy so as to change the objects' motions.	**Grade 6:** MS.PS3C.a When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.	HS.PS3C.a When two objects interacting through a field change relative position, the energy stored in the field is changed.
PS3.D: Energy in Chemical Processes and Everyday Life		**Grade 4:** UE.PS3D.a The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. **Grade 5:** UE.PS3D.b 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).	**Grade 7:** MS.PS3D.a 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. 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.	HS.PS3D.a Although energy cannot be destroyed, it can be converted to other forms—for example, to thermal energy in the surrounding environment. HS.PS3D.b Solar cells are human-made devices that capture the sun's energy and produce electrical energy. HS.PS3D.c Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.

Disciplinary Core Ideas: Physical Science – Waves and their Applications (PS4)

	K-2	3-5	6-8	High School
PS4.A: Wave Properties	**Grade 1:** LE.PS4A.a Sound can make matter vibrate, and vibrating matter can make sound.	**Grade 4:** UE.PS4A.a 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; it does not move in the direction of the wave except when the water meets the beach. UE.PS4A.b Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Grade 6:** MS.PS4A.a A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. MS.PS4A.b A sound wave needs a medium through which it is transmitted.	HS.PS4A.a 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.PS4A.b 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. HS.PS4A.c Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.
PS4.B: Electromagnetic Radiation	**Grade 1:** LE.PS4B.a Objects can be seen if light is available to illuminate them or if they give off their own light. Some objects give off their own light. LE.PS4B.b Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.)	**Grade 4:** UE.PS4B.a An object can be seen when light reflected from its surface enters the eyes.	**Grade 6:** MS.PS4B.a When light shines on an object, it is reflected, absorbed, transmitted, or scattered through the object, depending on the object's material and the frequency (color) of the light. MS.PS4B.b 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 (refraction). MS.PS4B.c A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through a vacuum, it cannot be a mechanical wave, like sound or water waves.	HS.PS4B.a 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.PS4B.b 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.PS4B.c Photoelectric materials emit electrons when they absorb light of a high-enough frequency.

	K-2	3-5	6-8	High School
				HS.PS4B.d 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.
PS4.C: Information Technologies and Instrumentation	**Grade 1:** LE.PS4C.a People also use a variety of devices to communicate (send and receive information) over long distances.			

Disciplinary Core Ideas: Life Science – From Molecules to Organisms: Structures and Processes (LS1)

	K-2	3-5	6-8	High School
LS1.A Structure and Function	**Grade 1:** LE.LS1A.a 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.	**Grade 4:** UE.LS1A.a Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	**Grade 6:** MS.LS1A.a All living things are made up of cells, which are 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.LS1A.b Within cells, special structures (organelles) are responsible for particular functions. The cell membrane forms the boundary that controls the material(s) that enter and leave the cell in order to maintain homeostasis. **Grade 7:** MS.LS1A.c 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.	HS.LS1A.a Systems of specialized cells within organisms help them perform the essential functions of life. HS.1A.b 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.LS1A.c 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 the essential functions of life. HS.LS1A.d Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing the organism to remain alive and functional even as external conditions change within some range. Feedback mechanisms can promote (through positive feedback) or inhibit (through negative feedback) activities within an organism to maintain homeostasis.
LS1.B: Growth and Development of Organisms	**Grade 1:** LE.LS1B.a Adult plants and animals can have offspring. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.	**Grade 3:** UE.LS1B.a Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	**Grade 7:** MS.LS1B.a Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. MS.LS1B.b Cells divide through the processes of mitosis and meiosis. **Grade 8:** MS.LS1B.c Animals engage in characteristic behaviors that increase the odds of reproduction.	HS.LS1B.a in multicellular organisms the cell cycle is necessary for growth, maintenance and repair of multicellular organisms. Disruptions in the cell cycles of mitosis and meiosis can lead to diseases such as cancer. HS.LS1B.b The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells.

	K-2	3-5	6-8	High School
			MS.LS1B.d Plants (flowering and non-flowering) reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. MS.LS1B.e Genetic factors as well as local conditions affect the growth of the adult plant.	HS.LS1B.c Cellular division and differentiation (stem cell) produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.
LS1.C: Organization for Matter and Energy Flow in Organisms	**Kindergarten:** LE.LS1C.a All animals need food in order to live and grow. Animals obtain their food from plants or from other animals. Plants need water and light to live and grow.	**Grade 5:** UE.LS1C.a 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. UE.LS1C.b Plants acquire their material for growth chiefly from air and water.	**Grade 7:** MS.LS1C.a Plants, plant-like protists (including algae and phytoplankton), and other microorganisms use the energy from light, to make sugars (food) from carbon dioxide from the atmosphere and water from the environment through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. MS.LS1C.b Within individual organisms, food (energy) 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 through aerobic and anaerobic respiration. MS.LS1C.c Cellular respiration in plants and animals involves 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.	HS.LS1C.a The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. HS.LS1C.b 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.LS1C.c As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. HS.LS1C.d 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.

	K-2	3-5	6-8	High School
LS1.D: Information Processing	**Grade 1:** LE.LS1D.a 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.	**Grade 4:** UE.LS1D.a Different sense receptors are specialized for particular kinds of information, which then may be processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.	**Grade 7:** MS.LS1D.a 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.	
LS1.E Public Health				HS.LS1E.a Viruses are obligate intracellular parasites that replicate using a cell's protein expression mechanisms. HS.LS1E.b Vaccines provide immunity to certain viral infections by exposing the immune system to viral antigens before infection which decreases the immune system's response time. Some vaccines may require more than one dose. HS.LS1E.c Antibiotics are effective treatments against most bacterial infections. Some bacteria may develop resistance to these treatments. HS.LS1E.d Microorganisms can cause diseases and can provide beneficial services. Microorganisms live in a variety of environments as both parasites and free-living organisms. HS.LS1E.e Microorganisms can reproduce quickly.

Disciplinary Core Ideas: Life Science – Ecosystems: Interactions, Energy, and Dynamics (LS2)

	K-2	3-5	6-8	High School
LS2.A: Interdependent Relationships in Ecosystems	**Grade 2:** LE.LS2A.a Plants depend on water and light to grow. LE.LS2A.b Plants may depend on animals for pollination or to move their seeds around.	**Grade 5:** UE.LS2A.a 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. UE.LS2A.b Some organisms, such as fungi and bacteria, break down dead organisms and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. UE.LS2A.c 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. UE.LS2A.d Newly introduced species can damage the balance of an ecosystem.	**Grade 6:** MS.LS2A.a Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. MS.LS2A.b 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.LS2A.c Growth of organisms and population increases are limited by access to resources. MS.LS2A.d 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.	HS.LS2A.a 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 that affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem. Organisms would have 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.LS2A.b Human activity directly and indirectly affect biodiversity and ecosystem health (e.g., habitat fragmentation, introduction of nonnative or invasive species, overharvesting, pollution and climate change).
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems		**Grade 5:** UE.LS2B.a Matter cycles between the air and soil and among plants, animals, decomposers, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or	**Grade 6:** MS.LS2B.a Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem.	HS.LS2B.a Photosynthesis, chemosynthesis, aerobic and anaerobic respiration and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Environmental conditions restrict which and when reactions can occur.

	K-2	3-5	6-8	High School
		solid) back into the environment.	MS.LS2B.b Transfers of matter into and out of the physical environment occur at every level. MS.LS2B.c Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. MS.LS2B.d The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Geochemical cycles include carbon, nitrogen, and the water cycle.	HS.LS2B.b Energy is inefficiently transferred from one trophic level to another that affect the relative number of organisms that can be supported at each trophic level and necessitates a constant input of energy from sunlight or inorganic compounds from the environment. HS.LS2B.c Photosynthesis, cellular respiration, decomposition and combustion are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes.
LS2.C: Ecosystem Dynamics, Functioning, and Resilience		**Grade 3:** UE.LS2C.a 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.	**Grade 7:** MS.LS2C.a 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.LS2C.b 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.	HS.LS2C.a The dynamic 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 and may result in new ecosystems. HS.LS2C.b Ecosystems with a greater biodiversity tend to have a greater resistance and resilience to change. 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.

	K-2	3-5	6-8	High School
LS2.D: Social Interactions and Group Behavior		**Grade 3:** UE.LS2D.a 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.	**Grade 8:** MS.LS2D.a Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.	

Disciplinary Core Ideas: Life Science – Heredity: Inheritance and Variation of Traits (LS3)

	K-2	3-5	6-8	High School
LS3.A: Inheritance of Traits	**Grade 1:** LE.LS3A.a Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents.	**Grade 3:** UE.LS3A.a Many characteristics of organisms are inherited from their parents. UE.LS3A.b Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.	**Grade 8:** MS.LS3A.a Genes are located in the chromosomes of cells, with each chromosome pair containing two variants (alleles) 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. MS.LS3A.b Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. **Grade 7:** MS.LS3A.c Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.	HS.LS3A.a 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.
LS3.B: Variation of Traits	**Grade 1:** LE.LS3B.a Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.	**Grade 3:** UE.LS3B.a Different organisms vary in how they look and function because they have different inherited information. UE.LS3B.b The environment also affects the traits that an organism expresses.	**Grade 7:** MS.LS3B.a In sexually reproducing organisms, each parent contributes to 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.	HS.LS3B.a In sexual reproduction, chromosomes can sometimes swap sections or cross over 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.

	K-2	3-5	6-8	High School
			Grade 8: MS.LS3B.b 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.	HS.LS3B.b Mutations may occur due to errors during DNA replication and/or caused by environmental factors. In general, only mutations that occur in gametes (sperm and egg) can be passed to offspring. Genes have variations (alleles) that code for specific variants of a protein (or RNA), and therefore specific traits of an individual. HS.LS3B.c 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.

Disciplinary Core Ideas: Life Science – Biological Evolution: Unity and Diversity (LS4)

	K-2	3-5	6-8	High School
LS4.A: Evidence of Common Ancestry and Diversity		**Grade 3:** UE.LS4A.a Some kinds of plants and animals that once lived on Earth are no longer found anywhere. UE.LS4A.b Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	**Grade 8:** MS.LS4A.a 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.LS4A.b 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.LS4A.c Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.	HS.LS4A.a 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 observable anatomical and embryological evidence.
LS4.B: Natural Selection		**Grade 3:** UE.LS4B.a Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.	**Grade 7:** MS.LS4B.a Natural selection leads to the predominance of certain traits in a population and the suppression of others. MS.LS4B.b Genetic engineering techniques can manipulate the DNA within various organisms. Technology has changed the way humans influence the inheritance of desired traits in organisms. (e.g., selective breeding, gene modification, gene therapy, or other methods)	HS.LS4B.a Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population (e.g. mutations and sexual reproduction) and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. Natural selection leads to populations that have more individuals with behavioral, anatomical, and physiological adaptations.

	K-2	3-5	6-8	High School
				HS.LS4.B.c The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS.LS4B.c)
LS4.C: Adaptation		**Grade 3:** UE.LS4C.a For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	**Grade 8:** MS.LS4C.a 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.	HS.LS4C.a 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.LS4C.b Adaptation also means that the distribution of traits in a population can change when conditions change. HS.LS4C.c 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.LS4C.d 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.

	K-2	3-5	6-8	High School
LS4.D: Biodiversity and Humans	**Grade 2:** LE.LS4D.a There are many living things in any area, and they exist in different places on land, in water, and in air.	**Grade 3:** UE.LS4D.a Populations live in a variety of habitats, and change in those habitats affects the organisms living there.	**Grade 7:** MS.LS4D.a Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services on which humans rely.	DCI.LS.HS.4D.a Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Disciplinary Core Ideas: Earth and Space Science – Earth's Place in the Universe (ESS1)

	K-2	3-5	6-8	High School
ESS1.A: The Universe and Its Stars	**Grade 1:** LE.ESS1A.a Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.	**Grade 5:** UE.ESS1A.a 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.	**Grade 6:** MS.ESS1A.a 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.ESS1A.b Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.	HS.ESS1A.a All stars, such as our sun, are evolving. The star called Sol, our sun, will burn out over a lifespan of approximately 10 billion years. HS.ESS1A.b The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. HS.ESS1A.c 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.ESS1A.d 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.ESS1A.e Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.

	K-2	3-5	6-8	High School
ESS1.B: Earth and the Solar System	**Grade 1:** LE.ESS1B.a Seasonal patterns of sunrise and sunset can be observed, described, and predicted.	**Grade 5:** UE.ESS1B.a 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.	**Grade 6:** MS.ESS1B.a The solar system consists of the sun and a collection of objects, including planets, their natural satellite(s) (moons), comets, and asteroids that are held in orbit around the sun by its gravitational pull on them. MS.ESS1B.b 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.ESS1B.c The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.	HS.ESS1B.a 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.ESS1B.b 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 Earth. These phenomena cause a cycle of ice ages and other gradual climate changes.
ESS1.C: The History of Planet Earth	**Grade 2:** LE.ESS1C.a Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe.	**Grade 4:** UE.ESS1C.a Local, regional, and global patterns of rock formations reveal changes over time due to Earth's forces such as earthquakes and volcanoes. The presence and location of certain fossil types indicate the order in which rock layers were formed.	**Grade 8:** MS.ESS1C.a 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.ESS1C.b Scientists use data from radioactive dating techniques to estimate the age of Earth's materials. MS.ESS1C.c Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches.	HS.ESS1C.a 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- HS.ESS1C.b 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.ESS1C.c Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of

	K-2	3-5	6-8	High School
				years. Studying these objects can provide information about Earth's formation and early history.

Disciplinary Core Ideas: Earth and Space Science – Earth's Systems (ESS2)

	K-2	3-5	6-8	High School
ESS2.A: Earth Materials and Systems	**Grade 2:** LE.ESS2A.a Wind and water can change the shape of the land.	**Grade 4:** UE.ESS2A.a Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. **Grade 5:** UE.ESS2A.b 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.	**Grade 8:** MS.ESS2A.a All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. MS.ESS2A.b 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.	HS.ESS2A.a Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. HS.ESS2A.b Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a viscous mantle and solid crust. HS.ESS2A.c Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. HS.ESS2A.d 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, hydrosphere 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

	K-2	3-5	6-8	High School
ESS2.B: Plate Tectonics and Large-Scale System Interactions	**Grade 2:** LE.ESS2B.a Maps show where things are located. One can map the shapes and kinds of land and water in any area.	**Grade 4:** UE.ESS2B.a The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth.	**Grade 8:** MS.ESS2B.a 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.	HS.ESS2B.a Plate tectonics is the unifying theory that explains the past and current movements of rocks at Earth's surface and provides a framework for understanding its geologic history. HS.ESS2B.b Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. HS.ESS2B.c The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. HS.ESS2B.d Plate tectonics can be viewed as the surface expression of mantle convection.
ESS2.C: The Roles of Water in Earth's Surface Processes	**Grade 2:** LE.ESS2C.a Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.	**Grade 5:** UE.ESS2C.a 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. UE.ESS2C.b Liquid water can become the gas form of water (water vapor) and liquid water can become a solid as ice.	**Grade 7:** MS.ESS2C.a Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. MS.ESS2C.b 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.ESS2C.c Global movements of water and its changes in form are propelled by sunlight and gravity.	HS.ESS2C.a The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

	K-2	3-5	6-8	High School
			MS.ESS2C.d Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. **Grade 8:** MS.ESS2C.e Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.	
ESS2.D: Weather and Climate	**Kindergarten:** LE.ESS2D.a 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.	**Grade 3:** UE.ESS2D.a 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. UE.ESS2D.b Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.	**Grade 7:** MS.ESS2D.a 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. Because these patterns are so complex, weather can only be predicted probabilistically. MS.ESS2D.b 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.	HS.ESS2D.a The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere and land systems, and this energy's re-radiation into space. HS.ESS2D.b Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. HS.ESS2D.c Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. HS.ESS2D.d 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 ocean and biosphere.

	K-2	3-5	6-8	High School
ESS2.E: Biogeology	**Kindergarten:** LE.ESS2E.a Plants and animals can change their environment.	**Grade 4:** UE.ESS2E.a Living things affect the physical characteristics of their environment.	**Grade 6:** MS.ESS2E.a Living organisms interact with Earth materials resulting in changes of the Earth.	HS.ESS2E.a The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

Disciplinary Core Ideas: Earth and Space Science – Human Sustainability (ESS3)

	K-2	3-5	6-8	High School
ESS3.A: Natural Resources	**Kindergarten:** LE.ESS3A.a 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.	**Grade 4:** UE.ESS3A.a Energy and fuels (fossil fuels, wind energy, solar energy, hydroelectric energy) 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.	**Grade 8:** MS.ESS3A.a 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.	HS.ESS3A.a Resource availability has guided the development of human society. HS.ESS3A.b All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.
ESS3.B: Natural Hazards	**Kindergarten:** LE.ESS3B.a 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.	**Grades 3 and 4:** UE.ESS3B.a A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.	**Grade 8:** MS.ESS3B.a 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.	HS.ESS3B.a 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.
ESS3.C: Human Impacts on Earth Systems	**Kindergarten:** LE.ESS3C.a 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.	**Grade 5:** UE.ESS3C.a Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, and the atmosphere. But individuals and communities are doing things to help protect Earth's resources and environments.	**Grade 8:** MS.ESS3C.a Human activities, globally and locally, 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. **Grades 6 and 8:** MS.ESS3C.b Typically as human populations and per-capita	HS.ESS3C.a The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. HS.ESS3C.b Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

	K-2	3-5	6-8	High School
			consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.	
ESS3.D: Global Climate Change			**Grade 7:** MS.ESS3D.a 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. Addressing 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.	HS.ESS3D.a 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.ESS3D.b Important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities (e.g., through computer simulations and other discoveries satellite imagery).

Disciplinary Core Ideas: Environmental Science – Resources and Resource Management (EVS1)

	K-2	3-5	6-8	High School
EVS1A: Louisiana's Natural Resources			**Grade 7:** MS.EVS1A.a Renewable resources have the ability to self-maintain due to the processes of photosynthesis. **Grade 8:** MS.EVS1A.b Non-renewable resources such as our state's fossil fuels are vast but limited. **Grade 7**: MS.EVS1A.c Replenishable resources such as groundwater and oxygen are purified by the movement through Earth's cycles.	HS.EVS1A.a Ecosystem capital can be characterized as goods (removable products) and services such as the functions and values of wetlands.
EVS1B: Resource Management for Louisiana			**Grade 6:** MS.EVS1B.a Responsible management of Louisiana's natural resources promotes economic growth, a healthy environment, and vibrant productive ecosystems.	HS.EVS1B.a Population growth along with cultural and economic factors impact resource availability, distribution and use. HS.EVS1B.b Some changes to our natural environment such as the building of levees and hydrological modification have provided for economic and social development but have resulted in unintended negative impacts.

Disciplinary Core Ideas: Environmental Science – Environmental Awareness and Protection (EVS2)

	K-2	3-5	6-8	High School
EVS2A: Pollution and the Environment				HS.EVS2A.a Pollution includes both natural and man-made substances which occur at rates or levels which incur harm (i.e. combustion of fossil fuels, agricultural waste, and industrial byproducts). Pollution can be categorized as point-source pollution and non-point source pollution. HS.EVS2A.b Different organisms have unique tolerances to pollution hazards. Many of the organisms most tolerant of pollution are the least desirable to humans (e.g., for food, for recreation, for ecosystem services)
EVS2B: Ecosystem Change				HS.EVS2B.a The introduction of exotic/invasive species causes a disruption in natural ecosystems and can lead to the loss of native species (i.e. threatened/endangered) HS.EVS2B.b Changes to ecosystems impact the availability of natural resources. (e.g. sediment starvation, climate change)
EVS2C: Environmental Choices				HS.EVS2C.a Different approaches can be used to manage impacts to our environment. Generally speaking, we can change human activities to limit negative impacts. Alternately, we can use technologies that reduce impact or we can perform restoration work to recover natural functions and values. HS.EVS2C.b Trade-offs occur when we make environmental choices.

Disciplinary Core Ideas: Environmental Science – Personal Responsibilities (EVS3)

	K-2	3-5	6-8	High School
EVS3A: Stewardship				HS.EVS3A.a Ecosystem resilience can be used as a model for a sustainable society. (e.g. recycling, energy efficiency, diversity) HS.EVS3A.b Louisiana citizens are responsible for conserving our state's natural resources. Personal actions can have a positive or negative impact.

Disciplinary Core Ideas: Engineering, Technology and Application of Science – Engineering Design (ETS1)

	K-2	3-5	6-8	High School
ETS1.A: Defining and Delimiting Engineering Problems	**Kindergarten and Grade 1:** ETS.LE.1A.a A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. **Grade 2:** ETS.LE.1.A.b Asking questions, making observations, and gathering information are helpful in thinking about problems. ETS.LE.1.A.c Before beginning to design a solution, it is important to clearly understand the problem.	**Grade 3:** ETS.UE.1.A.a 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.	**Grade 8:** ETS.MS.1A.a 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 is likely to limit possible solutions. Consider constraints to include: materials or resources and limits of scientific knowledge.	ETS.HS.1A.a 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. ETS.HS.1A.b 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.
ETS1.B: Developing Possible Solutions	**Kindergarten, Grades 1 and 2:** ETS.LE.1B.a Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for solutions to a problem.	**Grade 3:** ETS.UE.1B.a 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. ETS.UE.1B.b 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. **Grade 5:**	**Grades 6 and 7:** ETS.MS.1B.a A solution needs to be tested, to prove the validity of the design and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions.	ETS.HS.1B.a 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. ETS.HS.1B.b 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.

	K-2	3-5	6-8	High School
		ETS.UE.1B.c Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. **Grade 4:** ETS.UE.1B.d Testing a solution involves investigating how well it performs under a range of likely conditions.		
ETS1.C: Optimizing the Design Solution	**Grades 1 and 2:** ETS.LE.1C.a Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	**Grade 4:** ETS.UE.1C.a Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	**Grade 8:** ETS.MS.1C.a 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. ETS.MS.1C.b 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.	ETS.HS.1C.a 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.

MATTER AND ITS INTERACTIONS

Performance Expectation	Develop models to describe the atomic composition of simple molecules and extended structures.
Clarification Statement	Emphasis is on developing models of molecules that vary in complexity. Examples of extended structures could include minerals such as but not limited to halite, agate, calcite, or sapphire. Examples of molecular-level models could include drawings, 3-D models, or computer representations showing different molecules with different types of atoms.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. **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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS.PS1A.a) Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS.PS1A.e)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
Clarification Statement	Emphasis is on natural resources that undergo a chemical process to form synthetic materials. These natural resources may or may not be pure substances. Examples of new materials could include new medicine, foods, or alternative fuels, and focus is on qualitative as opposed to quantitative information.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence **8. 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.	**STRUCTURE AND PROPERTIES OF MATTER** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) under normal conditions that can be used to identify it. (MS.PS1A.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.PS1B.a)	**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.

MATTER AND ITS INTERACTIONS

Performance Expectation	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
Clarification Statement	Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride, calcium chloride or a citric acid and baking soda (sodium bicarbonate) reaction in order to warm or cool an object.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations and designing solutions in 6–8 builds on K– 5 experiences and progresses to include designing solutions supported by multiple sources of evidence consistent with scientific ideas, 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CHEMICAL REACTIONS** Some chemical reactions release energy (exothermic reactions), others store energy (endothermic reactions). (MS.PS1B.c) **OPTIMIZING THE DESIGN SOLUTION** Although one design may not perform the best across all tests, identifying the characteristics of the design that performs 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.ETS 1.C.a)	**ENERGY AND MATTER: FLOWS, CYCLES, AND CONSERVATION** The transfer of energy can be tracked as energy flows through a designed or natural system.

ENERGY

Performance Expectation	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
Clarification Statement	Emphasis is on the ability to maximize or minimize thermal energy transfer as it relates to devices used when an area loses electricity after a natural disaster. Examples of devices could include an insulated box or a solar cooker. Testing of the device relies on performance and not direct calculation of the total amount of thermal energy transferred.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations 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, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** Temperature is a measure of the average kinetic energy; the relationship between the temperature and the total energy of the system depends on the types, states, and amounts of matter present. (MS.PS3A.d) **CONSERVATION OF ENERGY AND ENERGY TRANSFER** Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS.PS3B.c) **DEFINING AND DELIMITING AN ENGINEERING PROBLEM** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.(MS.ETS1A.a) A solution needs to be tested,to prove the validity of the design and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions.(MS.ETS1B.a)	**ENERGY AND MATTER: FLOWS, CYCLES, AND CONSERVATION** The transfer of energy can be tracked as energy flows through a designed or natural system.

ENERGY

Performance Expectation	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 (i.e. mechanical, thermal, or other forms of energy) before and after the transfer in the form of temperature changes or motion of object. This does not include the quantification of the energy transferred in the system.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. 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, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. 8. Obtaining, evaluating, and communicating information	**CONSERVATION OF ENERGY AND ENERGY TRANSFER** When the kinetic energy of an object changes, there is inevitably some other change in energy at the same time. (MS.PS3B.a)	**ENERGY AND MATTER** Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's geologic history.
Clarification Statement	Emphasis is on analyses of rock formations and fossils they contain to establish relative ages of major events in Earth's history. Major events could include the formation of mountain chains and ocean basins, adaptation and extinction of particular living organisms, volcanic eruptions, periods of massive glaciation, and the development of watersheds and rivers through glaciation and water erosion. The events in Earth's history happened in the past continue today. Scientific explanations can include models.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS1C.a) Scientists use data from radioactive dating techniques to estimate the age of Earth's materials. (MS.ESS1C.b)	**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.

EARTH'S SYSTEMS

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. **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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH'S MATERIALS AND SYSTEMS** All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS.ESS2A.a)	**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, including the atomic scale.

EARTH'S SYSTEMS

Performance Expectation	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 a large mountain ranges) or small (such as rapid landslides on microscopic geochemical reactions), and how many geosciences processes usually behave gradually but are punctuated by catastrophic events (such as earthquakes, volcanoes, and meteor impacts). 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS2A.b) **THE ROLE 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.ESS2C.e)	**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.

EARTH'S SYSTEMS

Performance Expectation	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and sea floor 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).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence for phenomena. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE HISTORY OF PLANET EARTH** Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (MS.ESS1C.c) **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.ESS2B.a)	**PATTERNS** Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.

EARTH AND HUMAN ACTIVITY

Performance Expectation	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).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS3A.a) **LOUISIANA'S NATURAL RESOURCES** Non-renewable resources such as our state's fossil fuels are vast but limited. (MS.EVS1A.b)	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

EARTH AND HUMAN ACTIVITY

Performance Expectation	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
Clarification Statement	Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence for phenomena. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS3B.a)	**PATTERNS** Graphs, charts, and images can be used to identify patterns in data.

EARTH AND HUMAN ACTIVITY

Performance Expectation	Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.
Clarification Statement	Examples of the design process may 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 may 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).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations 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/or test a design of an object, tool, process or system. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**HUMAN IMPACTS ON EARTH'S SYSTEMS** Human activities, globally and locally, 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.ESS3C.a) 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.ESS3C.b) **DEVELOPING POSSIBLE SOLUTIONS** A solution needs to be tested to prove the validity of the design and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions. (ETS.MS.1B.a)	**CAUSE AND EFFECT** Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Construct and use argument(s) based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of survival and 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, or 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 or 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, or hard shells on nuts that squirrels bury.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. 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, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. 8. Obtaining, evaluating, and communicating information	**GROWTH AND DEVELOPMENT OF ORGANISMS** Animals engage in characteristic behaviors that increase the odds of reproduction. (MS.LS1B.c) Plants (flowering and non-flowering) reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS.LS1B.d) Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (MS.LS2D.a)	**CAUSE AND EFFECT** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	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, or fish growing larger in large ponds than they do in small ponds.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**GROWTH AND DEVELOPMENT OF ORGANISMS** Genetic factors as well as local conditions affect the growth of the adult plant. (MS.LS1B.e)	**CAUSE AND EFFECT** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Performance Expectation	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. Examples include radiation treated plants, genetically modified organisms (e.g. roundup resistant crops, bioluminescence), or mutations both harmful and beneficial.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**INHERITANCE OF TRAITS** Genes are located in the chromosomes of cells, with each chromosome pair containing two variants (alleles) 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. (MS.LS3A.a) 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.LS3A.b) **VARIATION OF TRAITS** 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.LS3B.b)	**STRUCTURE AND FUNCTION** Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. **Analyzing and interpreting data:** Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.LS4A.a)	**PATTERNS** Graphs, charts, and images can be used to identify patterns in data.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
Clarification Statement	Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EVIDENCE OF COMMON ANCESTRY AND DIVERSITY** 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.LS4A.b) Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS.LS4A.c)	**PATTERNS** Patterns can be used to identify cause and effect relationships.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EVIDENCE OF COMMON ANCESTRY AND DIVERSITY** 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.LS4A.b) Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS.LS4A.c)	**PATTERNS** Graphs, charts, and images can be used to identify patterns in data.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations of species 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. Students should be able to explain trends in data for the number of individuals with specific traits changing over time.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data **5. Using mathematics and computational thinking:** Mathematical and computational thinking in 6-8 builds on K-5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. • Use mathematical representations to describe and/or support scientific conclusions and design solutions. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ADAPTATION** Adaptation by natural selection acting over generations is one important process by which populations change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment tend to become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS.LS4C.a)	**CAUSE AND EFFECT** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

MATTER AND ITS INTERACTIONS

Performance Expectation	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
Clarification Statement	Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, or mixing zinc with hydrogen chloride. Examples of chemical and physical properties to analyze include density, melting point, boiling point, solubility, flammability, or odor.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) under normal conditions that can be used to identify it. (MS.PS1A.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.PS1B.a)	**PATTERNS** Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

MATTER AND ITS INTERACTIONS

Performance Expectation	Develop a model that predicts and describes changes in particle motion, temperature, and the state of a pure substance when thermal energy is added or removed.
Clarification Statement	Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings or diagrams. Examples of particles could include molecules or inert atoms such as the noble gases. Examples of pure substances could include water, carbon dioxide, or helium.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Gases and liquids are made of molecules or inert atoms (the noble gases) that are moving about relative to each other. (MS.PS1A.c) In a liquid, the molecules are constantly in motion and in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS.PS1A.d) The changes of state that occur with variations in temperature or pressure can be described and predicted using temperature and pressure models of matter. (MS.PS1A.f) 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. (MS.PS.3A.c) The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (MS.PS3A.e)	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

MATTER AND ITS INTERACTIONS

Performance Expectation	Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
Clarification Statement	Emphasis is on the law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms. The use of atomic masses, balancing symbolic equations, or intermolecular forces is not the focus of this performance expectation.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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 unobservable mechanisms. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.PS1B.a) The total number of each type of atom is conserved, and thus the mass does not change. (MS.PS1B.b)	**ENERGY AND MATTER** Matter is conserved because atoms are conserved in physical and chemical processes.

ENERGY

Performance Expectation	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	Emphasis is on observing change in temperature as opposed to calculating total thermal energy transferred. 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. 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 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** Temperature is a measure of the average kinetic energy; the relationship between the temperature and the total energy of the system depends on the types, states, and amounts of matter present. (MS.PS3A.d) **CONSERVATION OF ENERGY AND ENERGY TRANSFER** The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the mass of the sample, and the environment. (MS.PS3B.b) Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS.PS3B.c)	**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.

EARTH'S SYSTEMS

Performance Expectation	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 and location as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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 unobservable mechanisms. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS2C.a) Global movements of water and its changes in form are propelled by sunlight and gravity. (MS.ESS2C.c) **LOUISIANA'S NATURAL RESOURCES** Replenishable resources such as groundwater and oxygen are purified by the movement through Earth's cycles. (MS.EVS1A.c)	**ENERGY AND MATTER** Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

EARTH'S SYSTEMS

Performance Expectation	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 condensation).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS2C.b) **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. Because these patterns are so complex, weather can only be predicted probabilistically. (MS.ESS2D.a)	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

EARTH'S SYSTEMS

Performance Expectation	Develop and use a model to describe how unequal heating and rotation of the Earth causes patterns of atmospheric and oceanic circulation that determine regional climates.
Clarification Statement	Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation (e.g. el niño/la niña) 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **Developing and using models:** 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. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES:** Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS.ESS2C.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. Because these patterns are so complex, weather can only be predicted probabilistically. (MS.ESS2D.a) 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.ESS2D.b)	**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.

EARTH AND HUMAN ACTIVITY

Performance Expectation	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.)

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in 6-8 builds on K-5 experiences and progresses to specifying relationships between variables, clarifying arguments and making models. • Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument. 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. Addressing 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.ESS3D.a)	**STABILITY AND CHANGE** Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Use an argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
Clarification Statement	Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems. Systems could include circulatory, excretory, digestive, respiratory, muscular, endocrine, or nervous systems.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. 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, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND FUNCTION** 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 in order to maintain homeostasis. (MS.LS1A.c) **INFORMATION PROCESSING** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS.LS1D.a)	**SYSTEMS AND SYSTEM MODELS** Systems may interact with other systems; they may have subsystems and be a part of larger complex systems.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Construct a scientific explanation based on evidence for the role of photosynthesis and cellular respiration 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS** Plants, plant-like protists (including algae and phytoplankton), and other microorganisms use the energy from light, to make sugars (food) from carbon dioxide from the atmosphere and water from the environment through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS.LS1C.a) 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. 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. (MS.PS3D.a) **LOUISIANA'S NATURAL RESOURCES** Renewable resources have the ability to self maintain due to the processes of photosynthesis. (MS.EVS1A.a)	**ENERGY AND MATTER** Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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 unobservable mechanisms. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS** Within individual organisms, food (energy) 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 through aerobic and anaerobic respiration. (MS.LS1C.b) Cellular respiration in plants and animals involves 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. (MS.LS1C.c)	**ENERGY AND MATTER** Matter is conserved because atoms are conserved in physical and chemical processes.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

Performance Expectation	Undertake a design project that assists in maintaining diversity and ecosystem services.
Clarification Statement	Examples of ecosystem services could include water purification, nutrient recycling, habitat conservation or soil erosion mitigation. Examples of design solution constraints could include scientific, economic, or social considerations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. • Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ECOSYSTEM DYNAMICS, FUNCTIONING, AND RESILIENCE** Biodiversity describes the variety of species found in Earth's terrestrial and aquatic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS.LS2C.b) **BIODIVERSITY AND HUMANS** Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services on which humans rely. (MS.LS4D.a) **ENGINEERING DESIGN: DEVELOPING POSSIBLE SOLUTIONS** A solution needs to be tested to prove the validity of the design and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions (MS.ETS1B.a)	**STABILITY AND CHANGE** Small changes in one part of a system might cause large changes in another part.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

Performance Expectation	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
Clarification Statement	Emphasis is on recognizing patterns in data, making inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. 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, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. 8. Obtaining, evaluating, and communicating information	**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.LS2C.a)	**STABILITY AND CHANGE** Small changes in one part of a system might cause large changes in another part.

HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Performance Expectation	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
Clarification Statement	Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**GROWTH AND DEVELOPMENT OF ORGANISMS** Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (MS.LS1B.a) Cells divide through the processes of mitosis and meiosis. (LS.MS.1B.b) **INHERITANCE OF TRAITS** Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS.LS3A.d) In sexually reproducing organisms, each parent contributes to 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.LS3B.a)	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	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 about why some traits are suppressed and other traits become more prevalent for those individuals better at finding food, shelter, or avoiding predators.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. **Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL SELECTION** Natural selection leads to the predominance of certain traits in a population and the suppression of others. (MS.LS4B.a)	**CAUSE AND EFFECT** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Gather, read, and synthesize information about 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence **8. 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.	**NATURAL SELECTION** Genetic engineering techniques can manipulate the DNA within various organisms. Technology has changed the way humans influence the inheritance of desired traits in organisms. (e.g., selective breeding, gene modification, gene therapy, or other methods) (MS.LS4B.b)	**CAUSE AND EFFECT** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

MATTER AND ITS INTERACTIONS

Performance Expectation	Develop models to describe the atomic composition of simple molecules and extended structures.
Clarification Statement	Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include carbon dioxide and water. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3-D models, or computer representations showing different molecules with different types of atoms.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. Developing and using models:** Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS.PS1.A.a) Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS.PS1A.e)	**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.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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 reducing the effects of impact of two objects such as two cars hitting each other, an object hitting a stationary object, or a meteor hitting a spacecraft.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) in 6–8 builds on K–5 experiences and progresses to include designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.PS2A.a) **DEVELOPING POSSIBLE SOLUTIONS** A solution needs to be tested,to prove the validity of the design and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions (MS.ETS1B.a)	**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.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
Clarification Statement	Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law) in one dimension to a given frame of reference, or specification of units.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing Solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** 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 (acceleration) (MS.PS2A.b) 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.PS2A.c) The motion of an object is dependent upon the reference frame of the observer. The reference frame must be shared when discussing the motion of an object. (MS.PS2A.d)	**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, including atomic scales.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
Clarification Statement	Questions about data might require quantitative answers related to proportional reasoning and algebraic thinking. Examples of devices that use electric and magnetic forces could include electromagnets. 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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and making models. • Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**TYPES OF INTERACTIONS** Electric and magnetic (electromagnetic) forces can be attractive (opposite charges) or repulsive (like charges), have polar charges (north and south poles) and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS.PS2B.a)	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
Clarification Statement	Examples of evidence for arguments could include data generated from simulations or digital tools and charts displaying mass, strength of interaction, distance from the Sun, or orbital periods of objects within the solar system, not necessarily including Newton's Law of Gravitation or Kepler's Laws.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. Engaging in argument from evidence:** Engaging in argument from evidence in 6–8 builds from 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, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. 8. Obtaining, evaluating, and communicating information	**TYPES OF INTERACTIONS** 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.PS2B.b)	**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.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
Clarification Statement	Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, or electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations designed to provide qualitative evidence for the existence of fields.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 solutions. • Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**TYPES OF INTERACTIONS** 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.PS2B.c)	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

ENERGY

Performance Expectation	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 as well as kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different masses of rocks downhill, or the impact of a wiffle ball versus a tennis ball.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.PS3A.a)	**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.

ENERGY

Performance Expectation	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, or a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, or written descriptions of systems.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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 unobservable mechanisms. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** An object or system of objects may also contain stored (potential) energy, depending on their relative positions. (MS.PS3A.b) **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.PS3C.a)	**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.

WAVES AND THEIR APPLICATIONS IN TECHNOLOGIES FOR INFORMATION TRANSFER

Performance Expectation	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 and how the frequency and wavelength change the expression of the wave.
Clarification Statement	Emphasis is on describing mechanical waves with both qualitative and quantitative thinking.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data **5. Using mathematics and computational thinking:** 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 describe and/or support scientific conclusions and design solutions. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**WAVE PROPERTIES** A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS.PS4A.a)	**PATTERNS** Graphs, charts, and images can be used to identify patterns in data.

WAVES AND THEIR APPLICATIONS IN TECHNOLOGIES FOR INFORMATION TRANSFER

Performance Expectation	Develop and use a model to describe that waves are refracted, reflected, absorbed, transmitted, or scattered through various materials.
Clarification Statement	Emphasis is on both light and mechanical waves interacting with various objects such as light striking a mirror or a water wave striking a jetty. Examples of models could include drawings, simulations, or written descriptions.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering) **2. 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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**WAVE PROPERTIES** A sound wave needs a medium through which it is transmitted. (MS.PS4A.b) **ELECTROMAGNETIC RADIATION** When light shines on an object, it is reflected, absorbed, transmitted, or scattered through the object, depending on the object's material and the frequency (color) of the light. (MS.PS4B.a) 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 (Refraction). (MS.PS4B.b) A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through a vacuum, it cannot be a mechanical wave, like sound or water waves. (MS.PS4B.c)	**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.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	Develop and use a model of the Earth-sun-moon system to describe the reoccurring patterns of lunar phases, eclipses of the sun and moon, and seasons.
Clarification Statement	Earth's rotation relative to the positions of the moon and sun describes the occurrence of tides; the revolution of Earth around the sun explains the annual cycle of the apparent movement of the constellations in the night sky; the moon's revolution around Earth explains the cycle of spring/neap tides and the occurrence of eclipses; the moon's elliptical orbit mostly explains the occurrence of total and annular eclipses. Examples of models can be physical, graphical, or conceptual.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.ESS1A.a) **EARTH AND THE SOLAR SYSTEM** 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.ESS1B.b)	**PATTERNS** Patterns can be used to identify cause and effect relationships.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	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 their school or state).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE UNIVERSE AND ITS STARS** Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS.ESS1A.b) **EARTH AND THE SOLAR SYSTEM** The solar system consists of the sun and a collection of objects, including planets, their natural satellite(s) (moons), and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS.ESS1B.a) The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS.ESS1B.c)	**SYSTEMS AND MODELS** Models (e.g., physical, mathematical, computer models) can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	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), atmospheric composition, surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH AND THE SOLAR SYSTEM** The solar system consists of the sun and a collection of objects, including planets, their natural satellite(s) (moons), comets, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS.ESS1B.a)	**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.

EARTH AND HUMAN ACTIVITY

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. 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, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. 8. Obtaining, evaluating, and communicating information	**HUMAN IMPACTS ON EARTH SYSTEMS** 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.ESS3C.b) **BIOGEOLOGY** Living organisms interact with Earth materials resulting in changes of the Earth. (MS.ESS2E.a) **RESOURCE MANAGEMENT FOR LOUISIANA** Responsible management of Louisiana's natural resources promotes economic growth, a healthy environment, and vibrant productive ecosystems. (MS.EVS1B.a)	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Conduct an investigation to provide evidence that living things are made of cells, either one or many different numbers and types.
Clarification Statement	Emphasis is on developing evidence that living things are made of cells, distinguishing between living and nonliving things, and understanding that living things may be made of one or many cells, including specialized cells. Examples could include animal cells (blood, muscle, skin, nerve, bone, or reproductive) or plant cells (root, leaf, or reproductive).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 solutions. • Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND FUNCTION** All living things are made up of cells, which are the smallest living unit. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS.LS1A.a)	**SCALE, PROPORTION, AND QUANTITY** Phenomena that can be observed at one scale may not be observable at another scale.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
Clarification Statement	Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, such as the nucleus, chloroplasts, mitochondria, cell membrane, or cell wall.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND FUNCTION** Within cells, special structures (organelles) are responsible for particular functions. The cell membrane forms the boundary that controls the material(s) that enter and leave the cells in order to maintain homeostasis. (MS.LS1A.b)	**STRUCTURE AND FUNCTION** Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

Performance Expectation	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
Clarification Statement	Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant or scarce resources.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence for phenomena. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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.LS2A.a) 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.LS2A.b) Growth of organisms and population increases are limited by access to resources. (MS.LS2A.c)	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

Performance Expectation	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
Clarification Statement	Emphasis is on (1) predicting consistent patterns of interactions in different ecosystems and (2) relationships among and between biotic and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, mutually beneficial, or other symbiotic relationships.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) in 6–8 builds on K– 5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS** 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.LS2A.d)	**PATTERNS** Patterns can be used to identify cause and effect relationships.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

Performance Expectation	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
Clarification Statement	Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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/or use a model to predict and/or describe phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CYCLE OF MATTER AND ENERGY TRANSFER IN ECOSYSTEMS** Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. (MS.LS2B.a) Transfers of matter into and out of the physical environment occur at every level. (MS.LS2B.b) Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. (MS.LS2B.c) The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Geochemical cycles include carbon, nitrogen, and the water cycle. (MS.LS2B.d)	**ENERGY AND MATTER** The transfer of energy can be tracked as energy flows through a designed or natural system.

MATTER AND ITS INTERACTIONS

Performance Expectation	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, or evaporating salt water. Does not include atomic scale mechanism of evaporation and condensation or defining the unseen particles.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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 and/or use models to describe and/or predict phenomena. 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including boiling water, the inflation and shape of a balloon, and the effects of air on larger particles or objects. (UE.PS1A.a)	**SCALE, PROPORTION, AND QUANTITY** Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.

MATTER AND ITS INTERACTIONS

Performance Expectation	Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total amount of matter is conserved.
Clarification Statement	Examples of chemical changes includes reactions that produce new substances with new properties. Examples of physical changes could include phase changes, dissolving, or mixing.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data **5. 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, measure, estimate, and/or graph quantities (e.g., area, volume, time) to address scientific and engineering questions and problems. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** The amount of mass in matter is conserved when it changes form, even in transitions in which it seems to vanish. (UE.PS1A.b) **CHEMICAL REACTIONS** When two or more different substances are mixed, a new substance with different properties may be formed. (UE.PS1B.a) No matter what reaction or change in properties occurs, the total mass of the substances does not change. (UE.PS1B.b)	**ENERGY AND MATTER** Matter flows and cycles can be tracked in terms of mass of the substances before and after a process occurs. The total mass of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.

MATTER AND ITS INTERACTIONS

Performance Expectation	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, or liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, or solubility; density is not intended to be used as an identifiable property. No attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out Investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Measurements of a variety of properties can be used to identify materials. (UE.PS1A.c)	**SCALE, PROPORTION, AND QUANTITY** Standard units are used to measure and describe physical quantities such as mass, time, temperature, and volume.

MATTER AND ITS INTERACTIONS

Performance Expectation	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
Clarification Statement	Examples of interactions forming new substances can include mixing baking soda and vinegar. Examples of interactions not forming new substances can include mixing baking soda and water.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out Investigations:** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CHEMICAL REACTIONS** When two or more different substances are mixed, a new substance with different properties may be formed. (UE.PS1B.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	Support an argument that the gravitational force exerted by the Earth is directed down.
Clarification Statement	"Down" is a local description of the direction that points toward the center of the spherical Earth. Earth's mass causes objects to have a force on them that points toward the center of the Earth, "down". Support for arguments can be drawn from diagrams, evidence, and data that are provided. This does not include mathematical representation of gravitational force.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. Engaging in argument from evidence:** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s) • Construct and/or support an argument with evidence, data, and/or a model. 8. Obtaining, evaluating, and communicating information	**TYPES OF INTERACTIONS** The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (UE.PS2B.c)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

MATTER AND ENERGY IN ORGANISMS AND ECOSYSTEMS

Performance Expectation	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 or flowcharts.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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 and/or use models to describe and/or predict phenomena. 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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). (UE.PS3D.b) **ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS** Food provides animals with the materials they need for body repair and growth and energy they need to maintain body warmth and for motion. (UE.LS1C.a)	**ENERGY AND MATTER** Energy can be transferred in various ways and between objects.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Ask questions about how air and water affect the growth of plants.
Clarification Statement	Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil. The chemical processes of photosynthesis and cellular respiration are not addressed at this grade level.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in 3-5 builds on K-2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS** Plants acquire their material for growth chiefly from air and water. (UE.LS1C.b)	**ENERGY AND MATTER** Matter is transported into, out of, and within systems.

ECOSYSTEMS

Performance Expectation	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 of the Earth not including molecular explanations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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 and/or use models to describe and/or predict phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (UE.LS2A.a) Some organisms, such as fungi and bacteria, break down dead organisms and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. (UE.LS2A.b) 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. (UE.LS2A.c) Newly introduced species can damage the balance of an ecosystem. (UE.LS2A.d) **CYCLES OF MATTER AND ENERGY TRANSFER IN ECOSYSTEMS** Matter cycles between the air and soil and among plants, animals, decomposers, 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. (UE.LS2B.a)	**SYSTEMS AND SYSTEM MODELS** A system can be described in terms of its components and their interactions.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from the Earth.
Clarification Statement	Examples include the relative distances of the stars, but not the sizes. It does not include other factors that affect apparent brightness (such as stellar masses, age, stage).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. Engaging in argument from evidence:** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct and/or support an argument with evidence, data, and/or a model. 8. Obtaining, evaluating, and communicating information	**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. (UE.ESS1A.a)	**SCALE, PROPORTION, AND QUANTITY** Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	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	Patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months; not including the causes of the seasons.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**HISTORY OF PLANET EARTH** 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. (UE.ESS1B.a)	**PATTERNS** Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.

EARTH'S SYSTEMS

Performance Expectation	Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
Clarification Statement	Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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 and/or use models to describe and/or predict phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (UE.ESS2A.b)	**SYSTEMS AND SYSTEM MODELS** A system can be described in terms of its components and their interactions.

EARTH'S SYSTEMS

Performance Expectation	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.
Clarification Statement	Examples include oceans, lakes, rivers, glaciers, ground water, and polar ice caps.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. **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, measure, estimate, and/or graph quantities (e.g., area, volume, time) to address scientific and engineering questions and problems. 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (UE.ESS2C.a) Liquid water can become the gas form of water (water vapor) and liquid water can become a solid as ice. (UE.ESS2C.b)	**SCALE, PROPORTION, AND QUANTITY** Standard units are used to measure and describe physical quantities such as mass, time, temperature, and volume.

EARTH AND HUMAN ACTIVITY

Performance Expectation	Generate and compare multiple solutions about ways individual communities can use science to protect the Earth's resources and environment.
Clarification Statement	Examples of solutions can include cleanup of oil spills, protecting against coastal erosion, or prevention of polluted runoff into waterways.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations (science) and designing solutions (engineering) in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**HUMAN IMPACTS ON EARTH SYSTEMS** Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean and the atmosphere. But individuals and communities are doing things to help protect Earth's resources and environments. (UE.ESS3C.a) **DEVELOPING POSSIBLE SOLUTIONS** Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (ETS.UE.1B.c)	**SYSTEMS AND SYSTEM MODELS** A system can be described in terms of its components and their interactions.

ENERGY

Performance Expectation	Use evidence to construct an explanation relating the speed of an object to the energy of that object.
Clarification Statement	Relating the speed of an object to the energy of the object does not require calculation of the object's speed.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** The faster a given object is moving, the more energy it possesses. (UE.PS3A.a)	**ENERGY AND MATTER** Energy can be transferred in various ways and between objects.

ENERGY

Performance Expectation	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
Clarification Statement	When energy is transferred it may change forms such as when light from the sun warms a window pane.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out Investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (UE.PS3A.b) **CONSERVATION OF ENERGY AND ENERGY TRANSFER** Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (UE.PS3B.a) Light also transfers energy from place to place. (UE.PS3B.b) Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (UE.PS3B.c)	**ENERGY AND MATTER** Energy can be transferred in various ways and between objects.

ENERGY

Performance Expectation	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. Quantitative measurements of energy are not included.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**DEFINITIONS OF ENERGY** Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (UE.PS3A.b) **CONSERVATION OF ENERGY AND ENERGY TRANSFER** Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (UE.PS3B.a) **RELATIONSHIP BETWEEN ENERGY AND FORCES** When objects collide, the contact forces transfer energy so as to change the objects' motions. (UE.PS3C.a)	**ENERGY AND MATTER** Energy can be transferred in various ways and between objects.

ENERGY

Performance Expectation	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. Example of constraints could include the materials, cost, or time to design the device.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. • Apply scientific ideas to solve design problems. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CONSERVATION OF ENERGY AND ENERGY TRANSFER** Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (UE.PS3B.c) **ENERGY IN CHEMICAL PROCESSES AND EVERYDAY LIFE** The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (UE.PS3D.a) **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. (UE.ETS1C.a)	**ENERGY AND MATTER** Energy can be transferred in various ways and between objects.

WAVES AND THEIR APPLICATIONS IN TECHNOLOGIES FOR INFORMATION TRANSFER

Performance Expectation	Develop a model of waves to describe patterns in terms of amplitude and wavelength and to show that waves can cause objects to move.
Clarification Statement	Examples of models could include diagrams, analogies, or physical models using wire to illustrate wavelength and amplitude of waves. Examples of wave patterns could include the vibrating patterns associated with sound or the vibrating patterns of seismic waves produced by earthquakes. Does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. Developing and using models:** Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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; it does not move in the direction of the wave except when the water meets the beach. (UE.PS4A.a) Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (UE.PS4A.b)	**PATTERNS** Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.

WAVES AND THEIR APPLICATIONS IN TECHNOLOGIES FOR INFORMATION TRANSFER

Performance Expectation	Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
Clarification Statement	Develop a model to make sense of a phenomenon involving the relationship between light reflection and visibility of objects. In the model, identify the relevant components including light and its source, objects, the path that light follows, and the eye.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. 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 and/or use models to describe and/or predict phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ELECTROMAGNETIC RADIATION** An object can be seen when light reflected from its surface enters the eyes. (UE.PS4B.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

FROM MOLECULES TO ORGANISMS: STRUCTURE AND PROCESSES

Performance Expectation	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, shells, fur or skin.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. Engaging in argument from evidence:** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct and/or support an argument with evidence, data, and/or a model. 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND FUNCTION** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (UE.LS1A.a)	**SYSTEMS AND SYSTEM MODELS** A system can be described in terms of its components and their interactions.

FROM MOLECULES TO ORGANISMS: STRUCTURE AND PROCESSES

Performance Expectation	Construct an explanation to describe how animals receive different types of information through their senses, process the information in their brains, and respond to the information in different ways.
Clarification Statement	Emphasis is on systems of information transfer. Responses could include animals running from predators, animals returning to breeding grounds, animals scavenging for food, or humans responding to stimuli.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND FUNCTION** Different sense receptors are specialized for particular kinds of information, which then may be processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (UE.LS1D.a)	**CAUSE AND EFFECT** Events that occur together with regularity might or might not be a cause and effect relationship.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in landforms 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. Does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formation and layers.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE HISTORY OF PLANET EARTH** Local, regional, and global patterns of rock formations reveal changes over time due to Earth's forces such as earthquakes and volcanoes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (UE.ESS1C.a)	**PATTERNS** Patterns can be used as evidence to support an explanation.

EARTH'S SYSTEM

Performance Expectation	Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion.
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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH MATERIALS AND SYSTEMS** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (UE.ESS2A.a) **BIOGEOLOGY** Living things affect the physical characteristics of their environment. (UE.ESS2E.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

EARTH'S SYSTEM

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Analyze and interpret data to make sense of phenomena using logical reasoning. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**PLATE TECTONICS AND LARGE-SCALE SYSTEM INTERACTIONS** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth. (UE.ESS2B.a)	**PATTERNS** Patterns can be used as evidence to support an explanation.

EARTH'S SYSTEM

Performance Expectation	Ask questions that can be investigated and predict reasonable outcomes about how living things affect the physical characteristics of their environment.
Clarification Statement	Investigations include making observations in various habitats in real life or virtual circumstances. Living things could include animals such as beavers, crawfish, armadillos, nutria, gophers, and plants such as kudzu, water hyacinth, and Chinese tallow.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**BIOGEOLOGY** Living things affect the physical characteristics of their environment. (UE.ESS2E.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

EARTH AND HUMAN ACTIVITY

Performance Expectation	Obtain and combine information to describe that energy and fuels are derived from renewable and non-renewable resources and how their uses affect the environment.
Clarification Statement	Examples of renewable energy resources could include wind energy, hydroelectric energy, and solar energy; non-renewable energy resources are fossil fuels. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning fossil fuels.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence **8. 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.	**NATURAL RESOURCES** Energy and fuels (fossil fuels, wind energy, solar energy, hydroelectric energy) 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. (UE.ESS3A.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

EARTH AND HUMAN ACTIVITY

Performance Expectation	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
Clarification Statement	Examples of solutions could include designing flood, wind, or earthquake resistant structures and models to prevent soil erosion.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL HAZARDS** A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (UE.ESS3B.a) **DEVELOPING POSSIBLE SOLUTIONS TO ENGINEERING PROBLEMS** Testing a solution involves investigating how well it performs under a range of likely conditions. (UE.ETS1B.d)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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 an object that can make it start moving, or balanced forces pushing on an object from opposite sides will not produce any motion at all. Investigations include one variable at a time: number, size, or direction of forces.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (UE.PS2A.a) Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (UE.PS2A.b) **TYPES OF INTERACTIONS** Objects in contact exert forces on each other. (UE.PS2B.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
Clarification Statement	Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, or two children on a see-saw.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** 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. (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.) (UE.PS2A.c)	**PATTERNS** Patterns of change can be used to make predictions.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
Clarification Statement	Examples of an electric force could include the force on hair from an electrically charged balloon or 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 paper clips, or 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 the strength of the force or how the orientation of magnets affects the direction of the magnetic force. Examples could include forces produced by objects that can be manipulated by students, or electrical interactions could include static electricity.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations (for science) and designing solutions (for engineering) 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**TYPES OF INTERACTIONS** 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. (UE.PS2B.b)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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 or creating a device to keep two moving objects from touching each other.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations (for science) and designing solutions (for engineering) 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**TYPES OF INTERACTIONS** 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, their orientation relative to each other. (UE.PS2B.b) **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. (UE.ETS1A.a)	**PATTERNS** Patterns can be used as evidence to support an explanation.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	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 that organisms go through during their lives form a pattern. For plant life cycles there is an emphasis on flowering plants.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **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 and/or use models to describe and/or predict phenomena. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (UE.LS1B.a)	**PATTERNS** Patterns of change can be used to make predictions.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

Performance Expectation	Construct and support an argument that some animals form groups that help members survive.
Clarification Statement	Arguments could include examples of group behavior such as division of labor in a bee colony, flocks of birds staying together to confuse or intimidate predators, or wolves hunting in packs to more efficiently catch and kill prey.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. Engaging in argument from evidence:** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct and/or support an argument with evidence, data, and/or a model. 8. Obtaining, evaluating, and communicating information	**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. (UE.LS2D.a)	**SYSTEMS AND SYSTEM MODELS** A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Performance Expectation	Analyze and interpret data to provide evidence that plants and animals have traits inherited from their parents and that variation of these traits exists in a group of similar organisms.
Clarification Statement	Emphasis is on organisms other than humans and does not include genetic mechanisms of inheritance and prediction of traits. Data can include drawings, photographs, measurements, or written observations. Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**INHERITANCE OF TRAITS** Many characteristics of organisms are inherited from their parents. (UE.LS3A.a) **VARIATION OF TRAITS** Different organisms vary in how they look and function because they have different inherited information. (UE.LS3B.a)	**PATTERNS** Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.

HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Performance Expectation	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 or an animal that is given too much food and little exercise may become overweight.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**INHERITANCE OF TRAITS** Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (UE.LS3A.b) **VARIATION OF TRAITS** The environment also affects the traits that an organism expresses. (UE.LS3B.b)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	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 major fossil types such as marine fossils found on dry land, tropical plant fossils found in arctic areas, or fossils of extinct organisms and relative ages.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations. **4. Analyzing and interpreting data:** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EVIDENCE OF COMMON ANCESTRY AND DIVERSITY** Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (UE.LS4A.a) Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environment. (UE.LS4A.b)	**SCALE, PROPORTION, AND QUANTITY** Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	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 or animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**NATURAL SELECTION** Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (UE.LS4B.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	Construct and support 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 habitats make up a system in which the parts depend on each other.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **Engaging in argument from evidence:** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct and/or support an argument with evidence, data, and/or a model. 8. Obtaining, evaluating, and communicating information	**ADAPTATION** For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (UE.LS4C.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	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 change(s) could include changes in land characteristics, water distribution, temperature, food, and other biological communities. Louisiana specific examples could include impacts related to levees, dams, crop rotations, irrigation systems, hunting limits, diversion canals, or sea level rise.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **Engaging in argument from evidence:** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of a problem. 8. Obtaining, evaluating, and communicating information	**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. (UE.LS2C.a) **BIODIVERSITY AND HUMANS** Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (UE.LS4D.a) **DEVELOPING POSSIBLE SOLUTIONS** 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. (ETS.UE.1B.b)	**SYSTEMS AND SYSTEM MODELS** A system can be described in terms of its components and their interactions.

EARTH'S SYSTEMS

Performance Expectation	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. Examples of data representations could include pictographs and bar graphs.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (UE.ESS2D.a)	**PATTERNS** Patterns of change can be used to make predictions.

EARTH'S SYSTEMS

Performance Expectation	Obtain and combine information to describe climates in different regions around the world.
Clarification Statement	Information could include rainfall and temperature data.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence **8. 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.	**WEATHER AND CLIMATE** Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (UE.ESS2D.b)	**PATTERNS** Patterns of change can be used to make predictions.

EARTH AND HUMAN ACTIVITY

Performance Expectation	Make a claim about the merit of a design solution that reduces the impact of a weather-related hazard.
Clarification Statement	Examples of design solutions to weather-related hazards could include barriers to prevent flooding (including levees), wind-resistant roofs, tornado shelters and lightning rods.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **Engaging in argument from evidence:** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem 8. Obtaining, evaluating, and communicating information	**NATURAL HAZARDS** A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (UE.ESS3B.a) **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. (ETS.UE.1B.a)	**CAUSE AND EFFECT** Cause and effect relationships are routinely identified, tested, and used to explain change.

MATTER AND ITS INTERACTIONS

Performance Expectation	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, or flexibility. Patterns could include the similar properties that different materials share.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (LE.PS1A.c)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

MATTER AND ITS INTERACTIONS

Performance Expectation	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, or absorbency.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. 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. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Different properties are suited to different purposes. (LE.PS1A.a)	**CAUSE AND EFFECT** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

MATTER AND ITS INTERACTIONS

Performance Expectation	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. Provide students with the same number of objects to create a different object.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**STRUCTURE AND PROPERTIES OF MATTER** Different properties are suited to different purposes. (LE.PS1A.a) A great variety of objects can be built up from a small set of pieces. (LE.PS1A.b)	**ENERGY AND MATTER** Objects may break into smaller pieces, be put together into larger pieces, or change shapes.

MATTER AND ITS INTERACTIONS

Performance Expectation	Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
Clarification Statement	Demonstrations of reversible changes could include materials such as water, butter or crayons at different temperatures. Demonstrations of irreversible changes could include cooking an egg, freezing a plant leaf, or heating paper.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. **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. 8. Obtaining, evaluating, and communicating information	**CHEMICAL REACTIONS** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (LE.PS1B.a)	**CAUSE AND EFFECT** Events have causes that generate observable patterns.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

Performance Expectation	Plan and conduct an investigation to determine if plants need sunlight and water to grow.
Clarification Statement	Emphasis is on testing one variable at a time during investigations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing a solution 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS** Plants depend on water and light to grow. (LE.LS2A.a)	**CAUSE AND EFFECT** Events have causes that generate observable patterns.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

Performance Expectation	Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
Clarification Statement	Students could use the model to describe: (1) How the structure of the model gives rise to its function. (2) Structure-function relationships in the natural world that allow some animals to disperse seeds or pollinate plants.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **2. Developing and using models:** Modeling in K–2 builds on prior experiences and progresses to include using and developing models (e.g., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions. • Develop a simple model based on evidence to represent a proposed object or tool. 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS** Plants may depend on animals for pollination or to move their seeds around. (LE.LS2A.b)	**STRUCTURE AND FUNCTION** The shape and stability of structures of natural and designed objects are related to their function(s).

BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectation	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. Students could explore different habitats in the community (e.g., school, aquariums, and neighborhoods).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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 and/or measurements to collect data that can be used to make comparisons. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**BIODIVERSITY AND HUMANS** There are many kinds of living things in any area, and they exist in different places on land, in water, and in air. (LE.LS4D.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence **8. 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. • Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.	**THE HISTORY OF PLANET EARTH** Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (LE.ESS1C.a) **DEFINING AND DELIMITING ENGINEERING PROBLEMS** Asking questions, making observations, and gathering information are helpful in thinking about problems. (ETS.LE.1A.b)	**STABILITY AND CHANGE** Things may change slowly or rapidly.

EARTH'S SYSTEMS

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. • Generate and/or compare multiple solutions to a problem. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH MATERIALS AND SYSTEMS** Wind and water can change the shape of the land. (LE.ESS2A.a) **OPTIMIZING THE DESIGN SOLUTION** Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (LE.ETS1C.a)	**STABILITY AND CHANGE** Things may change slowly or rapidly.

EARTH'S SYSTEMS

Performance Expectation	Develop a model to represent the shapes and kinds of land and bodies of water in an area.
Clarification Statement	Models do not have to be to scale.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **Developing and using models:** Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions. • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**PLATE TECTONICS AND LARGE-SCALE SYSTEM INTERACTIONS** Maps show where things are located. One can map the shapes and kinds of land and water in any area. (LE.ESS2B.a) **DEVELOPING POSSIBLE SOLUTIONS** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for solutions to a problem. (ETS.LE.1B.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

EARTH'S SYSTEMS

Performance Expectation	Obtain and communicate information to identify where water is found on Earth and that it can be solid or liquid.
Clarification Statement	Students use reliable sources to identify the patterns of where water is found and its natural form (solid or liquid). Examples of how water can be found on Earth as water or ice could include a frozen pond, a liquid pond, a frozen lake, or a liquid lake.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence **8. 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. • Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.	**THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES** Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. (LE.ESS2C.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

WAVES AND THEIR APPLICATIONS

Performance Expectation	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 or plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound or holding an object near a vibrating tuning fork.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in K-2 build on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**WAVE PROPERTIES** Sound can make matter vibrate, and vibrating matter can make sound. (LE.PS4A.a)	**CAUSE AND EFFECT** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

WAVES AND THEIR APPLICATIONS

Performance Expectation	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, or 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. This can be explored with light tables, 3-way mirrors, overhead projectors or flashlights.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ELECTROMAGNETIC RADIATION** Objects can be seen if light is available to illuminate them or if they give off their own light. Some objects give off their own light. (LE.PS4B.a)	**CAUSE AND EFFECT** Events have causes that generate observable patterns.

WAVES AND THEIR APPLICATIONS

Performance Expectation	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), or reflective (such as a mirror).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ELECTROMAGNETIC RADIATION** Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.) (LE.PS4B.b)	**CAUSE AND EFFECT** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

WAVES AND THEIR APPLICATIONS

Performance Expectation	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," or a pattern of drumbeats.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**INFORMATION TECHNOLOGIES AND INSTRUMENTATION** People also use a variety of devices to communicate (send and receive information) over long distances. (LE.PS4C.a) **DEVELOPING POSSIBLE SOLUTIONS** A situation that people want to change or create can be approached as a problem to be solved through engineering. (LE.ETS1A.a)	**SYSTEMS AND SYSTEM MODELS** Systems in the natural and designed world have parts that work together.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Use tools and materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
Clarification Statement	Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells or animal scales; stabilizing structures by mimicking animal tails or roots on plants; keeping out intruders by mimicking thorns on branches or animal quills; and detecting intruders by mimicking eyes or ears.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (LE.LS1A.a) **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. (LE.LS1D.a) **DEVELOPING POSSIBLE SOLUTIONS** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for solutions to a problem. (LE.ETS1B.a) **OPTIMIZING THE DESIGN SOLUTION** Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (LE.ETS1C.a)	**STRUCTURE AND FUNCTION** The shape and stability of structures of natural and designed objects are related to their function(s).

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectation	Read grade-appropriate texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
Clarification Statement	Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. **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 and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).	**GROWTH AND DEVELOPMENT OF ORGANISMS** Adult plants and animals can have offspring. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (LE.LS1B.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Performance Expectation	Make observations to construct an evidence-based account that young plants and animals are similar, but not exactly like, their parents.
Clarification Statement	Examples of observations could include: leaves from the same kind of plant are similar in shape but can differ in size, or a particular breed of dog looks like its parents but is not exactly the same. Examples of patterns could include features that plants or animals share.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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 to construct an evidence-based account for natural phenomena. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (LE.LS3A.a) **VARIATION OF TRAITS** Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (LE.LS3B.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing and interpreting data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Use observations to describe patterns in the natural world in order to answer scientific questions. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**THE UNIVERSE AND ITS STARS** Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (LE.ESS1A.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

EARTH'S PLACE IN THE UNIVERSE

Performance Expectation	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, fall, or summer.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. Planning and carrying out investigations:** Planning and carrying out investigations to answer questions or test solutions to problems in K-2 build on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Make observations to collect data that can be used to make comparisons. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**EARTH AND THE SOLAR SYSTEM** Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (LE.ESS1B.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Louisiana Student Standards for Science

The Louisiana Student Standards for Science were created by over eighty content experts and educators with input from parents and teachers from across the state. Educators envisioned what students should know and be able to do to compete in our communities and created standards that would allow students to do so. The Louisiana Student Standards for Science provide appropriate content for all grades or courses, maintain high expectations and create a logical connection of content across and within grades.

The Louisiana Student Standards for Science represent the knowledge and skills needed for students to successfully transition to postsecondary educations and the workplace. The standards call for students to:

- Apply content knowledge
- Investigate, evaluate, and reason scientifically
- Connect ideas across disciplines

The Louisiana Student Standards do not dictate curriculum or teaching methods. Decisions about how to teach these expectations are left to local districts, schools, and teachers.

Structure and Components of the Standards

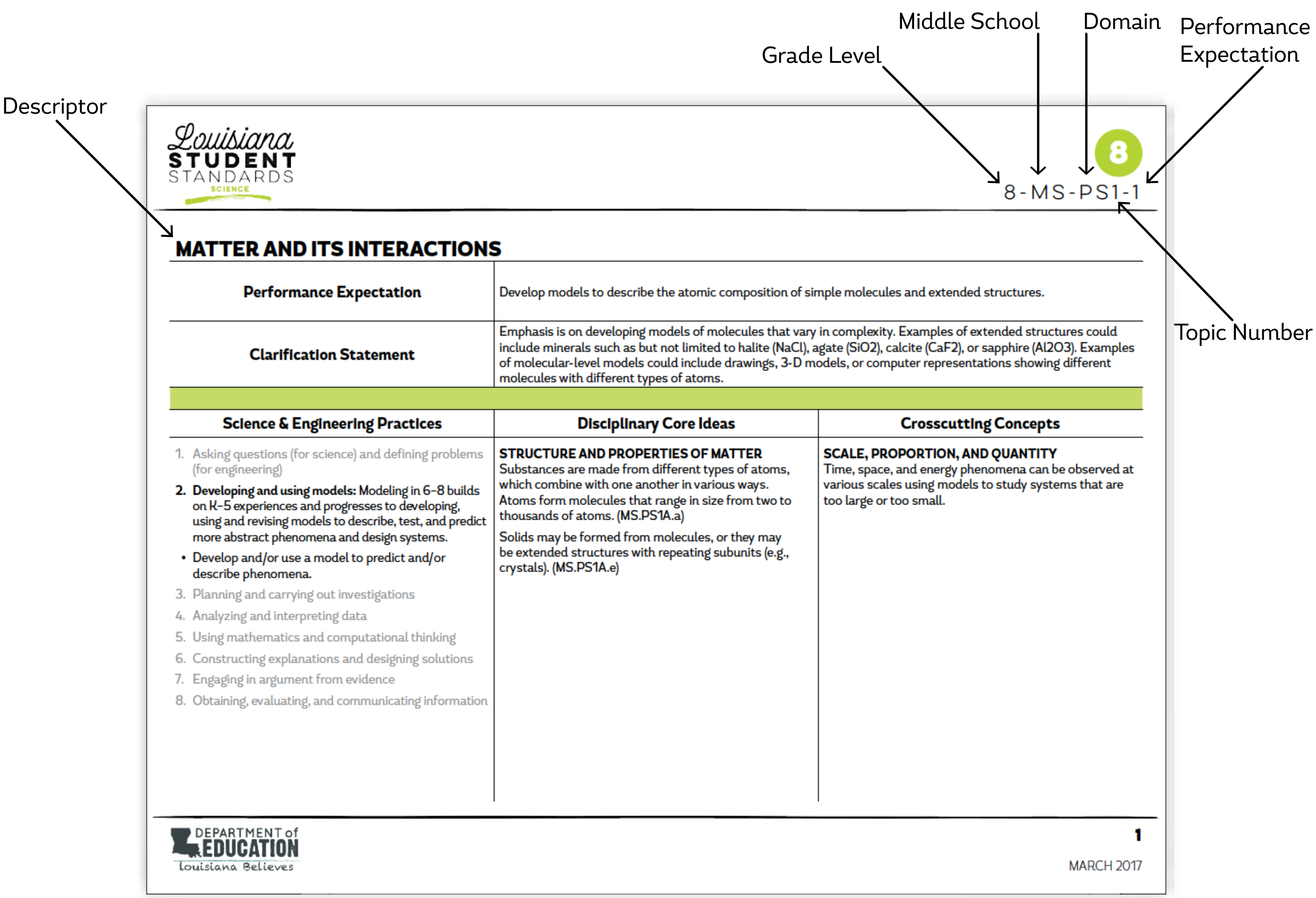
The Louisiana Student Standards for Science are arranged by grade levels for kindergarten through grade 8 and content areas for high school. The standards include:

- **Performance expectations** define what students should be able to do by the end of the year.
- **Science and engineering practices** are the practices that scientists and engineers use when investigating real world phenomena and designing solutions to problems. There are eight science and engineering practices that apply to all grade levels and content areas.
    1. Asking questions (science) and defining problems (engineering)
    2. Developing and using models
    3. Planning and carrying out investigations
    4. Analyzing and interpreting data
    5. Using mathematical and computational thinking
    6. Constructing explanations (science) and designing solutions (engineering)
    7. Engaging in argument with evidence
    8. Obtaining, evaluating, and communicating information
- **Disciplinary Core Ideas** describe the most essential ideas (content) in the major science disciplines that students will learn. Disciplinary Core Ideas are grouped into five science domains.
    1. Physical Science (PS)
    2. Life Science (LS)
    3. Earth and Space Science (ESS)
    4. Environmental Science (EVS)
    5. Engineering, Technology, and Applications of Science (ETS)
- **Crosscutting Concepts** are common themes that have application across all disciplines of science and allow students to connect learning within and across grade levels or content areas. The seven crosscutting concepts apply to all grade levels and content areas.
    1. Patterns
    2. Cause and effect
    3. Scale, proportion, and quantity
    4. Systems and System Models
    5. Energy and matter
    6. Structure and function
    7. Stability and change
- **Clarification statements** provide examples or additional explanation to the performance expectation.

Interpreting Standard Codes

Each performance expectation is identified by a code and descriptor. The coding is derived by the following formula: Grade level-Domain and Topic Number- Performance Expectation Number (space)

3-PS2-1 Motion and Stability: Forces and Interactions	The grade level is 3, the domain is Physical Science, the topic number is 2, and the performance expectation number is 1. The descriptor is, "Motion and Stability: Forces and Interactions."
7-MS-ESS2-4 Earth's Systems	The grade level is 7, the standard is middle school, the domain is Earth and Space Science, the topic number is 2, and the performance expectation is 4. The descriptor is, "Earth's Systems."
HS-LS1-1 From Molecules to Organisms: Structures and Processes	The standard is high school, the domain is Life Science, the topic number is 1, and the performance expectation number is 1. The descriptor is, "From Molecules to Organisms: Structures and Processes."



MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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, or two objects colliding and pushing on each other. Content includes contact forces with different relative strengths or different directions, but not both at the same time.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. **Planning and carrying out investigations:** Planning and carrying out investigations to answer questions (science) or test solutions (engineering) 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. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** Pushes and pulls can have different strengths and directions. (LE.PS2A.a) Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (LE.PS2A.b) **TYPES OF INTERACTIONS** When objects touch or collide, they push on one another and can change motion. (LE.PS2B.a) **RELATIONSHIP BETWEEN ENERGY AND FORCES** A bigger push or pull makes things speed up or slow down more quickly. (LE.PS3C.a)	**CAUSE AND EFFECT** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

MOTION AND STABILITY: FORCES AND INTERACTIONS

Performance Expectation	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, or knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object, a structure that would cause an object such as a marble or ball to turn or using a rope or string to pull an object. Content does not include friction as a mechanism for change in speed.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. **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. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**FORCES AND MOTION** Pushes and pulls can have different strengths and directions. (LE.PS2A.a) Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (LE.PS2A.b) **ENGINEERING DESIGN** A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (LE.ETS1A.a)	**CAUSE AND EFFECT** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

ENERGY

Performance Expectation	Make observations to determine the effect of sunlight on Earth's surface.
Clarification Statement	Sunlight heats Earth's natural surfaces including sand, soil, rocks, or water and the unnatural surfaces including man-made objects like plastics, asphalt, or concrete. Examples of observations could be relative changes in temperature of surfaces exposed to sunlight.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models **3. 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) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal. 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CONSERVATION OF ENERGY AND ENERGY TRANSFER** Sunlight warms Earth's surface. (LE.PS3B.a)	**CAUSE AND EFFECT** Events have causes that generate observable patterns.

ENERGY

Performance Expectation	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, or tents that minimize the warming effect of the sun.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions:** Constructing explanations (science) and designing solutions (engineering) 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/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**CONSERVATION OF ENERGY AND ENERGY TRANSFER** Sunlight warms Earth's surface. (LE.PS3B.a)	**CAUSE AND EFFECT** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSE

Performance Expectation	Use observations to describe patterns of what plants and animals (including humans) need to survive.
Clarification Statement	Examples of patterns could include that plants make their own food while animals do not, the different kinds of food needed by different types of animals, the requirement of plants to have light, or that all living things need water.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations **4. Analyzing and interpreting data:** Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Use observations to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS** All animals need food in order to live and grow. Animals obtain their food from plants or from other animals. Plants need water and light to live and grow. (LE.LS1C.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

EARTH'S SYSTEMS

Performance Expectation	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, or warm); examples of quantitative observations could include numbers of sunny, windy, or rainy days in a month. Examples of patterns could include that it is cooler in the morning than in the afternoon or the number of sunny days versus cloudy days in different months.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations **4. Analyzing and interpreting data:** Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Use observations to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**WEATHER AND CLIMATE** Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (LE.ESS2D.a)	**PATTERNS** Patterns in the natural and human designed world can be observed, used to describe phemonena, and used as evidence.

EARTH'S SYSTEMS

Performance Expectation	Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.
Clarification Statement	Examples of plants and animals changing their environment could include a squirrel digging in the ground to hide its food, tree roots breaking concrete, or a dandelion spreading seeds to generate more dandelions.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out Investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. 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. 8. Obtaining, evaluating, and communicating information	**BIOGEOLOGY** Plants and animals can change their environment. (LE.ESS2E.a) **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. (LE.ESS3C.a)	**SYSTEMS AND SYSTEM MODELS** Systems in the natural and designed world have parts that work together.

EARTH AND HUMAN ACTIVITY

Performance Expectation	Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.
Clarification Statement	Examples of relationships could include that deer eat buds and leaves and therefore usually live in forested areas; grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. **Developing and using models:** Modeling in K-2 builds on prior experiences and progresses to include using and developing models (e.g., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (LE.ESS3A.a)	**SYSTEMS AND SYSTEM MODELS** Systems in the natural and designed world have parts that work together.

EARTH AND HUMAN ACTIVITY

Performance Expectation	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 and safety precautions associated with that severe weather.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. **Asking questions and defining problems:** Asking questions (science) and defining problems (engineering) in K-2 builds on prior experiences and progresses to simple descriptive questions that can be tested. • Ask questions based on observations to find more information about the natural and/or designed world(s). 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**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. (LE.ESS3B.a)	**CAUSE AND EFFECT** Events have causes that generate observable patterns.

EARTH AND HUMAN ACTIVITY

Performance Expectation	Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
Clarification Statement	Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence **8. 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. • Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.	**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. (LE.ESS3C.a) **DEVELOPING POSSIBLE SOLUTIONS** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solution(s) to other people. (LE.ETS1B.a)	**CAUSE AND EFFECT** Events have causes that generate observable patterns.