Minnesota Academic Standards in Science – 2019

First Draft November 2018

Introduction

The First Draft of the Science Standards represents the work of the Science Standards review committee. This group of 36 includes K-12 teachers, administrators, college faculty, informal educators, and community members. The committee membership, timeline and assumptions that guide their work are found on the Minnesota Department of Education (MDE) Science webpage.

This draft of the standards represents a major shift in approach to standards and science learning, hence we suggest that you read the introductory material carefully, especially the foundational research.

We encourage you to provide feedback and comments about this draft of the standards via the online feedback survey from **November 9-26.** Town Hall meetings are scheduled at several locations across the state and via an online conference. These meetings provide background about the standards and provide an opportunity for input. The survey and the meeting schedule are posted at the above link.

The second draft of the standards will be published in February and the final draft will be available in May. The final draft will be available for planning purposes and the standards become law through the Minnesota rulemaking process. More information on the standards development process is at the Science webpage linked above.

Minnesota Statutes require that there be statements of standards and benchmarks. Standards are a summary description of student learning. The benchmarks identify the learning that is to be accomplished by all students by the end of each grade for K-8 and by the end of high school for the grade band 9-12.

Foundational Research influencing the Science Standards

The Assumptions for Guiding the Science Standards Committee's Work (Assumptions) direct that "the standards will be informed by *A Framework for K-12 Science Education*[1] (Framework) and include the dimensions of the scientific and engineering practices, crosscutting concepts, and disciplinary core ideas." The Framework document utilizes the research on science learning and instruction that has occurred in the past fifteen years to present a new vision for science standards. The *Framework for K-12 Science Education* is available as a free download at www.nap.edu. As you read the first draft, you will notice that the standards are based on Science and Engineering Practices and the benchmark statements integrate all three dimensions.

Dimension 1: Science and Engineering Practices

This dimension focuses on the important practices used by scientists and engineers which all students should learn to use with increasing sophistication over their years in school.

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

Dimension 2: Crosscutting Concepts

This dimension lists key concepts, or themes, which connect knowledge from the various disciplines of science and engineering into a coherent scientific view of the world.

1. Patterns
2. Cause and effect: mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: flows, cycles, and conservation
6. Structure and function
7. Stability and change

Dimension 3: Disciplinary Core ideas

This dimension includes the core ideas from the physical sciences, life sciences and earth and space sciences. Engineering, technology, and applications of science are included to provide an understanding of the built world.

Physical Sciences

PS 1: Matter and its interactions

PS 2: Motion and stability: Forces and interactions

PS 3: Energy

PS 4: Waves and their applications in technologies for information transfer

Life Sciences

LS 1: From molecules to organisms: Structures and processes

LS 2: Ecosystems: Interactions, energy, and dynamics

LS 3: Heredity: Inheritance and variation of traits

LS 4: Biological Evolution: Unity and diversity

Earth and Space Sciences

ESS 1: Earth's place in the universe

ESS 2: Earth's systems

ESS 3: Earth and human activity

Engineering, Technology, and the Applications of Science

ETS 1: Engineering design

ETS 2: Links among engineering, technology, science, and society

[1] Nation Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concept, and Core Ideas.* Washington DC. The National Academies Press.

Decisions by the Committee for the First Draft

1. The Career and College Readiness Statement will guide the writing of standards and benchmarks. This consideration led the committee to emphasize science and engineering skills, called practices in these standards.
2. Standards will be written as anchor standards (statements that span the K-12 grade range), and will be based on the Framework's Science and Engineering Practices. Where appropriate, separate anchor standards will be written for both the science and the engineering aspects of a practice.
3. Benchmarks will be written to reflect the integration of the three dimensions.
4. Benchmarks for grades K-5 will include core ideas from physical science, life science, and earth and space science at each grade.
5. Benchmarks for grades 6-8 will primarily have core ideas from physical science at grade 6, life science at grade 7, and earth and space science at grade 8.
6. Benchmarks for grades 9 – 12 will be organized by physics, chemistry, life science, and earth and space science.
7. The Standards Committee will delay, until the second draft, the full consideration of the following areas called for in the Assumptions:
    a. Contributions of Minnesota American Indian tribes and communities
    b. Technology and Information literacy Standards
    c. Computer science concepts and skills
    d. Environmental literacy
    e. Alignment with Minnesota Mathematics and ELA/literacy standards
    f. Full attention to issues of diversity and equity
    g. Balancing the specificity of the standards and benchmarks ("grain size")
8. The Standards Committee will plan to add the following to the benchmarks in later drafts: further clarifications, connections to local contexts, and/or examples. There will be additional benchmarks in some areas, especially chemistry and physics. The physics and chemistry benchmarks that are required of all students will be identified in later drafts.

    It is important to note that the standards and benchmarks do not direct or imply a particular combination of Practices, Crosscutting Concepts and Core Ideas that should be taught together. Instruction and curriculum about a core idea should utilize multiple practices and crosscutting concepts, which are woven together to help students understand the core idea and gain proficiency in engaging in practices and using the crosscutting concepts. It is likely that coherent curriculum units will target combinations of benchmarks, rather than single benchmarks.

Career and College Readiness Statement

Research[1] states that the majority of jobs and careers demand a set of skills whose foundation can be developed in the science classroom. Therefore, science instruction should provide students the skills that will prepare them for post-secondary education, potential careers, knowledge and appreciation of cultural diversity, and lifelong learning. These skills include communication, collaboration, critical thinking, creativity, adaptability,

resilience and problem solving, which should be learned along with the concepts and practices of science and engineering.

School systems should ensure that all students, regardless of geographic location, socioeconomic status, race, disability, gender, national origin, native language, and religion, have access to rigorous science instruction, and materials and equipment that are relevant to a student's environment and culture. Science education should cultivate broadly applicable knowledge and practices that will prepare students to be conscientious, informed, and productive members of society, able to make evidence-based decisions.

[1] Nation Research Council. (2012) A Framework for K-12 Science Education: Practices, Crosscutting Concept, and Core Ideas. Washington DC. The National Academies Press.

Reviewing the First Draft

In reviewing and providing feedback, the following questions should be kept in mind:

1. How well will the standards and benchmarks encourage improved science and engineering teaching and learning?
2. How well does the sequence of practices and core ideas from grade to grade provide student learning?
3. How well do the standards and benchmarks balance broadness and specificity, particularly in light of the Framework's goal to shift science education to greater coherence?

Standards

The eight practices are organized into four strands. Each practice has one or two anchor standards. When the practice has a strong component of engineering, the second standard conveys the engineering idea.

Code: Number = grade.strand.practice.standard.benchmark. For example. _.3.2.1_ = strand 3, practice 2, standard 1. Grade 9 means the grade band 9 – 12

* = related explicitly to engineering

Strand 1: Exploring phenomena or engineering problems

Practice 1: Asking questions and defining problems

Standard 1: _1.1.1_ Students will be able to ask questions of each other about the texts they read, the features of the phenomena they observe and the conclusions they draw.

Standard 2: _1.1.2._ Students will be able to ask questions to define the problem to be solved and to elicit ideas that lead to the constraints and specifications of its solution.*

Practice 3: Planning and carrying out investigations

Standard 1: _.1.3.1._ Students will design and conduct investigations and formulate questions based on observations, organizing and collecting data to make decisions from investigations in the classroom, school laboratory and/or field.

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

Practice 4. Analyzing and interpreting data

Standard 1: _.2.4.1._ Students will be able to represent observations and data in meaningful ways, including graphically and with mathematics that emphasize patterns in the data and relationships among variables in order for others to understand their evidence and their interpretations.

Practice 5. Using mathematics and computational thinking

Standard 1: _2.5.1_ Students will be able to use symbolic representations that can be used to represent data, to predict outcomes, and eventually derive further mathematical or algorithmic relationships that describe or model phenomena.

Strand 3: Developing possible explanations of phenomena or designing solutions to engineering problems

Practice 2. Developing and using models

Standard 1: _.3.2.1._ Students will be able to use diagrams, maps, and other abstract models as tools that enable them to elaborate on their own ideas or findings and present them to others.

Standard 2: _.3.2.2._ Students will be able to use models in engineering situations to identify problems, visualize and test solutions, and communicate about a design's features and effectiveness to others.*

Practice 6. Constructing explanations and designing solutions

Standard 1: _.3.6.1._ Students will be able to apply scientific principles and empirical evidence (primary or secondary) to construct causal explanations of phenomena or identify weaknesses in explanatory accounts developed by themselves or others.

Standard 2: _.3.6.2._ Students will be able to use their understanding of scientific principles and the engineering design process to either construct a device or implement a design solution that meets agreed-on criteria and constraints.*

Strand 4: Communicating reasons, arguments and ideas to others

Practice 7: Arguing from evidence

Standard 1: _.4.7.1._ Students will be able to use evidence to engage in argumentation to compare and evaluate competing ideas and methods, and to answer questions.

Standard 2: _.4.7.2._ Students will be able to use evidence in the process of constructing an argument necessary for advancing and defending a design solution.*

Practice 8: Obtaining, evaluating and communicating information

Standard 1: _.4.8.1._ Students will be able to use scientific resources, observations, evidence and analytical arguments to critically examine and evaluate claims and communicate critical thinking through discussion, and in writing.

Standard 2: _.4.8.2._ Students will be able to use appropriate combinations of sketches, modeling and language to communicate and critique proposed engineering design solutions.*

Benchmarks

Code: Number = grade.strand.practice.standard.benchmark. For example 5.4.3.2.1 = grade 5, strand 4, practice 3, standard 2, benchmark 1

The references in parentheses at the end of the benchmark refers to the dimensions on page 2-3. P = Practice, CC = Crosscutting Concept, CI = Core Idea,

* = a benchmark related to engineering

Kindergarten

Strand 1: Exploring phenomena or engineering problems

0.1.1.2.1 Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.* (P: 1, CC: 2, CI: ESS3,)

0.1.1.2.2 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.* (P: 1, CC: -, CI: ETS1)

0.1.3.1.1 Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. (P: 3, CC: 2, CI: PS2)

0.1.3.1.2 Make observations to determine the effect of sunlight on Earth's surface. (P: 3, CC 2, CI: PS3)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

0.2.4.1.1 Record and use observations to describe patterns of what plants and animals (including humans) need to survive. (P: 4, CC: 1, CI: LS1)

0.2.4.1.2 Record, use and share observations of local weather conditions to describe patterns over time. (P: 4, CC: 1, CI: ESS2)

0.2.4.2.1 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.* (P: 4, CC: 2, CI: PS2)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

0.3.2.1.1 Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live. (P: 2, CC: 4, CI: ESS3)

0.3.2.2.1 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.* (P: 2, CC: 6, CI: ETS1)

0.3.6.2.1 Use tools and materials provided to design and build a structure that will reduce the warming effect of sunlight on Earth's surface.* (P: 6, CC: 2, CI: PS3)

Strand 4: Communicating reasons, arguments and ideas to others

0.4.7.1.1 Construct an argument based on observational evidence for how plants and animals (including humans) can change the environment to meet their needs. (P: 7, CC: 4, CI: ESS2)

0.4.8.2.1 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.* (P: 8, CC: 2, CI: ESS3)

Grade 1

Strand 1: Exploring phenomena or engineering problems

1.1.3.1.1 Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. (P: 3, CC: 2, CI: PS4)

1.1.3.1.2 Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light. (P: 3, CC: 2, CI: PS4)

1.1.3.1.3 Make observations to make relative comparisons of the amount of daylight in the different times of year. (P: 3, CC: 1, CI:ESS1)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

1.2.4.1.1 Record and use observations of the sun, moon and stars to describe patterns that can be predicted (P: 4, CC: 2, CI: ESS1)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

1.3.6.1.1 Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated. (P: 6, CC: 2, CI: PS4)

1.3.6.1.2 Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. (P: 6, CC: 2, CI: LS3)

1.3.6.2.1 Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.* (P: 6, CC: -, CI: PS4)

1.3.6.2.2 Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* (P: 6, CC: 6, CI: LS1)

Strand 4: Communicating reasons, arguments and ideas to others

1.4.8.1.1 Read texts and use media to determine patterns in the behavior of parents and offspring that help offspring survive. (P: 8, CC: 1, CI: LS1)

Grade 2

Strand 1: Exploring phenomena or engineering problems

2.1.3.1.1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. (P: 3, CC:1, CI: PS1)

2.1.3.1.2 Plan and conduct an investigation to determine if plants need sunlight and water to grow. (P: 3, CC:2, CI: LS2)

2.1.3.1.3 Make observations of plants and animals to compare the diversity of life in different habitats. (P: 3, CC:-, CI: LS4)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

2.2.4.2.1 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for the intended purpose.* (P: 4, CC: 2, CI: ESS2)

2.2.4.2.2 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.* (P: 4, CC: -, CI: ETS1)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

2.3.2.1.1 Develop a model to represent the shapes and kinds of land and bodies of water in an area. (P: 2, CC: 1, CI: ESS2)

2.3.2.2.1 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.* (P: 2, CC: 6, CI: LS2)

2.3.6.1.1 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. (P: 6, CC: 5, CI: PS1)

2.3.6.1.2 Use information from several sources to provide evidence that Earth events can occur quickly or slowly. (P: 6, CC: 7, CI: ESS1)

2.3.6.2.1 Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.* (P: 6, CC: 7, CI: ESS2)

Strand 4: Communicating reasons, arguments and ideas to others

2.4.7.1.1 Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. (P: 7, CC: 2, CI: PS1)

2.4.8.1.1 Obtain and combine information to identify where water is found on Earth and that it can be solid or liquid. (P: 8, CC: 2, CI: ESS2)

Grade 3

Strand 1: Exploring phenomena or engineering problems

3.1.1.1.1: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. (P 1, CC 2, CI PS2)

3.1.1.2.1 Define a simple design problem that can be solved by applying scientific ideas about magnets.* (P: 1, CC: -, CI: PS2)

3.1.1.2.2 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.* (P: 1, CC: -, CI: ETS1)

3.1.3.1.1 Forces and Interactions: Plan and conduct an investigation to provide evidence of the effects of forces on the motion of an object. (P: 3, CC:2, CI: PS2)

3.1.3.1.2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. (P: 3, CC:1, CI: PS2)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

3.2.4.1.1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. (P: 4, CC: 1, CI: LS3)

3.2.4.1.2 Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. (P: 4, CC: 3, CI: LS4)

3.2.4.1.3 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. (P: 4, CC: 1, CI: ESS2)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

3.3.2.1.1 Construct multiple models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. (P: 2, CC: 1, CI: LS1)

3.3.6.1.1 Use evidence to support the explanation that traits can be influenced by the environment. (P: 6, CC: 2, CI: LS3)

3.3.6.1.2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. (P: 6, CC: 2. CI: LS4)

Strand 4: Communicating reasons, arguments and ideas to others

3.4.7.1.1 Construct an argument that some animals form groups that help members survive. (P: 7, CC: 2, CI: LS2)

3.4.7.1.2 Construct an argument with evidence that evaluates how in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. (P: 7, CC: 2, CI: LS4)

3.4.7.2.1 Using evidence, 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.* (3-5, 3) (P: 7, CC: 4, CI: LS2)

3.4.7.2.2 Using evidence, make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.* (3-5, 3) (P: 7, CC: 2, CI: ESS3)

3.4.8.1.1 Obtain and combine information to describe climates in different regions of the world. (P: 8, CC: 1, CI: ESS2)

Grade 4

Strand 1: Exploring phenomena or engineering problems

4.1.1.1.1 Ask questions and predict outcomes about the changes in energy, related to speed, that occur when objects interact. (P: 1, CC: 5, CI: PS3)

4.1.3.1.1 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (P: 3, CC: 5, CI: PS3)

4.1.3.1.2 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation. (P: 3, CC: 2, CI: ESS2)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

4.2.4.1.1 Analyze and interpret data from maps to describe patterns of Earth's features. (P: 4, CC: 1, CI: ESS2)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

4.3.2.1.1 Construct and evaluate a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. (P: 2, CC: 1, CI: PS4)

4.3.2.1.2 Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. (P: 2, CC: 2, CI: PS4)

4.3.2.1.3 Develop a model to represent the shapes and kinds of land and bodies of water in an area. (P: 2, CC: 1, CI: ESS2)

4.3.6.1.1 Use evidence to construct an explanation relating the speed of an object to the energy of that object. (P: 6, CC: 5, CI: PS3)

4.3.6.1.2 Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. (P: 6, CC: 1, CI: ESS1)

4.3.6.2.1 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* (P: 6, CC: 5, CI: PS3)

4.3.6.2.2 Generate and compare multiple solutions that use patterns to transfer information.* (P: 6, CC: 1, CI: PS4)

4.3.6.2.3 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.* (P: 6, CC: 2, CI: ESS3)

Strand 4: Communicating reasons, arguments and ideas to others

4.4.7.1.1 Using evidence, construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. (P: 7, CC: 4, CI: LS1)

4.4.8.1.1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. (P: 8, CC: 2, CI: ESS3)

Grade 5

Strand 1: Exploring phenomena or engineering problems

5.1.3.1.1 Make observations and measurements to identify materials based on their properties. (P: 3, CC: 3, CI: PS1)

5.1.3.1.1 Conduct an investigation to determine whether the mixing of two or more substances results in new substances. (P: 3, CC: 2, CI: PS1)

5.1.3.2.1 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.* (P: 3, CC: -, CI: ETS1)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

5.2.4.1.1 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. (P: 4, CC: 1, CI: ESS1)

5.2.5.1.1 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. (P: 5, CC: 3, CI: PS1)

5.2.5.1.2 Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. (P: 5, CC: 3, CI: ESS2)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

5.3.2.1.1 Construct and refine a model to describe that matter is made of particles too small to be seen. (P: 2, CC: 3, CI: PS1)

5.3.2.1.2 Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. (P: 2, CC: 5, CI: PS3)

5.3.2.1.3 Construct a model to predict the movement of matter among plants, animals, decomposers, and the environment. (P: 2, CC: 4, CI: LS2)

5.3.2.1.4 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. (P: 2, CC: 4, CI: ESS2)

5.3.6.2.1 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.* (P: 6, CC: 5, CI: ETS1)

Strand 4: Communicating reasons, arguments and ideas to others

5.4.7.1.1 Use evidence to support an argument that the gravitational force exerted by Earth on objects is directed down. (P: 7, CC: 2, CI: PS2)

5.4.7.1.2 Use observational evidence to support an argument that plants get the materials they need for growth chiefly from air and water. (P: 7, CC: 5, CI: LS1)

5.4.7.1.3 Use evidence to support an argument that the apparent brightness of the sun and stars is due to their relative distances from Earth. (P: 7, CC: 3, CI: ESS1)

5.4.8.1.1 Obtain and combine multiple sources of information about ways individual communities use science ideas to protect the Earth's resources and environment. (P: 8, CC: 4, CI: ESS3)

Grade 6

Strand 1: Exploring phenomena or engineering problems

6.1.1.1.1 Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. (P: 1, CC: 2, CI: PS2)

6.1.3.1.1 Plan an investigation to provide evidence that the change in an object's motion depends on the qualitative comparisons of balanced and unbalanced forces on the object and the mass of the object. (P: 3, CC: 7, CI: PS2)

6.1.3.1.2 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. (P: 3, CC: 2, CI: PS2)

6.1.3.1.3 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. (P: 3, CC: 3, CI: PS3)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

6.2.4.1.1 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. (P: 4, CC: 1, CI: PS1)

6.2.4.1.2 Construct and interpret graphical displays of data to describe the relationship of kinetic energy to the mass of an object and to the speed of an object. (P: 4, CC: 3, CI: PS3)

6.2.5.1.2 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. (P: 5, CC: 1, CI: PS4)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

6.3.2.1.1 Develop models to describe the atomic composition of simple molecules and extended structures. (P: 2, CC: 3, CI: PS1)

6.3.2.1.2 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. (P: 2, CC: 2, CI: PS1)

6.3.2.1.3 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. (P: 2, CC: 5, CI: PS1)

6.3.2.1.4 Develop and compare multiple models to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. (P: 2, CC: 6, CI: PS3)

6.3.2.1.5 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. (P: 2, CC: 4, CI: PS4)

6.3.2.2.1 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.* (P: 2, CC: -, CI: ETS1)

6.3.6.2.2 Construct, test and modify a device that either releases or absorbs thermal energy by chemical processes.* (P: 6, CC: 5, CI: PS1)

6.3.6.2.3 Design a solution to a problem involving the motion of two colliding objects using Newton's 3rd Law.* (P: 6, CC: 4, CI: PS2)

6.3.6.2.4 Design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* (P: 6, CC: 5, CI: PS3)

Strand 4: Communicating reasons, arguments and ideas to others

6.4.7.1.1 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. (P: 7, CC: 3, CI: PS2)

6.4.7.1.2 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. (P: 7, CC: 5, CI: PS3)

6.4.8.1.1 Gather and make sense of multiple sources of information to describe that synthetic materials come from natural resources and impact society. (P: 8, CC: 6, CI: PS1)

6.4.8.1.2 Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. (P: 8, CC: 6, CI: PS4)

Grade 7

Strand 1: Exploring phenomena or engineering problems

7.1.3.1.1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. (P: 3, CC: 3, CI: LS1)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

7.2.4.1.2 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. (P: 4, CC: 2, CI: LS2)

7.2.4.1.2 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. (P: 4, CC: 1, CI: LS4)

7.2.4.1.3 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. (P: 4, CC: 1, CI: LS4)

7.2.5.1.1 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. (P: 5, CC: 2, CI: LS4)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

7.3.2.1.1 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. (P: 2, CC: 6, CI: LS1)

7.3.2.1.2 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. (P: 2, CC: 5, CI: LS1)

7.3.2.1.3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (P: 2, CC: 5, CI: LS2)

7.3.2.1.4 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. (P: 2, CC: 6, CI: LS3)

7.3.2.1.5 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. (P: 2, CC: 2, CI: LS3)

7.3.2.2.1 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.* (P: 2, CC: -, CI: ETS1)

7.3.6.1.1 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. (P: 6, CC: 2, CI: LS1)

7.3.6.1.2 Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. (P: 6, CC: 2, CI: LS1)

7.3.6.1.3 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. (P: 6, CC: 1, CI: LS2)

7.3.6.1.4 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. (P: 6, CC: 1, CI: LS4)

7.3.6.1.5 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. (P: 6, CC: 2, CI: LS4)

Strand 4: Communicating reasons, arguments and ideas to others

7.4.7.1.1 Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. (P: 7, CC: 4, CI: LS1)

7.4.7.1.2 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. (P: 7, CC: 2, CI: LS1)

7.4.7.1.3 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. (P: 7, CC: 7, CI: LS2)

7.4.7.2.1 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* (P: 7, CC: 2, CI: LS2)

7.4.8.1.1 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. (P: 8, CC: 2, CI: LS1)

7.4.8.1.2 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. (P: 8, CC: 2, CI: LS4)

Grade 8

Strand 1: Exploring phenomena or engineering problems

8.1.1.1.1 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. (P: 1, CC: 7, CI: ESS3)

8.1.1.2.1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.* (P: 1, CC: -, CI: ETS1)

8.1.3.1.2 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. (P: 3, CC: 2, CI: ESS2)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

8.2.4.1.1 Analyze and interpret data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects in order to determine the kinds of geologic processes occurring on those objects. (P: 4, CC: 3, CI: ESS1)

8.2.4.1.2 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. (P: 4, CC: 1, CI: ESS2)

8.2.4.1.3 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. (P: 4, CC: 1, CI: ESS3)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

8.3.2.1.1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. (P: 2, CC: 1, CI: ESS1)

8.3.2.1.2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. (P: 2, CC: 4, CI: ESS1)

8.3.2.1.3 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. (P: 2, CC: 7, CI: ESS2)

8.3.2.1.4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. (P: 2, CC: 5, CI: ESS2)

8.3.2.1.5 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. (P: 2, CC: 4, CI: ESS2)

8.3.2.2.1 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.* (P: 2, CC: -, CI: ETS1)

8.3.6.1.1 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. (P: 6, CC: 3, CI: ESS1)

8.3.6.1.2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. (P: 6, CC: 3, CI: ESS2)

8.3.6.1.3 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. (P: 6, CC: 2, CI: ESS3)

8.3.6.2.1 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* (P: 6, CC: 2, CI: ESS3)

Strand 4: Communicating reasons, arguments and ideas to others

8.4.7.1.1 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. (P: 7, CC: 2, CI: ESS3)

8.4.7.2.1 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.* (P: 7, CC: -, CI: ETS1)

Grade 9 - 12 Chemistry

Strand 1: Exploring phenomena or engineering problems

9C.1.3.1.1 Plan and conduct an investigation to gather evidence, including bulk property data, to compare the structure of substances and infer the strength of electrical forces between particles. (P: 3, CC: 1, CI: PS1)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

9C.2.5.1.1 Use mathematical representations or computational models to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. (P: 5, CC: 5, CI: PS1)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

9C.3.2.1.1 Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (P: 2, CC: 1, CI: PS1)

9C.3.2.1.2 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. (P: 2, CC: 5, CI: PS1)

9C.3.2.1.3 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. (P: 2, CC: 5, CI: PS1)

9C.3.6.1.1 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. (P: 6, CC: 1, CI: PS1)

9C.3.6.1.2 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature and concentration of the reacting particles on the rate at which the reaction occurs (P: 6, CC: 1, CI: PS1)

9C.3.6.2.1 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.* (P: 6, CC: 7, CI: PS1)

Strand 4: Communicating reasons, arguments and ideas to others

9C.4.8.2.1 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* (P: 8, CC: 6, CI: PS6)

Grade 9-12 Earth and Space Sciences

Strand 1: Exploring phenomena or engineering problems

9E.1.1.2.1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.* (P: 1, CC: -, CI: ETS1)

9E.1.3.1.1 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. (P: 3, CC:6, CI:ESS2)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

9E.2.4.1.1 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. (P: 4, CC: 7, CI: ESS2)

9E.2.4.1.2 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's systems. (P: 4, CC: 7, ESS3)

9E.2.4.2.1 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.* (P: 4, CC: -, CI: ETS1)

9E.2.5.1.1 Use mathematical or computational representations to predict the motion of natural and human-made objects that are in orbit in the solar system. (P: 5, CC: 3, CI: ESS1)

9E.2.5.1.2 Use a computational simulation or construct simplified spreadsheet calculations to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity. (P: 5, CC: 7, CI: ESS3)

9E.2.5.1.3 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. (P: 5, CC: 4, CI: ESS3)

9E.2.5.2.1 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.* (P: 5, CC: 4, CI: ETS1)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

9E.3.2.1.1 Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. (P: 2, CC: 1, CI: ESS1)

9E.3.2.1.2 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. (P: 2, CC: 7, CI: ESS2)

9E.3.2.1.3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. (P: 2, CC: 1, CI: ESS2)

9E.3.2.1.4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. (P: 2, CC: 5, CI: ESS2)

9E.3.2.1.5 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. (P: 2, CC: 4, CI: ESS2)

9E.3.6.1.1 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. (P: 6, CC: 5, CI: ESS1)

9E.3.6.1.2 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. (P: 6, CC: 7, CI: ESS1)

9E.3.6.1.3 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. (P: 6, CC: 2, CI: ESS3)

9E.3.6.2.1 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* (P: 6, CC: 7, CI: ESS3)

Strand 4: Communicating reasons, arguments and ideas to others

9E.4.7.1.1 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. (P: 7, CC: 1, CI: ESS1)

9E.4.7.1.2 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. (P: 7, CC: 2, CI: ESS2)

9E.4.7.2.1 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* (P: 7, CC: -, CI: ESS3)

9E.4.8.1.1 Communicate scientific ideas about the way stars, over their life cycle, produce elements. (P: 8, CC: 5, CI: ESS3)

Grade 9-12 Life Sciences

Strand 1: Exploring phenomena or engineering problems

9L.1.1.1.1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (P: 1, CC: 2, CI: LS3)

9L.1.3.1.1 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (P: 3, CC: 7, CI: LS1)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

9L.2.4.1.1 Apply concepts of statistics and probability to explain and/or predict the variation and distribution of expressed traits in a population. (P: 4, CC: 3, CI: LS3)

9L.2.4.1.2 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. (P: 4, CC: 1, CI: LS4)

9L.2.5.1.1 Create and/or revise a mathematical and/or computational model or simulation to support explanations of factors that affect carrying capacities of ecosystems at different scales. (P: 5, CC: 3, CI: LS2)

9L.2.5.1.2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (P: 5, CC: 3, CI: LS2)

9l.2.5.1.3 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. (P: 5, CC: 5, CI: LS2)

9L.2.5.1.4 Create or revise a mathematical model that accurately demonstrates the ecological or economic impacts of human activity on various biodiversity markers. (P: 5, CC: 7, CI: LS4)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

9L.3.2.1.1 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. (P: 2, CC: 6, CI: LS1)

9L.3.2.1.2 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (P: 2, CC: 2, CI: LS1)

9L.3.2.1.3 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. (P: 2, CC: 2, CI: LS1)

9L.3.2.1.4 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. (P: 2, CC: 5, CI: LS1)

9L.3.2.1.5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. (P: 2, CC: 7, CI: LS2)

9L.3.6.1.1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells. (P: 6, CC: 6, CI: LS1)

9L.3.6.1.2 Construct and revise an explanation based on evidence for how various elements combine with carbon to form molecules that form the basis for life on Earth. (P: 6, CC: 5, CI: LS1)

9L.3.6.1.3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. (P: 6, CC: 5, CI: LS2)

9L.3.6.1.4 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. (P: 6, CC: 2, CI: LS4)

9L.3.6.1.5 Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (P: 6, CC: 2, CI: LS4)

9L.3.6.2.1 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* (P: 6, CC: 7, CI: LS2)

9L.3.6.2.2 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.* (P: 6, CC: -, CI: ETS1)

Strand 4: Communicating reasons, arguments and ideas to others

9L.4.7.1.1 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. (P: 7, CC: 7, CI: LS2)

9L.4.7.1.2 Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce. (P: 7, CC: 2, CI: LS2)

9L.4.7.1.3 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. (P: 7, CC: 2, CI: LS3)

9L.4.7.1.4 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. (P: 7, CC: 2, CI: LS4)

9L.4.8.1.1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (P:8, CC: 1, CI: ESS3)

Grade 9 - 12 Physics

Strand 1: Exploring phenomena or engineering problems

9P.1.1.1.1 Evaluate questions about the advantages of using digital transmission and storage of information. (P: 1, CC: 7, CI: PS4)

9P.1.3.1.1 Plan and conduct an investigation to gather evidence, including bulk property data, to compare the structure of substances and infer the strength of electrical forces between particles. (P: 3, CC: 1, CI: PS1)

9P.1.3.1.2 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. (P: 3, CC: 2, CI: PS2)

9P.1.3.1.3 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperatures are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). (P: 3, CC: 3, CI: PS3)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

9P.2.5.1.1 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. (P: 5, CC: 4, CI: PS2)

9P.2.5.1.2 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. (P: 5, CC: 1, CI: PS2)

9P.2.5.1.3 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 or out of the system are known. (P: 5, CC: 4, CI: PS3)

9P.2.5.1.4 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. (P: 5, CC: 2, CI: PS2)

Strand 3: Developing possible explanations of phenomena or designing solutions to problems

9P.3.2.1.1 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). (P: 2, CC: 5, CI: PS3)

9P.3.2.1.2 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. (P: 2, CC: 2, CI: PS3)

9P.3.6.2.1 Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* (P: 6, CC: 2, CI: PS2)

9P.3.6.2.2 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* (P: 6, CC: 5, CI: PS3)

9P.3.6.2.1.3 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.* (P: 6, CC: -, CI: ETS1)

Strand 4: Communicating reasons, arguments and ideas to others

9P.4.7.1.1 Evaluate the claims, evidence, and reasoning behind the argument 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. (P: 7, CC: 4, CI: LS2)

9P.4.8.1.1 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. (P: 8, CC: 2, CI: PS4)

9P.4.8.2.1 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* (P:8, CC: 2, CI: PS4)

9P.4.8.2.2 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* (P: 8, CC: 6, CI: PS6)