PUBLIC SCHOOLS OF EDISON TOWNSHIP

OFFICE OF CURRICULUM AND INSTRUCTION

Science Grade 6

Length of Course:	Term
Elective/Required:	Required
Schools:	Middle Schools
Eligibility:	Grade 6
Credit Value:	N/A
Date Approved:	August 26, 2019

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Statement of Purpose

In July 2011, the National Research Council (NRC) of the National Academy of Sciences developed *A Framework for K-12 Science Education*. This guidance provides a sound, evidence-based foundation for standards by drawing on current scientific research - including research on the methods in which students learn science effectively - and identifies the science all students in grade K-12 should know.

The NRC's Framework describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises understanding. It presents three dimensions that will be combined to form each standard:

Dimension 1: Practices
Practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world. They also include the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term "practices" instead of a term like "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC's intent is to better explain and extend what is meant by "inquiry" in science and the range of cognitive, social, and physical practices that it requires.

Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through an investigation, while engineering design involves the formulation of a problem that can be solved through design. Emphasizing the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering, and mathematics to everyday life.

Dimension 2: Cross Cutting Concepts
The Cross Cutting Concepts have application across all domains of science and, as such, are a way of linking different domains together. They include:

- Patterns, similarity, and diversity;
- Cause and effect;
- Scale, proportion, and quantity;
- Systems and system models;
- Energy and matter;
- Structure and function; and
- Stability and change.

The Framework emphasizes that these concepts need to be made explicit for students because they provide an organizational schema for inter-relating knowledge from various science fields into a coherent and scientifically-based view of the world.

<u>Dimension 3: Disciplinary Core Ideas</u>

Disciplinary Core Ideas have the power to focus K-12 science curriculum, instruction, and assessment on the most important aspects of science. To be considered core, the ideas meet at least two of the following criteria (and, ideally, all four):

- Have broad importance across multiple sciences or engineering disciplines, or be a key organizing concept of a single discipline;
- Provide a key tool for understanding or investigating more complex ideas and solving problems;
- Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge; and/or
- Be teachable and learnable over multiple grades at increasing levels of depth and sophistication.

Disciplinary Core Ideas are grouped in four domains: the physical sciences, the life sciences, the earth and space sciences; and engineering, technology, and applications of science.

Adopted by the State Board of Education in 2014, as the Next Generation Science Standards, they were renamed as the New Jersey Student Learning Standards for Science (NJSLS-S) in May 2016.

The goal of the 6th grade Science curriculum is to produce students who have gained sufficient knowledge of the practices, crosscutting concepts, and core ideas of science and engineering to engage in public discussions on science-related issues, to be critical consumers of scientific information related to their everyday lives, and to continue to learn about science throughout their lives. Students will be exposed to a “3D” approach to learning which intertwines the cross cutting concepts, scientific practices and disciplinary core ideas.

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Course Objectives

The student will be able to:

- NJSLS/MS-ESS1-1: Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
- NJSLS/MS-ESS1-2: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
- NJSLS/MS-ESS1-3: 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.
- NJSLS/MS-ESS1-4: Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.
- NJSLS/MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
- NJSLS/MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
- NJSLS/MS-ESS2-3: Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.
- NJSLS/MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- NJSLS/MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
- NJSLS/MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
- NJSLS/MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.
- NJSLS/MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- NJSLS/MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- NJSLS/MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

- NJSLS/MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
- NJSLS/MS-LS4-1: Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
- NJSLS/MS-LS4-2: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
- NJSLS/MS-LS4-3: Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
- NJSLS/MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- NJSLS/MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- NJSLS/MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Timeline

First Marking Period Unit

Unit 1: Astronomy

Second Marking Period Unit

Unit 2: Earth Systems

Third Marking Period Units

Unit 3: Earth’s Geologic History

Unit 4: Weather and Climate

Fourth Marking Period Units

Unit 5: Stability and Change on Earth

Unit 6: Human Impact on Earth’s Systems and Global Climate Change

Grade 6 Unit 1: Astronomy **Instructional days: 40**

Unit Summary
Essential Question: ***How do the interactions of objects in our Universe influence each other? How can objects in our universe be modeled for our understanding?*** **This unit is broken down into three sub-ideas: the universe and its stars, Earth and the solar system, and the history of planet Earth.** Students examine the Earth's place in relation to the solar system, the Milky Way galaxy, and the universe. There is a strong emphasis on a systems approach and using models of the solar system to explain the cyclical patterns of eclipses, tides, and seasons. There is also a strong connection to engineering through the instruments and technologies that have allowed us to explore the objects in our solar system and obtain the data that support the theories explaining the formation and evolution of the universe. Students examine geosciences data in order to understand the processes and events in Earth's history. The crosscutting concepts of *patterns*, *scale, proportion, and quantity* and *systems and systems models* provide a framework for understanding the disciplinary core ideas.
Student Learning Objectives
Generate and analyze evidence (through simulations or long term investigations) to explain why the Sun's apparent motion across the sky changes over the course of a year. (ESS1.B) ***[Clarification Statement: This SLO is based on a disciplinary core idea found in the Framework. It is included as a scaffold to the following SLO.]***
Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. ***[Clarification Statement: Examples of models can be physical, graphical, or conceptual.]*** **(MS-ESS1-1)**
Develop and use a model that shows how gravity causes smaller objects to orbit around larger objects at increasing scales, including the gravitational force of the sun causes the planets and other bodies to orbit around it holding together the solar system. (ESS1.A; ESS1.B) ***[Clarification Statement: This SLO is based on disciplinary core ideas found in the Framework. It is included as a scaffold to the following SLO.]***
Analyze and interpret data to determine scale properties of objects in the solar system. [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] ***[Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.] (MS-ESS1-3)***
Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. ***[Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.] (MS-ESS1-2)***

Possible Student Misconceptions (based on research):
• The ideas "the sun is a star" and "the earth orbits the sun" appear counterintuitive to elementary-school students. The ideas "the sun is a star" and "the earth orbits the sun" and are not likely to be believed or even understood in elementary grades. Whether it is possible for elementary students to understand these concepts even with good teaching needs further investigation. • Explanations of the day-night cycle, the phases of the moon, and the seasons are very challenging for students. To understand these phenomena, students should first master the idea of a spherical earth, itself a challenging task. Similarly, students must understand the concept of "light reflection" and how the moon gets its light from the sun before they can understand the phases of the moon. Finally, students may not be able to understand explanations of any of these phenomena before they reasonably understand the relative size, motion, and distance of the sun, moon, and the earth (NSDL, 2015). • Students of all ages have difficulty understanding what causes the seasons. They may not be able to understand explanations of the seasons before they reasonably understand the relative size, motion, and distance of the sun and earth. Many students before and after instruction in earth science think that winter is colder than summer because the earth is further from the sun in winter. This idea is often related to the belief that the earth orbits the sun in an elongated elliptical path. Other students, especially after instruction, think that the distance between the northern hemisphere and the sun changes because the earth leans toward the sun in the summer and away from the sun in winter. Students' ideas about how light travels and about the earth-sun relationship, including the shape of the earth's orbit, the period of the earth's revolution around the sun, and the period of the earth's rotation around its axis, may interfere with students' understanding of the seasons. For example, some students believe that the side of the sun not facing the earth experiences winter, indicating confusion between the daily rotation of the earth and its yearly revolution around the sun. • It is a common misconception that the Earth's shadow causes the phases of the Moon. Just like the Earth, the moon is only half-lit by the Sun at any time. We see it from different angles, that's how moon phases occur. The sunlit portion of the lunar side which always faces Earth can vary from 0% (at new moon) to 100% (at full moon). Occasionally, the Earth's shadow falls on the moon's face – that's called a lunar eclipse. This can only happen during a full moon – when the Earth can get in the way between the Sun and Moon.
Unit Sequence
Part A - Essential Question: What pattern in the Earth–sun–moon system can be used to explain lunar phases, eclipses of the sun and moon, and seasons?
Concepts/ Enduring Understanding
• Patterns in the apparent motion of the sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. • The Earth and solar system 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. • Patterns can be used to identify cause-and-effect relationships that exist in the apparent motion of the sun, moon, and stars in the sky. • Science assumes that objects and events in the solar system systems occur in consistent patterns that are understandable through measurement and observation.
Formative Assessment
Students who understand the concepts are able to:

- Students will develop and use a physical, graphical, or conceptual model to describe patterns in the apparent motion of the sun, moon, and stars in the sky.

Recommended Activities/ Assessment

- Identify Moon Phases
- Apply Patterns of Moon Phases to predict future moon phases and recall past ones
- Modeling Solar and Lunar Eclipses
- Analyzing Data of Earth, Sun, Moon Phenomena to explain occurrences
- Create Model of Seasons and explain how/why each season occurs
- District Unit 1 Common Assessment

Resources

Apparent Motion - Pearson Textbook Chapter 1, Lesson 1, page 10 Phases Eclipses
Rotation, Orbits, and the Seasons Discovery Techbook- Unit 6, Concept 3 Discovery
Techbook -Unit 6, Concept 3
Discovery Techbook - Unit 6, Concept 2 Pearson Textbook- Chapter 1, Lesson 4 Pearson
Textbook-Chapter 1, Lesson 4
Pearson Textbook - Chapter 1, Lesson 2

Part B - Essential Question: ***What is the role of gravity in the motions within galaxies and the solar system?***

Concepts/ Enduring Understanding

- Gravity plays a role in the motions within galaxies and the solar system.
- Gravity is the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them.
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.
- Models can be used to represent the role of gravity in the motions and interactions within galaxies and the solar system.
- Science assumes that objects and events in the solar systems occur in consistent patterns that are understandable through measurement and observation.

Formative Assessment

Students who understand the concepts are able to:

- Students develop and use models to explain the relationship between the tilt of Earth's axis and seasons.

Part C - Essential Question: *What are the scale properties of objects in the solar system?*

Concepts/ Enduring Understanding

- Objects in the solar system have scale properties.
- Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects.
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.
- Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large.
- Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems.

Formative Assessment

Students who understand the concepts are able to:

Analyze and interpret data to determine similarities and differences among objects in the solar system.

Recommended Activities/Assessments (Parts B and C)

- Create scaled models of objects in the solar system (size and distance)
- Create/Compare elliptical, spiral, irregular galaxy shapes
- Analyzing data to explain relationships between objects in the solar system/galaxy
  - Mass, Distance, Gravity Relationship
- Calculate/Compare Distances between objects in the Milky Way using light-years and other measurements
- District MP 1 Benchmark Assessment

Resources (Parts B and C)

Gravity and Motion
Pearson Textbook - Chapter 1, Lesson 3

Types of Galaxies
Discovery Techbook - Unit 7, Concept 3

Common Core Standards Alignment

ELA/Literacy	Mathematics	Technology	Career Ready Practice

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-3),(MS-ESS1-4) RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3) SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS1-1),(MS-ESS1-2)	MP.2 Reason abstractly and quantitatively. (MS-ESS1-3) MP.4 Model with mathematics. (MS-ESS1-1),(MS-ESS1-2) 6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3) 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3) 6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2),(MS-ESS1-4) 7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-2),(MS-ESS1-4)	8.1.8.A.4 Graph and calculate data within a spreadsheet and present a summary of the results.	CRP2. Apply appropriate academic and technical skills.

Next Generation Science Standards and Foundations for the Unit
The performance expectations above were developed using the following elements from A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Develop and use a model to describe phenomena. (MS-ESS1-1),(MS-ESS1-2) **Analyzing and Interpreting Data** Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)	**ESS1.A: The Universe and Its Stars** ·Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1) · Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2) **ESS1.B: Earth and the Solar System** · The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3) · This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)	**Patterns** · Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1) **Scale, Proportion, and Quantity** · Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3) **Systems and System Models** · Models can be used to represent systems and their interactions. (MS-ESS1-2) - ***Connections to Engineering, Technology, and Applications of Science***

	The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)	**Interdependence of Science, Engineering, and Technology** · Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-ESS1-3) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** · Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-1),(MS-ESS1-2)

Grade 6 Unit 2: Earth Systems **Instructional days: 40**

Unit Summary
Essential Questions: If no one was there, how do we know the Earth's history? What provides the forces that drive Earth's systems? Is it possible to predict and protect ourselves from natural hazards? Students examine geoscience data in order to understand processes and events in Earth's history. Important crosscutting concepts in this unit are *scale, proportion, and quantity*, *stability and change*, and *patterns* in relation to the different ways geologic processes operate over geologic time. An important aspect of the history of Earth is that geologic events and conditions have affected the evolution of life, but different life forms have also played important roles in altering Earth's systems. Students understand how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data Students are expected to demonstrate proficiency in *analyzing and interpreting* data and *constructing explanations*. They are also expected to use these practices to demonstrate an understanding of the core ideas.
Student Learning Objectives
Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. *[Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [*Assessment Boundary: Assessment does not include the identification and naming of minerals.*]* (MS-ESS2-1)
Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. *[Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]* (MS-ESS2-2)
Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. *[Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).]* [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.*]* (MS-ESS2-3)
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).]* (MS-ESS3-2)

Possible Student Misconceptions (based on research):
• Students of all ages may hold the view that the world was always as it is now, or that any changes that have occurred must have been sudden and comprehensive. The students in these studies did not, however, have any formal instruction on the topics investigated. Moreover, students taught by traditional means are not able to construct coherent explanations about the causes of volcanoes and earthquakes. • Few students understand the molecular basis of heat conduction even after instruction. For example, students attribute to particles properties such as "hotness" and "coldness" or believe that heat is produced by particles rubbing against each other. During instruction, students use ideas that give heat an active drive or intent to explain observations of convection currents. They also draw parallels between evaporation and the water cycle and convection, sometimes explicitly explaining the upwards motion of convection currents as evaporation. • Students rarely think energy is measurable and quantifiable. Students' alternative conceptualizations of energy influence their interpretations of textbook representations of energy. • Students tend to think that energy transformations involve only one form of energy at a time. Although they develop some skill in identifying different forms of energy, in most cases their descriptions of energy-change focus only on forms which have perceivable effects. The transformation of motion to heat seems to be difficult for students to accept, especially in cases with no temperature increase. Finally, it may not be clear to students that some forms of energy, such as light, sound, and chemical energy, can be used to make things happen. • The idea of energy conservation seems counterintuitive to middle- and high-school students who hold on to the everyday use of the term energy, but teaching heat dissipation ideas at the same time as energy conservation ideas may help alleviate this difficulty. Even after instruction, however, students do not seem to appreciate that energy conservation is a useful way to explain phenomena. A key difficulty students have in understanding conservation appears to derive from not considering the appropriate system and environment. In addition, middle- and high-school students tend to use their conceptualizations of energy to interpret energy conservation ideas. For example, some students interpret the idea that "energy is not created or destroyed" to mean that energy is stored up in the system and can even be released again in its original form. Or, students may believe that no energy remains at the end of a process, but may say that "energy is not lost" because an effect was caused during the process (for example, a weight was lifted). Although teaching approaches which accommodate students' difficulties about energy appear to be more successful than traditional science instruction, the main deficiencies outlined above remain despite these approaches (NSDL, 2015).
Unit Sequence
Part A - Essential Question: ***What drives the cycling of Earth's materials?***
Concepts/ Enduring Understanding
• Energy drives the process that results in the cycling of Earth's materials. • Convection currents in the mantle drive geoscience processes. • The processes of melting, crystallization, weathering, deformation, and sedimentation act together to form minerals and rocks through the cycling of Earth's materials. • All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. • Energy flowing and matter cycling within and among the planet's systems, derives from the sun and Earth's hot interior. • Energy that flows and matter that cycle produce chemical and physical changes in Earth's materials and living organisms. • Explanations of stability and change in Earth's natural systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.
Formative Assessment

Students who understand the concepts are able to:

- Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

Part B - Essential Question: *Do all of the changes to Earth systems occur in similar time scales?*

Concepts/ Enduring Understanding

- Geoscience processes have changed Earth's surface at varying time and spatial scales.
- Processes change Earth's surface at time and spatial scales that can be large or small; many geoscience processes usually behave gradually but are punctuated by catastrophic events.
- Geoscience processes shape local geographic features.
- 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.
- Interactions among Earth's systems have shaped Earth's history and will determine its future.
- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.
- Time, space, and energy phenomena within Earth's systems can be observed at various scales using models to study systems that are too large or too small.

Formative Assessment

Students who understand the concepts are able to:

- Construct a scientific explanation for how geoscience processes have changed Earth's surface at varying time and spatial scales based on valid and reliable evidence obtained from sources (including the students' own experiments).
- Construct a scientific explanation for how geoscience processes have changed Earth's surface at varying time and spatial scales based on 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.
- Collect evidence about processes that change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges).
- Collect evidence about processes that change Earth's surface at time and spatial scales that can be small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events

Recommended Activities/Assessments (Parts A and B)

- Model of Earth's layers
- Identify and explain the formation of the 3 main types of rocks
- Model and explain the process of the Rock Cycle and how rocks change over time
- District Unit 2 Common Assessment

Resources (Parts A and B)
Cycling of Earth's Materials (Rock Cycle) • Discovery Techbook - Unit 3, Concept 7 • Pearson Textbook - Chapter 3, Lesson 6
Part C - Essential Question: ***How is it possible for the same kind of fossils to be found in New Jersey and in Africa?***
Concepts/ Enduring Understanding
• Tectonic processes continually generate new seafloor at ridges and destroy old sea floor at trenches. • 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. • Patterns in rates of change and other numerical relationships can provide information about past plate motions. • The distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions. • 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) provide evidence of past plate motions.
Formative Assessment
Students who understand the concepts are able to: • Analyze and interpret data such as distributions of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions. • Analyze how science findings have been revised and/or reinterpreted based on new evidence about past plate motions.
Recommended Activities/Assessments
• Modeling Pangaea • Analyzing and Interpreting Evidence of Continental Drift to help support the Theory of Plate Tectonics • Infer how the continents once were positioned and how they might be in the future • Model Plate Tectonics features and processes • District MP 2 Benchmark Assessment
Resources
Plate Tectonics-Discovery Techbook - Unit 2, Lessons 1 - 3 Pearson Textbook - Chapter 4, Lessons 1 - 3

Part D - Essential Question: ***How can we predict natural hazards and prepare for when they are natural disasters?***

Concepts/ Enduring Understanding

- Natural hazards can be the result of interior processes, surface processes, or severe weather events.
- 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.
- 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.
- Data on natural hazards can be used to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- Data on natural hazards can include the locations, magnitudes, and frequencies of the natural hazards.
- Graphs, charts, and images can be used to identify patterns of natural hazards in a region.
- Graphs, charts, and images can be used to understand patterns of geologic forces that can help forecast the locations and likelihoods of future events.
- Technologies that can be used to mitigate the effects of natural hazards can be global or local.
- Technologies used to mitigate the effects of natural hazards vary from region to region and over time.

Formative Assessment

Students who understand the concepts are able to:

- Analyze and interpret data on natural hazards to determine similarities and differences and to distinguish between correlation and causation.

Recommended Activities/Assessments

- Plot earthquakes and active volcanoes. Compare geologic features to specific resources available in those areas
- Design earthquake proof buildings
- Analyze data on natural hazards to help prevent/foresee catastrophic events

Resources

Why Earthquakes Occur -Discovery Techbook- Unit 2 Concept 4

Common Core Standards Alignment

ELA/Literacy	Mathematics	Technology	Career Ready Practice

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-2),(MS-ESS2-3),(MS-ESS2-5) RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS2-3) RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-3),(MS-ESS2-5) SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1),(MS-ESS2-2),(MS-ESS2-6)	MP.2 Reason abstractly and quantitatively. (MS-ESS2-2),(MS-ESS2-3),(MS-ESS2-5) 6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)	8.1.8.A.4 Graph and calculate data within a spreadsheet and present a summary of the results.	CRP2. Apply appropriate academic and technical skills.

Next Generation Science Standards and Foundations for the Unit
The performance expectations above were developed using the following elements from A Framework for K-12 Science Education:

Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models · Develop and use a model to describe phenomena. (MS-ESS2-1) **Constructing Explanations and Designing Solutions** · Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe nature operate today as they did in the past and will continue to do so in the future. (MS-ESS1-4),(MS-ESS2-2) **Analyzing and Interpreting Data** Analyze and interpret data to provide evidence for phenomena. (MS-ESS2-3)	**ESS1.C: The History of Planet Earth** The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4) **ESS2.A: Earth's Materials and Systems** · All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1) · The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2) **ESS2.B: Plate Tectonics and Large-Scale System Interactions**	**Stability and Change** · Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1) **Scale Proportion and Quantity** · Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-4),(MS-ESS2-2) **Patterns** · Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3) - ***Connections to Nature of Science***

	Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3) **ESS3.B: Natural Hazards** Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)	**Scientific Knowledge is Open to Revision in Light of New Evidence** Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3)

Grade 6 Unit 3: Earth's Geologic History **Instructional days: 15**

Unit Summary
Essential Questions: How do rock layers and fossils provide a record of Earth's geologic history? In this unit of study, students analyze the geologic time scale in order to understand how rock strata and fossils depict Earth's history. Students search for patterns in the evidence to support their understanding of the fossil record and how those patterns show relationships between modern organisms and their common ancestors. The crosscutting concepts of *cause and effect, patterns*, and *structure and function* are called out as organizing concepts for these disciplinary core ideas. Students use the practices of *analyzing graphical displays* and *gathering, reading, and communicating information*. Students are also expected to use these practices to demonstrate an understanding of the core ideas.
Student Learning Objectives
Analyze and interpret data for patterns in the fossil record that documents the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. ***[Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.] (MS-LS4-1)***
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.]*** **(MS-LS4-2)**
Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. ***[Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]*** **(MS-LS4-3)**
Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. ***[Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.]*** **[Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.] (MS-ESS1-4)**
Unit Sequence
Part A - Essential Question: ***How do we know that the Earth is approximately 4.6-billion-years-old?***

Concepts/ Enduring Understanding
• The geologic time scale is used to organize Earth's 4.6-billion-year-old history. • Rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. • 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. • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small
Formative Assessment
Students who understand the concepts are able to: • Construct a scientific explanation based on valid and reliable evidence from rock strata obtained from sources (including the students' own experiments). • Construct a scientific explanation based on rock strata 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.
Recommended Activities/Assessments
• Define the term fossil and explain how fossils are formed • Use relative dating methods to place geologic events in a correct sequence
Resources
Fossils and Studying Earth's Past • Discovery Techbook - Unit 1, Concept 1 • Pearson Textbook - Chapter 8, Lesson 2 • Pearson Textbook, Chapter 8, Lesson 4
Part B - Essential Question: ***How do we know when an organism (fossil) was alive?***
Concepts/ Enduring Understanding
• The fossil record documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. • The collection of fossils and their placement in chronological order as identified through the location of sedimentary layers in which they are found or through radioactive dating is known as the fossil record. • Relative fossil dating is achieved by examining the fossil's relative position in sedimentary rock layers. • Objects and events in the fossil record occur in consistent patterns that are understandable through measurement and observation.

• Patterns exist in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in rock layers. • Patterns can occur within one species of organism or across many species.
Formative Assessment
Students who understand the concepts are able to: • Use graphs, charts, and images to identify patterns within the fossil record. • Analyze and interpret data within the fossil record to determine similarities and differences in findings. • Make logical and conceptual connections between evidence in the fossil record and explanations about the existence, diversity, extinction, and change in many life forms throughout the history of life on Earth.
Recommended Activities/Assessments
• Using graphs, charts, and images to identify and explain patterns within the fossil record • Relative fossil dating is achieved by examining the fossil's relative position in sedimentary rock layers
Resources
Fossils and Studying Earth's Past • Discovery Techbook - Unit 1, Concept 1 • Pearson Textbook - Chapter 8, Lesson 2 • Pearson Textbook, Chapter 8, Lesson 4
Part C - Essential Question: ***How do we know that birds and dinosaurs are related?***
Concepts/ Enduring Understanding
• Similarities and differences exist in the gross anatomical structures of modern organisms. • There are anatomical similarities and differences among modern organisms and between modern organisms and fossil organisms. • Similarities and differences exist in the gross anatomical structures of modern organisms and their fossil relatives. • Similarities and differences in the gross anatomical structures of modern organisms enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. • Patterns and anatomical similarities in the fossil record can be used to identify cause-and-effect relationships. • Science assumes that objects and events in evolutionary history occur in consistent patterns that are understandable through measurement and observation.
Formative Assessment

Students who understand the concepts are able to:

- Apply scientific ideas to construct explanations for evolutionary relationships.
- Apply the patterns in gross anatomical structures among modern organisms and between modern organisms and fossil organisms to construct explanations of evolutionary relationships.
- Apply scientific ideas about evolutionary history to construct an explanation for evolutionary relationships evidenced by similarities or differences in the gross appearance of anatomical structures.

Recommended Activities/Assessments

- Compare and contrast similarities and differences of organisms using their anatomical structures
- Analyze data/evidence to explain how different organisms are related
- Form arguments as to how comparative anatomy provides evidence that supports or refutes evolutionary relationships between species
- District Unit 3 Common Assessment

Resources

Common Ancestry/ Evidence for Evolution

- Discovery (Life Science) Techbook- Unit 4 Concept 1

Common Core Standards Alignment

ELA/Literacy	Mathematics	Technology	Career Ready Practice
RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-LS4-1),(MS-LS4-2),(MS-LS4-3),(MS-LS4-4)(MS-LS4-5) RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram,model, graph, or table). (MS-LS4-1),(MS-LS4-3) RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-LS4-3),(MS-LS4-4) WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the	6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-LS4-1),(MS-LS4-2)	8.1.8.A.4 Graph and calculate data within a spreadsheet and present a summary of the results	CRP4. Communicate clearly and effectively and with reason.

selection, organization, and analysis of relevant content. (MS-LS4-2),(MS-LS4-4) WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS4-5) WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-2),(MS-LS4-4) SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-2),(MS-LS4-4) SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS4-2),(MS-LS4-4)			

Next Generation Science Standards and Foundations for the Unit
The performance expectations above were developed using the following elements from A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3) Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1) **Constructing Explanations and Designing Solutions** Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2) - **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence**	**LS4.A: Evidence of Common Ancestry and Diversity** The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1) Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2) Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)	**Patterns** Patterns can be used to identify cause and effect relationships. (MS-LS4-2) Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1),(MS-LS4-3) **Cause and Effect** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4),(MS-LS4-5),(MS-LS4-6) - **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** Science assumes that objects and events in natural systems occur in consistent patterns that are

Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1)		understandable through measurement and observation. (MS-LS4-1),(MS-LS4-2)

Grade 6 Unit 4: Weather and Climate **Instructional days: 25**

Unit Summary
Essential Question: What factors interact and influence weather and climate? **This unit is broken down into three sub-ideas: Earth's large-scale systems interactions, the roles of water in Earth's surface processes, and weather and climate.** Students make sense of how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. A systems approach is also important here, examining the feedbacks between systems as energy from the Sun is transferred between systems and circulates through the ocean and atmosphere. The crosscutting concepts of *cause and effect*, *systems and system models*, and *energy and matter* are called out as frameworks for understanding the disciplinary core ideas. In this unit, students are expected to demonstrate proficiency in *developing and using models* and *planning and carrying out investigations* as they make sense of the disciplinary core ideas. Students are also expected to use these practices to demonstrate understanding of the core ideas.
Student Learning Objectives
Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. *[Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]* (MS-ESS2-4)
Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. *[Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]* **(MS-ESS2-5**)
Explain how variations in density result from variations in temperature and salinity drive a global pattern of interconnected ocean currents. *[Note: This SLO is based on a disciplinary core idea found in the Framework. It is included as a scaffold to the following SLO.]* (ESS2.C)
Use a model to explain the mechanisms that cause varying daily temperature ranges in a coastal community and in a community located in the interior of the country. *[Note: This SLO is based disciplinary core ideas found in the Framework. It is included as a scaffold to the following SLO.]* (ESS2.C; ESS2.D)
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. *[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]* **(MS-ESS2-6**)
Possible Student Misconceptions (based on research):

- Although upper elementary students may identify air as existing even in static situations & recognize that it takes space, recognizing that air has weight may be challenging even for high-school students. Students of all ages (including college students) may believe that air exerts force or pressure only when it is moving and only downwards. Only a few middle-school students use the idea of pressure differences between regions of the atmosphere to account for wind; instead they may account for winds in terms of visible moving objects or the movement of the earth.
- Before students understand that water is converted to an invisible form, they may initially believe that when water evaporates it ceases to exist, or that it changes location but remains a liquid, or that it is transformed into some other perceptible form (fog, steam, droplets, etc.). With special instruction, some students in gr.5 may be able to identify the air as the final location of evaporating water. They must accept air as a permanent substance before they can identify the air as the final location of evaporating water. For many, difficulty understanding the existence of water vapor in the atmosphere persists in middle school years. They can understand rainfall in terms of gravity once they attribute weight to little drops of water (typically in upper elementary grades), but the mechanism through which condensation occurs may not be understood until high school.
- Students of all ages may confuse the ozone layer with the greenhouse effect, and may have a tendency to imagine that all environmentally friendly actions help to solve all environmental problems (ex: that the use of unleaded petrol reduces the risk of global warming). Students have difficulty linking relevant elements of knowledge when explaining the greenhouse effect & may confuse the natural greenhouse effect with the enhancement of that effect (NSDL, 2015).

Unit Sequence

Part A - Essential Question: *What are the processes involved in the cycling of water through Earth's systems?*

Concepts/ Enduring Understanding

- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
- Global movements of water and its changes in form are propelled by sunlight and gravity.
- The cycling of water through Earth's systems is driven by energy from the sun and the force of gravity.
- Within Earth's systems, the transfer of energy drives the motion and/or cycling of water.

Formative Assessment

Students who understand the concepts are able to:

- Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- Model the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle.

Recommended Activities/Assessments

- Model the water cycle and use it to describe:
  - The main processes
  - What powers it (energy from the sun)

Resources

Energy Transfer and the Water Cycle- Discovery Techbook - Unit 3 Concept 1

Part B - Essential Question: ***What is the relationship between the complex interactions of air masses and changes in weather conditions?***

Concepts/ Enduring Understanding

- The motions and complex interactions of air masses result in changes in weather conditions.
- The complex patterns of the changes in and movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.
- Examples of data that can be used to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions include weather maps, diagrams, and visualizations; other examples can be obtained through laboratory experiments.
- Air masses flow from regions of high pressure to regions of low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time.
- Because patterns of the changes and the movement of water in the atmosphere are so complex, weather can only be predicted probabilistically.
- Sudden changes in weather can result when different air masses collide.
- Weather can be predicted within probabilistic ranges.
- Cause-and effect-relationships may be used to predict changes in weather.

Formative Assessment

*S*tudents who understand the concepts are able to:

- Collect data to serve as the basis for evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

Recommended Activities/Assessments

Describe meteorology tools	Analyzing and interpreting weather maps	District Unit 4 Common Assessments
Predicting weather patterns	Explain air masses and types of fronts	

Resources

Meteorology

- Discovery Techbook - Unit 3, Concept 2

Part C - Essential Question: ***What are the major factors that determine regional climates?***

Concepts/ Enduring Understanding

- Unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
- Patterns of atmospheric and oceanic circulation that determine regional climates vary by latitude, altitude, and geographic land distribution.
- Atmospheric circulation that, in part, determines regional climates is the result of sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds.
- Ocean circulation that, in part, determines regional climates is the result of the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents.
- Models that can be used to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates can be diagrams, maps and globes, or digital representations.

Formative Assessment

Students who understand the concepts are able to:

- 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.

Recommended Activities/Assessments

- Explain the cause and effect relationship that ocean currents and temperatures have on world climate
- Describe the Patterns of ocean currents
- Phenomena of El Niño and La Niña (interaction of wind and water)
- Ocean Current Lab (Use/Modify as needed https://goo.gl/CrAqYq)
- District MP 3 Benchmark Assessment

Resources

Oceans and Climate

- Discovery Techbook - Unit 3, Concept 6

Common Core Standards Alignment

ELA/Literacy	Mathematics	Technology	Career Ready Practice

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-2),(MS-ESS2-3),(MS-ESS2-5) RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-3),(MS-ESS2-5) WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS2-5) SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1),(MS-ESS2-2),(MS-ESS2-6)	MP.2 Reason abstractly and quantitatively. (MS-ESS2-2),(MS-ESS2-3),(MS-ESS2-5) 6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)	8.1.8.A.4 Graph and calculate data within a spreadsheet and present a summary of the results.	CRP2. Apply appropriate academic and technical skills.

Next Generation Science Standards and Foundations for the Unit
The performance expectations above were developed using the following elements from A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Develop and use a model to describe phenomena. (MS-ESS1-1),(MS-ESS1-2) · Develop a model to describe unobservable mechanisms. (MS-ESS2-4) **Planning and Carrying Out Investigations** Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)	**ESS2.C: The Roles of Water in Earth's Surface Processes** · Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) · The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5) · Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4) · Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6) **ESS2.D: Weather and Climate** · Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6) · Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)	**Cause and Effect** · Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5) **Systems and System Models** · Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6) **Energy and Matter** · Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)

	The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)	

Grade 6 Unit 5: Stability and Change on Earth **Instructional days: 20**

Unit Summary
Essential Questions: How have geological processes and subsequent human activity led to the distribution of natural resources on Earth? Students construct an understanding of the ways that human activities affect Earth's systems. Students use practices to understand the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts on the development of these resources. Students also understand that the distribution of these resources is uneven due to past and current geosciences processes or removal by humans. The crosscutting concepts of *patterns, cause and effect*, and *stability and change* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in *asking questions, analyzing and interpreting data, constructing explanations, and designing solutions.* Students are also expected to use these practices to demonstrate understanding of the core ideas.
Student Learning Objectives
Construct a scientific explanation based on evidence for how the uneven distribution 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 nonrenewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distribution 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).]*** **(MS-ESS3-1)**
Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. ***[Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]*** **(MS-ESS3-4)**
Unit Sequence
Part A - Essential Question: ***Why aren't natural resources distributed evenly across the world?***
Concepts/ Enduring Understanding
• Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. • All human activities draw on Earth's land, ocean, atmosphere, and biosphere resources and have both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

- Minerals, fresh water, and biosphere resources are distributed unevenly around the planet as a result of past geologic processes.
- Cause-and-effect relationships may be used to explain how uneven distributions of Earth's mineral, energy, and groundwater resources have resulted from past and current geosciences processes.
- Resources that are unevenly distributed as a result of past processes include but are not limited to petroleum, metal ores, and soil.
- Mineral, fresh water, ocean, biosphere, and atmosphere resources are limited, and many are not renewable or replaceable over human lifetimes.
- The distribution of some of Earth's land, ocean, atmosphere, and biosphere resources are changing significantly due to removal by humans

Formative Assessment

Students who understand the concepts are able to:

- Construct a scientific explanation based on valid and reliable evidence of how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geosciences processes.
- Obtain evidence from sources, which must include the student's own experiments.
- Construct a scientific explanation based on the assumption that theories and laws that describe the current geosciences process operates today as they did in the past and will continue to do so in the future.

Recommended Activities/Assessments

- Classification on renewable and nonrenewable
- Model where resources come from
- Analyze real world data/examples to explain human usage and sources of resources.
- District Unit 5 Common Assessment

Resources

Natural Resources- Discovery Techbook Unit 5 Concept 1

Part B - Essential Question: ***How are humans causing changes to the natural state of the Earth?***

Concepts/ Enduring Understanding

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment
- Increases in human population and per-capita consumption of natural resources impact Earth's 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.

- Cause and effect relationships may be used to predict how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- The consequences of increases in human populations and consumption of natural resources are described by science.
- Science does not make the decisions for the actions society takes.
- Scientific knowledge can describe the consequences of human population and per-capita consumption of natural resources impact Earth's systems but does not necessarily prescribe the decisions that society takes.

Formative Assessment

Students who understand the concepts are able to:

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

Recommended Assignments/Assessments

- Graphing human population and analyze the impacts on Earth's resources
- Create an oral or written argument that supports or refutes a current pollution solution. Use data to support your side
- Conservation and Sustainability Lab

Resources

Human Population Growth- Discovery Techbook Unit 5 Concept 5

Over-Exploitation of Resources-Discovery Techbook Unit 5 Concept 6

Common Core Standards Alignment

ELA/Literacy	Mathematics	Technology	Career Ready Practice
RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1),(MS-ESS3-2),(MS-ESS3-4),(MS-ESS3-5) RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS3-2) WHST.6-8.1	MP.2 Reason abstractly and quantitatively. (MS-ESS3-2),(MS-ESS3-5) 6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3),(MS-ESS3-4) 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS3-3),(MS-ESS3-4) 6.EE.B.6	8.1.8.A.4 Graph and calculate data within a spreadsheet and present a summary of the results.	CRP2. Apply appropriate academic and technical skills.

Write arguments focused on discipline content. (MS-ESS3-4) WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1) WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS3-3) WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1),(MS-ESS3-4)	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-1),(MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4),(MS-ESS3-5) 7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1),(MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4),(MS-ESS3-5)		

Next Generation Science Standards and Foundations for the Unit
The performance expectations above were developed using the following elements from A Framework for K-12 Science Education:

Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1) **Engaging in Argument from Evidence** Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)	**ESS3.A: Natural Resources** Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) **ESS3.C: 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-ESS3-4)	**Patterns** · Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) **Cause and Effect** · Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1),(MS-ESS3-4) **Stability and Change** · Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5) - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World**

		· All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1),(MS-ESS3-4) · The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2) - ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)

Grade 6 Unit 6: Human Impact on Earth's Systems and Global Climate Change

Instructional days: 20

Unit Summary
Essential Questions: How does human activity affect Earth's systems? In this unit of study, students analyze and interpret data and design solutions to build on their understanding of the ways that human activities affect Earth's systems. The emphasis of this unit is the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts of these uses. The crosscutting concepts of *cause and effect* and *the influence of science, engineering, and technology on society and the natural world* are called out as organizing concepts for these disciplinary core ideas. In this unit of study students are expected to demonstrate proficiency in *analyzing and interpreting data* and *designing solutions.*
Student Learning Objectives
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. ***[Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating) solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]*** **(MS-ESS3-3)**
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.]*** **(MS-ESS3-5)**
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS-ETS1-1)
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS-ETS1-2)
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3)
Unit Sequence
Part A - Essential Question: ***How do we monitor the health of the environment (our life support system)?***
Concepts/ Enduring Understanding

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species.
- Changes to Earth's environments can have different impacts (negative and positive) for different living things.
- 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.
- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

Formative Assessment

Students who understand the concepts are able to:

- Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Part B - Essential Question: How can natural processes and human activity be used to explain the mechanisms that control the global temperature of the atmosphere?

Concepts/ Enduring Understanding

- Stability in Earth's surface temperature might be disturbed either by sudden events or gradual changes that accumulate over time.
- Human activities and natural processes are examples of factors that have caused the rise in global temperatures over the past century.
- Human activities play a major role in causing a rise in global temperatures.
- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming).
- Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on 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.
- Evidence that some factors have caused the rise in global temperature over the last century 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.

Formative Assessment

Students who understand the concepts are able to:

- Ask questions to identify and clarify a variety of evidence for an argument about the factors that have caused the rise in global temperatures over the past century.
- Ask questions to clarify human activities and natural processes that are major factors in the current rise in Earth's mean surface temperature.

Recommended Activities/Assessments

- Water pollution/Oil Spill lab
- Air pollution lab
- Land pollution lab
- Greenhouse gas/Global Warming lab
- STEM PBL PROJECT: Design a method for monitoring and minimizing a human impact on the environment. Students will include:
    - Criteria and restraints of their design problem
    - Potential impacts on people and the environment
    - Evaluate competing design solutions
    - Discuss redesign processes based on peer input and results
- District Unit 6 Common Assessment

Resources

Anthropogenic Changes- Discovery Techbook Unit 5 Concept 4	Human Population Growth- Discovery Techbook Unit 5 Concept 5
Over-Exploitation of Resources- Discovery Techbook Unit 5 Concept 6	Pollution- Discovery Techbook Unit 5 Concept 7

Common Core Standards Alignment

ELA/Literacy	Mathematics	Technology	Career Ready Practice
WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ESS3-3) WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS3-3)	7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS3-3),(MS-ESS3-4) 6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.(MS-ESS3-1),(MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4),(MS-ESS3-5) 7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1),(MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4),(MS-ESS3-5)	8.2.8.A.4 Redesign an existing product that impacts the environment to lessen its impact(s) on the environment.	CRP5. Consider the environmental, social and economic impacts of decisions.

Next Generation Science Standards and Foundations for the Unit
The performance expectations above were developed using the following elements from A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1) Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) **Asking Questions and Defining Problems** Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) Engaging in Argument from Evidence Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2) **Analyzing and Interpreting Data** Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)	**ESS3.C: Human Impacts on Earth Systems** Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4) **ESS3.D: Global Climate Change** Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5) **ETS1.A: Defining and Delimiting Engineering Problems** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)	**Cause and Effect** Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-3) **Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

	Models of all kinds are important for testing solutions. (MS-ETS1-4)	