EARTH AND SPACE SCIENCE
GRADES 9-12

EWING PUBLIC SCHOOLS
2099 Pennington Road
Ewing, NJ 08618

Board Approval Date: September 19, 2022 — Michael Nitti
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In accordance with The Ewing Public Schools' Policy 2230, Course Guides, this curriculum has been reviewed and found to be in compliance with all policies and all affirmative action criteria.

Table of Contents

Course Description

Look at the front page of a national newspaper over the course of a year and you'll see that Earth and space science dominates the headlines far more than any other scientific field: hurricanes, tornadoes, earthquakes, tsunamis, volcanoes, climate change, exploding meteors, droughts, floods, coal resources, gas prices, mineral resources, water supplies, oil spills, hydro fracking, solar storms, environmental impacts, etc. Earth and Space Science directly impacts the lives of humans in countless ways. The very course of civilization has been intimately shaped by climate change, natural catastrophes, and the availability of natural resources.

Students in high school develop understanding of a wide range of topics in Earth and Space Science that build upon science concepts from middle school through more advanced content, practice, and crosscutting themes. Earth Science and Space Science emphasizes the interrelationships of Astronomy, Geology, Meteorology, and Oceanography by focusing on cycles, interactions, and common themes. The content of the performance expectations are based on current community-based geoscience literacy efforts such as the Earth Science Literacy Principles and is presented with a greater emphasis on an Earth Systems Science approach. There are strong connections to mathematical practices of analyzing and interpreting data. The performance expectations strongly reflect the many societally relevant aspects of Earth and Space Science (resources, hazards, environmental impacts) with an emphasis on using engineering and technology concepts to design solutions to challenges facing human society. Earth and Space Science is offered in a block schedule, meeting daily for 87 minutes for half of the academic year (90 days). This course is divided into 11 units of study:

- Unit 1 – Introduction to Earth and Space Science
- Unit 2 – Earth's Interior
- Unit 3 – Plate Tectonics
- Unit 4 – Earthquakes
- Unit 5 – Volcanoes
- Unit 6 – Earth's History
- Unit 7 – Oceanography
- Unit 8 – Atmosphere
- Unit 9 – Weather and Climate
- Unit 10 – Rivers
- Unit 11 – Space Systems

The course aligns to the Next Generation Science Standards (NGSS) with a focus on students mastering both content and science and engineering practices. The NGSS performance expectations strongly reflect the many societally relevant aspects of earth science with an emphasis on using engineering and technology concepts to design solutions to challenges facing human society.

Students use the eight NGSS Science and Engineering Practices to demonstrate understanding of the disciplinary core ideas:

- Asking questions (science) and defining problems (engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using math and computational thinking
- Constructing explanations (science) and designing solutions (engineering)
- Engaging in argument from evidence
- Obtaining, evaluating and communicating information

The following crosscutting concepts identified within the NGSS support the development of a deeper understanding of the disciplinary core ideas:

- Scale, proportion and quantity
- Energy and matter
- Interdependence of Science, Engineering and Technology
- Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Patterns
- Stability and Change
- Influence of Engineering, Technology, and Science on Society and the Natural World
- Structure and Function
- Cause and Effect

Career Readiness, Life Literacies, and Key Skills

During this course, students will work on developing, to an age appropriate level, the following Career Readiness, Life Literacies, and Key Skills:

Disciplinary Concepts:

- Career Awareness and Planning
  - An individual's strengths, lifestyle goals, choices, and interests affect employment and income.
  - Developing and implementing an action plan is an essential step for achieving one's personal and professional goals.
  - Communication skills and responsible behavior in addition to education, experience, certifications, and skills are all factors that affect employment and income.

- Creativity and Innovation
  - Gathering and evaluating knowledge and information from a variety of sources, including global perspectives, fosters creativity and innovative thinking.
- Critical Thinking and Problem-solving
  - Multiple solutions exist to solve a problem.
  - An essential aspect of problem solving is being able to self-reflect on why possible solutions for solving problems were or were not successful.
- Digital Citizenship
  - Detailed examples exist to illustrate crediting others when incorporating their digital artifacts in one's own work.
  - Digital communities are used by Individuals to share information, organize, and engage around issues and topics of interest.
  - Digital technology and data can be leveraged by communities to address effects of climate change.
- Global and Cultural Awareness
  - Awareness of and appreciation for cultural differences is critical to avoid barriers to productive and positive interaction.
- Information and Media Literacy
  - Increases in the quantity of information available through electronic means have heightened the need to check sources for possible distortion, exaggeration, or misrepresentation.

- Digital tools make it possible to analyze and interpret data, including text, images, and sound. These tools allow for broad concepts and data to be more effectively communicated.
- Sources of information are evaluated for accuracy and relevance when considering the use of information.
- There are ethical and unethical uses of information and media.

- Technology Literacy
  - Some digital tools are appropriate for gathering, organizing, analyzing, and presenting information, while other types of digital tools are appropriate for creating text, visualizations, models, and communicating with others. • Digital tools allow for remote collaboration and rapid sharing of ideas unrestricted by geographic location or time.

Technology Integration

Computer Science and Design Thinking

During this course, students will work on developing, to an age appropriate level, the following Computer Science and Design Thinking Skills:

Disciplinary Concepts and Core Ideas:

- Data & Analysis
  - People use digital devices and tools to automate the collection, use, and transformation of data.
  - The manner in which data is collected and transformed is influenced by the type of digital device(s) available and the intended use of the data.
  - Data is represented in many formats. Software tools translate the low-level representation of bits into a form understandable by individuals. Data is organized and accessible based on the application used to store it.
  - The purpose of cleaning data is to remove errors and make it easier for computers to process.
  - Computer models can be used to simulate events, examine theories and inferences, or make predictions.
- Engineering Design
  - Engineering design is a systematic, creative and iterative process used to address local and global problems.
  - The process includes generating ideas, choosing the best solution, and making, testing, and redesigning models or prototypes.

- Engineering design requirements and specifications involve making trade-offs between competing requirements and desired design features.
- Interaction of Technology and Humans
  - Economic, political, social, and cultural aspects of society drive development of new technological products, processes, and systems.
  - Technology interacts with society, sometimes bringing about changes in a society's economy, politics, and culture, and often leading to the creation of new needs and wants.
  - New needs and wants may create strains on local economies and workforces.
  - Improvements in technology are intended to make the completion of tasks easier, safer, and/or more efficient.
- Nature of Technology
  - Technology advances through the processes of innovation and invention which relies upon the imaginative and inventive nature of people.
  - Sometimes a technology developed for one purpose is adapted to serve other purposes.
  - Engineers use a systematic process of creating or modifying technologies that is fueled and constrained by physical laws, cultural norms, and economic resources. Scientists use systematic investigation to understand the natural world.
- Effects of Technology on the Natural World
  - Resources need to be utilized wisely to have positive effects on the environment and society.
  - Some technological decisions involve trade-offs between environmental and economic needs, while others have positive effects for both the economy and environment.

ELA Integration

- NJSLS.RST.11-12.1-Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-5) (HS-ESS1-6) (HS-ESS2-2) (HS-ESS3-1) (HS-ESS3-2) (HS-ESS3-3) (HS-ESS3-4) (HS-ESS3-5)
- NJSLS.RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2) (HS-ESS3-5)
- NJSLS.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ESS3-5)
- NJSLS.RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or

challenging conclusions with other sources of information. (HS-ESS1-5) (HS-ESS1-6)

- NJSLS.SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-ESS1-3)
- NJSLS.SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-1) (HS-ESS2-3) (HS-ESS2-4)
- NJSLS.WHST.9-12.1 Write arguments focused on discipline-specific content. (HS-ESS1-6) (HS-ESS2-7)
- NJSLS.WHST .9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2) (HS-ESS1-3) (HS-ESS1-5)
- NJSLS.WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)

Math Integration:

- NJSLS.MP.2 Reason abstractly and quantitatively. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-3) (HS-ESS1-4) (HS-ESS1-5) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-2) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-6) (HS-ESS3-5)
- NJSLS.MP.4 Model with mathematics. (HS-ESS1-1) (HS-ESS1-4) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-6)
- NJSLS.HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-ESS1-1),(HS-ESS1-2) (HS-ESS1-4)
- NJSLS.HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4)
- NJSLS.HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4)HSS-ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. (HS-ESS1-6)
- NJSLS.HSF-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. (HS-ESS1-6)
- NJSLS.HSN-Q.A .1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-2) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-6) (HS-ESS3-5)
- NJSLS.HSN-Q.A .2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4) (HS-ESS1-5) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-6) (HS-ESS3-5)
- NJSLS.HSN-Q.A .3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4) (HS-ESS1-5) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-2) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-5) (HS-ESS2-6) (HS-ESS3-5)

Unit 1: Introduction to Earth and Space Science (6 Days)

Why Is This Unit Important?

This unit will build upon previous Earth Science knowledge and provide a foundation for the development of understanding the Earth and Space Science course.

- Students will describe the major fields of study in science and explain the major areas of Earth Science.
- Students will describe biogeochemical cycles such as the carbon, nitrogen and water cycles.
- Students will identify the Earth system's four spheres and explain the interactions between the Earth's four spheres.

Disciplinary Core Ideas:

ESS2.D: Weather and Climate

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6)

Science and Engineering Practices:

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-3),(HS-ESS2-6)

Cross Cutting Concepts:

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)

Enduring Understandings:

- Students will describe the major fields of study in science.
- Students will describe the major areas of Earth Science.
- Students will explain the cycle of carbon in Earth systems.
- Students will describe the cycle of water in Earth systems.
- Students will identify the Earth system's four spheres.
- Students will explain the interactions between the Earth's four spheres.

Essential Questions:

- How and why is Earth constantly changing?
- What importance does the abundance of liquid water play in the Earth's systems?
- How do plants and other organisms that captured carbon dioxide and release oxygen cause atmospheric changes?
- What are the five steps of the water cycle?
- Explain the biogeochemical cycles which move materials between the lithosphere, hydrosphere, and atmosphere.
- How does carbon move from one Earth System sphere to another?
- How does carbon change as it moves from one part of the carbon cycle to another?
- Where is carbon stored? For how long is it stored?
- Where is carbon found in the major Earth systems (biosphere, atmosphere, hydrosphere, geosphere)?
- What is meant by the term carbon cycle?
- What is the chemical process by which carbon dioxide in the atmosphere is transformed into organic carbon in the biosphere?
- What is the mechanism by which carbon dioxide is returned to the atmosphere from the geosphere?
- What are the important greenhouse gases and how do they function to warm the Earth's surface and atmosphere?

Acquired Knowledge:

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.
- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

Acquired Skills:

- Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
    - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6)
- Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
    - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)
- Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2)

Assessments:

Formative Assessment:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
    - Propose higher order questions
    - Present information to students and ask a question
    - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects
    - Students organize data that represent measurements of changes in hydrosphere, cryosphere, atmosphere, biosphere, or geosphere in response to a change in Earth's surface and describe what each data set represents.
    - Students use evidence to develop a model in which they identify the relative concentrations of carbon present in the hydrosphere, atmosphere, geosphere and biosphere and represent carbon cycling from one sphere to another.
- Chapter Test

Benchmark Assessment:

- **HS-ESS2-6.** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- What is your Earth Science IQ?
- Earth's 4 Spheres
- Open vs Closed Systems Reinforcement

In Class Activities and Laboratory Experiences:

- Earth's Systems Nearpod
- Carbon Cycle Flow Activity
- Egg and Density Lab
- Open and Closed Systems Activity
- Water Cycle Gizmo
- Nitrogen Cycle Gizmo
- Uniformitarianism & Catastrophism in the Grand Canyon Video

Closure and Reflection Activities

- Connect the Spheres: Earth System Interaction Student Capture Activity

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- https://www.youtube.com/watch?v=b4YPtgJw0QU
- https://edu.rsc.org/resources/carbon-cycle-game
- https://www.youtube.com/watch?v=a7mt3ClK7dM
- https://www.youtube.com/watch?v=W88Sact1kws
- https://www.youtube.com/watch?v=jxbIJH4fTYo
- https://www.youtube.com/watch?v=FgEZpX3n5mo

Unit 2: Interior of the Earth (6 Days)

Why Is This Unit Important?

The Earth's Core unit helps students understand how the layers of the Earth interact and how these interior interactions affect the Earth's surface.

- Students will identify the structure and composition of the interior of the Earth.
- Students will explain the formation of the planet Earth.
- Students will describe the sources of Earth's internal heat.

Disciplinary Core Ideas:

ESS2.A: Earth Materials and Systems

- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3)

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3)

PS4.A: Wave Properties

- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)

Science and Engineering Practices:

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-3),(HS-ESS2-6)

Cross Cutting Concepts:

Energy and Matter

- Energy drives the cycling of matter within and between systems. (HS-ESS2-3)

Enduring Understandings:

- Students will identify the composition of the interior of the Earth.
- Students will explain the formation of the planet Earth.
- Students will describe the sources of Earth's internal heat.
- Students will identify the structure of the Earth's interior.

Essential Questions:

- What causes regular changes in earth's landmasses?
- How has the movement of plate tectonics and Pangaea been supported?
- What are the causes of ocean currents?
- Why does the Earth have distinct layers?
- How do we know the Earth has different layers?
- How are events and dates in Earth's planetary history reconstructed?
- What is convection?
- What processes cause the continents to move?
- What are the sources of heat within the earth?
- How does the movement of tectonic plates impact the surface of Earth?

Acquired Knowledge:

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.
- The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust.
- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.

Acquired Skills:

- in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
  - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6)

Assessments:

Formative Assessment:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
  - Propose higher order questions
  - Present information to students and ask a question
  - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects:
  - Students use evidence to develop a model in which they identify and describe locations of specific continental features and specific ocean-floor features.
  - Students describe the relationships between Earth's internal processes.
  - Students use a model to illustrate the formation of continental and ocean floor features.
- Chapter Test

Benchmark Assessment:

- **HS-ESS2-3.** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- Meteorite Impact Activity
- Parallax Demo

In Class Activities and Laboratory Experiences:

- Earth's Interior Model
- Parallax Activity

Closure and Reflection Activities:

- Earth's Layers Drag and Drop (Nearpod)

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- https://news.harvard.edu/gazette/story/2021/02/new-theory-behind-asteroid-that-killed-the-dinosaurs/
- https://education.nationalgeographic.org/resource/resource-library-earth-structure
- https://lco.global/spacebook/distance/parallax-and-distance-measurement/
- https://pubs.usgs.gov/gip/interior/

Unit 3: Plate Tectonics (10 Days)

Why Is This Unit Important?

The key idea focused in this unit are the interactions between the crust and uppermost mantle and how this has been responsible for changing surface of the Earth.

- Students will explain movement along plate boundaries relate to the distribution of continents, mountains, and earthquakes.
- Students will describe continental drift and list the evidence that was used to support the continental drift hypothesis.
- Students will describe the evidence used to support the plate tectonics theory.
- Students will explain the differences between the continental drift hypothesis and the theory of plate tectonics.
- Students will explain seafloor spreading and describe the evidence that was used to support seafloor spreading.
- Students will calculate the rate of seafloor spreading.
- Students will describe the model mechanism for plate motion.

Disciplinary Core Ideas:

ESS1.C: The History of Planet Earth

- Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. *(ESS2.B Grade 8 GBE) (secondary to HS-ESS1-5)*,(HS-ESS2-1)

Science and Engineering Practices:

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5)

Cross Cutting Concepts:

Patterns

- Empirical evidence is needed to identify patterns. (HS-ESS1-5)

Enduring Understandings:

- Students will explain how the divergent, convergent, and transform plate boundaries relate to the distribution of continents, mountains, and earthquakes.
- Students will describe the evidence used to support the plate tectonics theory.
- Students will describe continental drift and list the evidence that was used to support the continental drift hypothesis.
- Students will explain the differences between the continental drift hypothesis and the theory of plate tectonics.
- Students will explain seafloor spreading and describe the evidence that was used to support seafloor spreading.
- Students will calculate the rate of seafloor spreading.
- Students will describe the model mechanism for plate motion.

Essential Questions:

- What are the hypotheses scientists hold as to the cause of plate movement?
- How are continental drift and plate tectonics related?
- How have plate movements caused changes in the positions and shapes of Earth�prime;s landmasses?
- What results from plate tectonics?
- How and why is Earth constantly changing?
- How does radioactive decay of unstable isotopes generate new energy within the Earth's crust and mantle drive mantle convection?
- How can continental rocks be so much older than rocks of the ocean floor?
- What is thermal convection and how does it act as the mechanism in which tectonic plates are moved across the surface of our planet?
- What is the theory of plate tectonics and how does it explain the past and current movements of the rocks at Earth's surface?
- How are plate movements responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust?

Acquired Knowledge:

- Continental rocks, which can be older than four billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history.
- Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.

Acquired Skills:

- Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
  - Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5)

Assessments:

Formative Assessment:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
  - Propose higher order questions
  - Present information to students and ask a question
  - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects:
  - Using a model, students identify that crustal materials of different ages attributed to plate tectonic activity and the formation of new rocks from magma rising where plates are moving apart.
  - Students use data as evidence to support motion of crustal plates (both oceanic and continental plates).
  - Students describe how the ages of crustal rocks occur in a repeatable and predictable pattern in both oceanic and continental rocks.
  - Students synthesize the relevant evidence to describe the relationship between the motion of continental plates.
- Chapter Test

Benchmark Assessment:

- **HS-ESS1-5.** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- Seafloor Spreading in Iceland
- Conduction/Convection Gizmos

In Class Activities and Laboratory Experiences:

- Pangaea/Continental Drift Model
- Rates of Seafloor Spreading Activity
- Plate Tectonic Gizmos
- (pHet) Plate Movement Simulation

Closure and Reflection Activities:

- Tectonic Plate Movement Graphic Organizer

Accommodations or Modifications (Special Education)

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- www.youtube.com/watch?v=DLwJT_igmIs
- http://phet.colorado.edu/en/simulation/plate-tectonics
- http://www.teachertube.com/video/plate-tectonics-17144
- https://www.youtube.com/watch?v=HrKTuCDierM

Unit 4: Earthquakes (10 Days)

Why Is This Unit Important?

This unit focuses on the cause of major shifts in tectonics plates and the results of movement along plate boundaries.

- Students will explain how earthquakes result from the buildup of energy in rocks.
- Students will describe how compression, tension and shear forces make rocks move along normal, reverse, and strike-slip faults.
- Students will explain how earthquake energy travels in seismic waves.
- Students will differentiate between primary, secondary and surface waves.
- Students will explain areas on Earth that frequently experience earthquakes.
- Students will describe how earthquakes are measured.

Disciplinary Core Ideas:

ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),*(Note: This Disciplinary Core Idea is also addressed by HS-ESS2-2.)*

Science and Engineering Practices:

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)

Cross Cutting Concepts:

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6)
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)

Enduring Understandings:

- Students will explain how earthquakes result from the buildup of energy in rocks.
- Students will describe how compression, tension and shear forces make rocks move along faults.
- Students will distinguish among normal, revers, and strike-slip faults.
- Students will explain how earthquake energy travels in seismic waves.
- Students will differentiate between primary, secondary and surface waves.
- Students will explain where most earthquakes occur on Earth.
- Students will describe how earthquakes are measured.

Essential Questions:

- What causes regular changes in earth's landmasses?
- How has the movement of plate tectonics and Pangaea been supported?
- How have plate movements caused changes in the positions and shapes of Earth's landmasses?
- What results from plate tectonics?
- How and why is Earth constantly changing?

Acquired Knowledge:

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust.

Acquired Skills:

- Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
    - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1)

Assessments:

Formative Assessment:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
    - Propose higher order questions
    - Present information to students and ask a question
    - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessments:

- Projects:
    - Students use evidence to develop a model in which they identify and describe continental and ocean floor features and the tectonic process by which they developed.
    - Using a model, students describe internal processes (volcanism, mountain building or tectonic uplift) as causal agents in building up Earth's surface over time.
- Chapter Test

Benchmark Assessment:

- No Benchmark Assessments with this unit

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Set:

- Measuring Seismic Waves Graphic Organizer
- Elastic Rebound Activity
- Travel Time Curve
- Virtual Earthquake Pre-lab

In Class Activities and Laboratory Experiences:

- Case Study: 2010 Haiti Earthquake
- Types of Faults Models
- Seismic Waves Travel Times
- Seismic Waves Activity
- Locating an Epicenter Nearpod
- Modify Model of Earth's Interior
- Earthquake Risk Map Activity
- Modified Mercalli Scale Activity
- Studying Earth's Interior Nearpod

Closure and Reflection Activities:

- Virtual Earthquake Lab
- Seismic Safe Structures Activity

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- http://phet.colorado.edu/en/simulation/wave-on-a-string
- https://www.khanacademy.org
- http://earthquake.usgs.gov/earthquakes/
- http://scedc.caltech.edu/recent/index.html

Unit 5: Volcanism (8 Days)

Why Is This Unit Important?

The central idea of this unit is the tension between internal systems, which are largely responsible for creating land at Earth's surface through both volcanism and mountain building.

- Students will understand how the layers of the interior of the Earth interact
- Students will develop models and explanations for the ways that feedbacks between different Earth systems control the appearance of Earth's surface.

Disciplinary Core Ideas:

ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),*(Note: This Disciplinary Core Idea is also addressed by HS-ESS2-2.)*

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. *(ESS2.B Grade 8 GBE) (secondary to HS-ESS1-5)*,(HS-ESS2-1)
- Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. *(ESS2.B Grade 8 GBE)* (HS-ESS2-1)

Science and Engineering Practices:

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1)

Cross Cutting Concepts:

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6)
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)

Enduring Understandings:

- Students will describe how volcanoes can affect people.
- Students will identify conditions that cause volcanoes to form.
- Students will identify the relationship between volcanoes and Earth's tectonic plates.
- Students will explain how the explosiveness of volcanic eruptions are related to the silica and water vapor content of its magma.
- Students will identify the three types of volcanic cones.

Essential Questions:

- What determines whether volcanoes are deadly or not?
- What conditions cause magma to form?
- What effects the type of volcanic eruption?
- Can volcanoes have a global effect on the earth?
- Why do volcanoes have different shapes and sizes?
- Why do volcanoes form in certain locations?
- What processes contribute to the formation of volcanoes?
- How can scientists predict volcanic eruptions and avoid hazards?
- What composes the interior of a volcano?

Acquired Knowledge:

- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.
- Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.
- Earth's 's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust.

Acquired Skills:

- Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
  - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1)
- Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
  - Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)

Assessments:

Formative Assessment:

- Homework
- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
  - Propose higher order questions
  - Present information to students and ask a question
  - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects:
    - Students use evidence to develop a model in which they identify and describe specific continental and ocean-floor features and the volcanic and surface processes (such as weathering and erosion) by which they developed.
    - In the model, students describe the relationships between components, including:
        - Specific internal processes, mainly volcanism, mountain building or tectonic uplift, are identified as causal agents in building up Earth’s surface over time.
        - Specific surface processes, mainly weathering and erosion, are identified as causal agents in wearing down Earth's surface over time.
        - Interactions and feedbacks between processes are identified (e.g., mountain-building, changes weather patterns that then change the rate of erosion of mountains).
        - The rate at which the features change is related to the time scale on which the processes operate. Features that form or change slowly due to processes that act on long timescales (e.g., continental positions due to plate drift) and features that form or change rapidly due to processes that act on short timescales (e.g., volcanic eruptions) are identified.
    - Students use the model to illustrate the relationship between the formation of continental and ocean floor features
        - Earth’s internal and surface processes operating on different temporal or spatial scales.
- Chapter Test

Benchmark Assessment:

- **HS-ESS2-1.** Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] [Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth’s surface.]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- Eruption of Mount St. Helens
- Where on Earth are Volcanoes?
- Volcanoes and Earth's Moving Plates
- Hawaiian Islands, Volcanoes and Legends
- Magma Formation
- Name That Cone!

In Class Activities and Laboratory Experiences:

- Volcano Nearpod
- Hawaiian Hotspots Lab
- Adopt an Active Volcano Project
- Volcanoes of the Deep-Sea Video
- Kilauea Video

Closure and Reflection Activities:

- Identifying Volcanic Cones Activity
- Types of Volcanic Cones Graphic Organizer

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- https://www.volcanodiscovery.com/home.html
- http://www.livescience.com/27295-volcanoes.html
- http://volcanoes.usgs.gov/index.html
- http://geology.com/volcanoes/
- http://volcano.oregonstate.edu/
- http://www.avo.alaska.edu/
- http://hvo.wr.usgs.gov/volcanoes/

Unit 6: Earth's History (7 Days)

Why Is This Unit Important?

Earth's history involves the coevolution of the biosphere with Earth's other systems, not only in the ways that climate and environmental changes have shaped the course of evolution, also in how emerging life forms have been responsible for changing Earth.

- Students will understand how to reconstruct and date events in Earth's planetary history
- Students will construct explanations for the scales of time over which Earth processes operate.

Disciplinary Core Ideas:

ESS2.D: Weather and Climate

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6)

ESS2.E Biogeology

- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)

Science and Engineering Practices:

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-3),(HS-ESS2-6)

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)

Cross Cutting Concepts:

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7)

Enduring Understandings:

- Students will describe the formation of the Earth's early atmosphere and the composition of the lower atmosphere.
- Students will list the conditions necessary for fossils to form and describe several processes of fossil formation.
- Students will explain how fossil correlation is used to determine rock ages.
- Students will determine how fossils can be used to explain changes in Earth's surface, life forms, and environments.
- Students will describe the methods used to assign relative ages to rock layers.
- Students will interpret gaps in the rock record.
- Students will give an example of how rock layers can be correlated with other rock layers.
- Students will identify how absolute age differs from relative age.
- Students will describe how the half-lives of isotopes are used to determine a rock's age.

Essential Questions:

- What is the concept of relative age?
- What is the relationship between the concept of relative age and the principle of superposition?
- What are fossils, how are they formed and what are they used for in Geology?
- How is a fossil mold different from a fossil cast?
- How are characteristics of an index fossil useful to geologists?
- How do carbon films form?
- How do radioactive isotopes decay?
- What is uniformitarianism?
- Why can't scientists use carbon-14 to determine the age of an igneous rock?

Acquired Knowledge:

- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.
- Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

Acquired Skills:

- Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
    - Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)
- Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
    - Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)

Assessments:

Formative Assessment:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
    - Propose higher order questions
    - Present information to students and ask a question
    - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects:
    - Students construct an account of Earth's formation and early history that includes that Earth formed along with the rest of the solar system 4.6 billion years ago, the early Earth was bombarded by impacts just as other objects in the solar system were bombarded, and erosion and plate tectonics on Earth have destroyed much of the evidence of this bombardment, explaining the relative scarcity of impact craters on Earth.
    - Students include and describe the following evidence in their explanatory account
        - The age and composition of Earth's oldest rocks
        - Activity of plate tectonic processes, such as volcanism, and surface processes, such as erosion, operating on Earth.
    - Students use reasoning to connect the evidence to construct the explanation of Earth's formation and early history, including that:
        - The oldest Earth rocks point to an origin of the solar system 4.6 billion years ago, with the creation of a solid Earth crust about 4.4 billion years ago.
        - The relative lack of impact craters and the age of most rocks on Earth compared to other bodies in the solar system can be attributed to processes such as volcanism, plate tectonics, and erosion that have reshaped Earth's surface, and that this is why most of Earth's rocks are much younger than Earth itself.

- Students identify and describe evidence supporting the evolution of life on Earth, including:
  - Scientific explanations about the composition of Earth's atmosphere shortly after its formation.
  - Current atmospheric composition.
- Students use at least two examples to construct oral and written logical arguments. The examples:
  - Include that the evolution of photosynthetic organisms led to a drastic change in Earth's atmosphere and oceans.
  - Identify causal links and feedback mechanisms between changes in the biosphere and changes in Earth's other systems.

- Chapter Test

Benchmark Assessment:

- **HS-ESS1-6.** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion y ears ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]
- **HS-ESS2-6.** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]
- **HS-ESS2-7.** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Set:

- Major Events in the History of the Earth
- Earth's History Timeline Pre-lab
- Fossils Identification Activity
- Extinction of the Dinosaurs Video

In Class Activities and Laboratory Experiences:

- Earth's History Timeline Lab
- Correlating Sedimentary Strata Lab
- Radioactive Dating Game
- Fossil Project
- Half-life Practice Worksheet
- Events in Geologic Time Project

Closure and Reflection Activities:

- Relative Age of Rock Layers Activity
- Radioactive Decay: A Sweet Simulation

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- http://phet.colorado.edu/en/simulation/legacy/radioactive-dating-game
- http://www.scotese.com/earth.htm
- http://www.fossilmuseum.net/GeologicalHistory.htm
- http://www.ucmp.berkeley.edu/help/timeform.php
- http://www.ucmp.berkeley.edu/fosrec/BarBar.html

Unit 7: Oceanography (10 Days)

Why Is This Unit Important?
The goal of this unit is to understand the significance of water on Earth and its importance to a host of unique features on your home planet.

- Students will identify the origin of water on Earth
- Students will explain how the oceans affect weather and climate

Disciplinary Core Ideas:

ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)

ESS2.D: Weather and Climate

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2)

Science and Engineering Practices:

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2)

Cross Cutting Concepts:

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)
- Energy drives the cycling of matter within and between systems. (HS-ESS2-3)

Enduring Understandings:

- Students will explain the origin of the water in Earth's the oceans.
- Students will describe the composition of seawater.
- Students will describe density currents.
- Students will explain how the Coriolis Effect influences surface currents.
- Students will discuss the temperatures of ocean waters.
- Students will explain how ocean tides form.

Essential Questions:

- How are events and dates in Earth's planetary history reconstructed?
- How does the movement of tectonic plates impact the surface of Earth?
- How and why is Earth constantly changing?
- What importance does the abundance of liquid water play in the Earth's systems?
- How do plants and other organisms that captured carbon dioxide and release oxygen cause atmospheric changes?
- What are the causes of ocean currents?

Acquired Knowledge:

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.)
- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

Acquired Skills:

- Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
  - Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)
- Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
  - Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

Assessments:

Formative Assessment:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
    - Propose higher order questions
    - Present information to students and ask a question
    - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects:
    - Students organize data from global climate models and climate observations over time that relate to the effect of climate change on the physical parameters or chemical composition of the atmosphere, geosphere, hydrosphere, or cryosphere.
    - Students use their analysis of the data to describe a selected aspect of present or past climate and the associated physical parameters (e.g., temperature, precipitation, sea level) or chemical composition (e.g., ocean pH) of the atmosphere, geosphere, hydrosphere or cryosphere.
    - Students use their analysis of the data to predict the future effect of a selected aspect of climate change on the physical parameters (e.g., temperature, precipitation, sea level) or chemical composition (e.g., ocean pH) of the atmosphere, geosphere, hydrosphere or cryosphere.
    - Students describe whether the predicted effect on the system is reversible or irreversible.
- Oceanography Test

Benchmark Assessment:

- No Benchmark Assessment for this unit

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- Features of the Ocean Floor
- Ocean Currents Reinforcement
- Gulf Stream Enrichment
- Volcanoes of the Deep-Sea Video
- The Blue Planet: The Deep

In Class Activities and Laboratory Experiences:

- Density Lab
- Mapping the Ocean Floor Lab
- Coriolis Effect Activity
- Life on the Ocean Floor Nearpod
- Coral Reef Gizmos
- Oceanographers Report Project

Closure and Reflection Activities:

- Original Deep Organism Project
- Buoy Lab
- Tide Lab

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- http://rjd.miami.edu/assets/pdfs/learning-tools/high-school/MODULE%201%20Ocean%20and%20Coastal%20Habitat%20-%20SECTION%201%20Ocean%20Zones.pdf
- https://education.nationalgeographic.org/resource/resource-library-ocean-currents
- https://tidesandcurrents.noaa.gov/
- https://manoa.hawaii.edu/exploringourfluidearth/physical/ocean-floor

Unit 8: Atmosphere (7 Days)

Why Is This Unit Important?

In the Atmosphere unit, students will learn how gases move between the atmosphere and other parts of the Earth system, yet the composition of the atmosphere remains fairly constant. Local events can change the composition of the atmosphere and have global consequences.

- Describe the evolution of the Earth's atmosphere throughout its history
- Explain the effect of human interaction on the concentration of certain gases in the atmosphere

Disciplinary Core Ideas:

ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)

ESS2.D: Weather and Climate

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2)

Science and Engineering Practices:

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2)

Cross Cutting Concepts

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

Enduring Understandings:

- Students will interconnect Earth events taking place within the global environment, and determine the interdependencies at many levels and scale.
- Students will describe what happens to solar energy once it reaches the Earth.
- Students will describe how the energy budget of the Earth is balanced.
- Students will discuss how changes in the composition of a planet's atmosphere will affect the temperature of that planet.
- Students will describe how energy from the sun moves through the atmosphere by radiation, conduction, and convection.
- Students will identify the characteristics of each atmospheric layer.
- Students will analyze the Earth's heat budget.
- Students will identify how geography influences temperature changes in the troposphere.
- Students will explain the characteristics of the water cycle.
- Students will investigate the effects of air pollution and ozone on the formation of smog.
- Students will learn that the tilt of the Earth on its axis causes the variations in sunlight throughout the year.
- Students will analyze the vertical structure of the atmosphere to understand its impact on life.

Essential Questions:

- How have changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities affected global and regional climate?
- What phenomena cause the recurring cycle of ice ages and gradual climate change?
- What role does electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space play in the global climate?
- Explain the biogeochemical cycles which move materials between the lithosphere, hydrosphere, and atmosphere.
- Where is carbon found in the major Earth systems (biosphere, atmosphere, hydrosphere, geosphere)?
- What is the chemical process by which carbon dioxide in the atmosphere is transformed into organic carbon in the biosphere?
- What is the impact on the atmosphere of the burning of fossil fuel?
- How does chemical weathering transfer carbon dioxide from the atmosphere and store it in rock?
- What is the mechanism by which carbon dioxide is returned to the atmosphere from the geosphere?
- What are the important greenhouse gases and how do they function to warm the Earth's surface and atmosphere?
- What are some of the likely impacts of climate change on the atmosphere, hydrosphere, and biosphere?
- How is the energy that is received by Earth distributed?

Acquired Knowledge:

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes.
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks
- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

Acquired Skills:

- Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
  - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6)
  - Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)
- Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
  - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)

Assessments:

Formative Assessments:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
    - Propose higher order questions
    - Present information to students and ask a question
    - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects:
    - Students Identify and describe the phenomenon to be investigated:
        - How the properties of water effects Earth materials and surface processes, which includes the following idea: a connection between the properties of water and its effects on Earth materials.
        - Students describe the data that will be collected and the evidence describing energy transfer that causes the patterns of temperature, the movement of air, and the movement and availability of water at Earth's surface.
    - Students will investigate the role of the heat capacity of water to affect the temperature, movement of air and movement of water at the Earth's surface.

- Chapter Test

Benchmark Assessment:

- **HS-ESS-2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- Good Ozone vs Bad Ozone
- Atmospheric Temperature Enrichment
- Model of Earth's Atmosphere
- Global Winds Activity
- Atmosphere Riddles

In Class Activities and Laboratory Experiences:

- Model Layers of the Atmosphere Activity
- Ozone in the Atmosphere Virtual
- Earth's Blanket of Gases Activity
- Angle of Insolation Lab
- Acid Rain Lab

Closure and Reflection Activities:

- Greenhouse Effect Gizmos
- Structure of the Earth's Atmosphere Virtual Lab

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- http://www.pbslearningmedia.org/resource/ess05.sci.ess.watcyc.ozonehole/ozone-hole/
- http://sunshine.chpc.utah.edu/Labs/OurAtmosphere/ozone_main.html
- https://www.epa.gov/acidrain/what-acid-rain#:~:text=Acid%20rain%2C%20or%20acid%20deposition,even%20dust%20that%20is%20acidic
- https://flexbooks.ck12.org/cbook/ck-12-middle-school-earth-science-flexbook-2.0/section/10.17/primary/lesson/global-wind-belts-ms-es/

Unit 9: Weather and Climate (6 Days)

Why Is This Unit Important?

The emphasis in this unit is on system interactions that control weather and climate, with a major focus on the mechanisms and implications of climate change. Students also understand the complex and significant interdependencies between humans and the rest of Earth's systems through the impacts of natural hazards, our dependencies on natural resources, and the environmental impacts of human activities.

- The Weather and Climate unit help students formulate an answer to the question: Identify factors that regulate weather and climate
- Model and predict the effects of human activities on Earth's climate

Disciplinary Core Ideas:

ESS1.B: Earth and the Solar System

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. *(secondary to HS-ESS2-4)*

ESS2.A: Earth Materials and Systems

- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

ESS2.D: Weather and Climate

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-4)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6),(HS-ESS2-4)

ESS3.D: Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)

Science and Engineering Practices:

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

Cross Cutting Concepts:

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4)

Stability and Change

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-5)

Enduring Understandings:

- Students will explain how solar heating and water vapor in the atmosphere affect weather.
- Students will explain the unintended consequences of harvesting natural resources from an ecosystem.
- Students will compare over time the impact of human activity on the cycling of matter and energy though ecosystems. Students will assess how the natural environment has changed since humans have inhabited the regions using maps, local planning documents and historical records.
- Students will describe what determines climate.
- Students will explain how latitude and other factors affect the climate of a region.
- Students will differentiate between different climate regions.
- Students will explain what causes seasons.
- Students will determine possible causes of climatic change.

Essential Questions:

- How have changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities affected global and regional climate?
- What are the varying time-scales that global and regional climate change can occur on?
- What phenomena cause the recurring cycle of ice ages and gradual climate change?
- What role does electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space play in the global climate?
- How do the outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere?
- What are the associated economic, social, environmental, and geopolitical costs and risks as well as benefits of all forms of energy production and other resource extraction?
- How have natural hazards and other geologic events significantly altered the sizes of human populations and driven human migrations?
- What type of regulations and responsible management of natural resources are needed to ensure the sustainability of human societies and biodiversity that supports them?

Acquired Knowledge:

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes.
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.
- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

Acquired Skills:

- Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
  - Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)
- Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
  - Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

Assessments:

Formative Assessment:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
  - Propose higher order questions
  - Present information to students and ask a question
  - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects:
  - Students identify and describe a model of Earth's climate relevant for mechanistic descriptions. Models include at least one factor that affects the input of energy, at least one factor that affects the output of energy, and at least one factor that affects the storage and redistribution of energy. Factors are derived from the following list:
    - Ocean circulation.
    - Atmospheric composition (including amount of water vapor and CO2).
    - Atmospheric circulation.
    - Human activities.
  - Students organize these factors into three group: those that affect the input of energy, those that affect the output of energy, and those that affect the storage and redistribution of energy.
    - Weather and Climate Test

Benchmark Assessment:

- **HS-ESS2-4.** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]
- **HS-ESS3-5.** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Set:

- Ozone Hole Video
- Weather vs Climate
- Climate Change Pre-quiz
- Seasons Video (Nearpod)

In Class Activities and Laboratory Experiences:

- Atmospheric Carbon vs Global Temperature Anomaly
- Climate of Doubt: Politics of Global Warming Video
- Global Sea-level Rise Activity
- Studying the Ice Ages Activity
- Seasons Gizmo
- Career Exploration: Climatologist

Closure and Reflection Activities:

- Seasons Graphic Organizer
- Seasons Drag and Drop (Nearpod)

Accommodations or Modifications (Special Education)

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners)

- Analyze and work with case studies to connect and extend lessons to the real world

Technology Connections:

- http://sealevel.climatecentral.org/
- https://coast.noaa.gov/digitalcoast/tools/slr
- https://www.pbs.org/wgbh/pages/frontline/environment/climate-of-doubt/press-release-19/#:~:text=Climate%20of%20Doubt%20describes%20the,change%20caused%20by%20human%20activity.
- http://phet.colorado.edu/en/simulation/legacy/greenhouse
- https://education.nationalgeographic.org/resource/season
- www.youtube.com/watch?v=wwdB22opre0
- https://www.weather.gov/lmk/seasons#:~:text=As%20the%20earth%20spins%20on,is%20what%20causes%20the%20seasons

Unit 10: Rivers (6 Days)

Why Is This Unit Important?

This unit focuses on the impact rivers have on the appearance of the Earth's surface and the Sun's influence over the processes of weathering and erosion.

- Explain how does surface water shape the surface of the Earth
- Identify the role of rivers in the hydrologic cycle

Disciplinary Core Ideas:

ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)

Science and Engineering Practices:

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)

Cross Cutting Concepts:

Structure and Function

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)

Enduring Understandings:

- Students will differentiate between soil erosion and deposition.
- Students will compare and contrast soil permeability and porosity.
- Students will identify the different types of mechanical weathering
- Students will identify the different types of chemical weathering.
- Students will identify three stages of stream development.
- Students will explain the causes of runoff.
- Students will explain how alluvial fans and deltas form.

Essential Questions:

- What are the five steps of the water cycle?
- What importance does the abundance of liquid water play in the Earth's systems?
- What causes regular changes in earth's landmasses?
- What is the difference between weathering and erosion.

Acquired Knowledge:

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

Acquired Skills:

- Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
    - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)

Assessments:

Formative Assessments:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
    - Propose higher order questions
    - Present information to students and ask a question
    - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessments:

- Projects:
  - Students describe the phenomenon under investigation, which includes the following idea: a connection between the properties of water and its effects on Earth materials and surface processes.
  - Students develop an investigation plan and describe the data that will be collected and the evidence to be derived from the data, including:
    - Properties of water, such as the heat capacity of water and density of water in its solid and liquid states.
    - The effect of the properties of water on energy transfer that causes the patterns of temperature, the movement of air, and the movement and availability of water at Earth's surface.
    - Mechanical effects of water on Earth materials that can be used to infer the effect of water on Earth's surface processes. Examples can include:
    - Stream transportation and deposition using a stream table, which can be used to infer the ability of water to transport and deposit materials
    - Erosion using variations in soil moisture content, which can be used to infer the ability of water to prevent or facilitate movement of Earth materials
    - The expansion of water as it freezes, which can be used to infer the ability of water to break rocks into smaller pieces.
    - Chemical effects of water on Earth materials that can be used to infer the effect of water on Earth's surface processes. Examples can include:
      - Solubility of different materials in water, which can be used to infer chemical weathering and recrystallization.
      - Reaction of iron to rust in water, which can be used to infer the role of water in chemical weathering.
    - In their investigation plan, students include a means to indicate or measure the predicted effect of water on Earth's materials or surface processes. Examples include:
      - The role of the heat capacity of water to affect the temperature, movement of air and movement of water at the Earth's surface.
      - The role of flowing water to pick up, move and deposit sediment.
      - The role of the polarity of water (through cohesion) to prevent or facilitate erosion.
      - The role of the changing density of water (depending on physical state) to facilitate the breakdown of rock.
      - Water as a component in chemical reactions that change Earth materials.
  - Rivers Test

Benchmark Assessment:

- **HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Set:

- Groundwater Reinforcement
- Chemical vs Physical Weathering

In Class Activities and Laboratory Experiences:

- Stream Deposition Graphic Organizer
- Stages of Stream Development
- Soil Formation Activity

Closure and Reflection Activities:

- Measuring Stream Flow Virtual Lab
- Groundwater Movement Activity
- Stream Erosion Lab

Technology Connections:

- http://www.geography.learnontheinternet.co.uk/topics/river_erosion.html
- https://www.sciencecourseware.org/VirtualRiver/
- https://www.reference.com/science/three-stages-stream-development-b4eb2fef2e15d072
- https://www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-formation#:~:text=Soil%20formation%20begins%20with%20the,inherent%20physical%20and%20chemical%20characteristics.

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Unit 11: Space Systems (10 Days)

Why Is This Unit Important?
This unit examines the processes governing the formation, evolution, and workings of the solar system and universe.

- Explain what is meant by the term "universe"
- Explain the processes that occur inside stars
- Predict patterns caused by Earth's movement in the solar system

Disciplinary Core Ideas:

ESS1.A: The Universe and Its Stars

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1)
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3)
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2)
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2),(HS-ESS1-3)

ESS1.B: Earth and the Solar System

- Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4)

PS3.D: Energy in Chemical Processes and Everyday Life

- Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. *(secondary to HS-ESS1-1)*

PS4.B: Electromagnetic Radiation

- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. *(secondary to HS-ESS1-2)*

Science and Engineering Practices:

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-1)

Using Mathematical and Computational Thinking

- Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)

Constructing Explanations and Designing Solutions

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS1-2)

Obtaining, Evaluating, and Communicating Information

- Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS1-3)

Cross Cutting Concepts:

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1)
- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4)

Energy and Matter

- Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2)
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-ESS1-3)

Enduring Understandings

- Students will be able to evaluate evidence supporting the big bang theory.
- Students will understand the relationship between color and temperature of a star.
- Students will explain how stellar distances are determined.
- Students will distinguish between temperature and luminosity and apparent magnitude.
- Students will describe how the H-R Diagram is constructed and used to identity stellar properties.
- Students will plot stars on the H-R diagram.
- Students will summarize the sequence of events leading to the formation of a star like our sun.
- Students will describe the observational evidence supporting the modern theory of star formation.

- Students will explain how the formation of a star is affected by its mass.
- Students will explain why/how stars evolve off the main sequence.
- Students will summarize the evolutionary stages followed by a sun-like star once it leaves the main sequence.
- Students will explain how white dwarfs form.
- Students will compare and contrast the death of high and low mass stars.
- Students will evaluate the models of the universe developed by Aristotle, Ptolemy, Copernicus, and Kepler.
- Students will describe the three main types of galaxies.
- Students will analyze the nebular hypothesis.
- Students will cite evidence for the theory of the expanding universe.

Essential Questions:

- How do short-term changes in the behavior of our sun directly affect humans?
- What will be the eventual fate of our sun?
- Where in its life cycle is our Sun and what is its approximate life span?
- How does Hubble's Diagram provide evidence for the expanding universe?
- How are the three main types of galaxies different from one another?
- How is stellar parallax used to measure the distances to stars?
- How did the matter of our world form during the Big Bang and within the cores of stars?
- How was the solar system formed and how has it changed and evolved in the 5 billion years since its formation?
- How do distant galaxies provide evidence of the Big Bang?
- How does the composition stars and spectral mapping of primordial radiation support the Big Bang theory?
- How does the electromagnetic spectrum help astronomers learn about stars?
- What is plotted on the H-R Diagram?
- How do astronomers measure star temperatures?
- What is the general relationship between color and temperature of a star?
- What is the birthplace for all stars?
- How do stars form into main sequence stars?
- How do main sequence stars form into white dwarfs?
- How do massive main sequence stars form into black holes?
- What causes a star to explode?
- What is the difference between apparent magnitude and luminosity?
- What is the major difference between Ptolemy and Copernicus' models of the solar system?
- How did the Earth and its solar system develop?

Acquired Knowledge:

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.
- Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.
- Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.
- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.

Acquired Skills:

- Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
  - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-1)
- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
  - Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)
- Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
  - Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS1-2)
- Obtaining, evaluating, and communicating information in 9-12 builds on K-8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.
  - Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS1-3)

Assessments:

Formative Assessment:

- Daily Do Now and Essential Questions
- Homework
- Group discussions/presentations
- Blooket/Kahoot games
- Liveworksheets
- Nearpod
- Gizmos
- Group discussions/presentations:
  - Propose higher order questions
  - Present information to students and ask a question
  - Have students discuss their answers with their peers at their table and discuss together as a group
- Exit Tickets

Summative Assessment:

- Projects:
  - Students use evidence to develop a model in which they identify and describe the relevant components, including hydrogen as the sun's fuel, helium and energy as the products of fusion processes in the sun, and, that the sun, like all stars, has a lifespan based primarily on its initial mass, and the sun's lifespan is about 10 billion years.
  - Students use the model to predict how the relative proportions of hydrogen to helium change as the sun ages.
  - Students construct an explanation that includes a description of how astronomical evidence from numerous sources is used collectively to support the Big Bang theory, which states that the universe is expanding and that thus it was hotter and denser in the past, and that the entire visible universe emerged from a very tiny region and expanded.
  - Students identify and describe the relevant components in Kepler's laws of planetary motion.
  - Students use Newton's law of gravitation plus his third law of motion to predict how the acceleration of a planet towards the sun varies with its distance from the sun, and to argue qualitatively about how this relates to the observed orbit.
- Chapter Test

Benchmark Assessment:

- **HS-ESS1-1.** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11- y ear sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.]
- **HS-ESS1-2.** Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. [Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).]

- **HS-ESS1-3.** Communicate scientific ideas about the way stars, over their life cycle, produce elements. [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a s tar and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathway s for stars of differing masses are not assessed.]
- **HS-ESS1-4.** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.] [Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus.]

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Set:

- Rotation vs Revolution
- The Universe: Life and Death of a Star Video
- The Universe: Beyond the Big Bang

In Class Activities and Laboratory Experiences:

- Reason for the Seasons
- Motions of the Moon Stations Lab
- Famous Astronomers Research Project
- Terrestrial vs Jovian Planets Graphic Organizer
- Dwarf Planets Activity
- Black Holes: The Ultimate Abyss Video
- Modeling the Expansion of the Universe
- Career Exploration: Astrophysicist

Closure and Reflection Activities:

- H-R Diagram Activity
- Nuclear Reactions Gizmos
- Galaxies Identification Lab
- Big Bang Theory Hubble's Law Gizmos
- Solar System Gizmos
- Orbital Motion-Kepler's Laws Gizmos

Accommodations or Modifications (Special Education):

- Teacher made worksheets, graphic organizers, study guides, and other resources

Accommodations or Modifications (Gifted Learners):

- Analyze and work with case studies to connect and extend lessons to the real world

Instructional Materials:

- McDougal Littell Earth Science; 2007

Technology Connections:

- http://www.seasky.org/celestial-objects/stars.html
- http://phet.colorado.edu/en/simulation/legacy/gravity-and-orbits
- https://astronomy.swin.edu.au/cosmos/h/hertzsprung-russell+diagram
- https://nineplanets.org/type-of-galaxies/

Sample Standards Integration

<u>Career Readiness, Life Literacies, and Key Skills</u> **9.4.12.CI.1:** For example, in Unit 7, students explore the resistance to accepting cause and effect relationships between certain industrial practices and their resulting impacts on our environment. **9.4.12.CT.2:** For example, in Unit 2, students will work collaboratively to build a project where they apply their understanding of earthquakes to design, test, and modify a structure specifically designed to mitigate the effects of an earthquake. **9.4.8.IML.5:** For example, in Unit 3, students analyze information from multiple sources to develop a model to understand climate change.
<u>8.1 Computer Science and Design Thinking</u> **All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and create and communicate knowledge.** For example in Unit 2, students will access, manage, evaluate, and synthesize information to analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
LGBT and Disabilities Law: In Unit 3 the Oceanographers Report Project has students explore the contributions of oceanographers from varying minorities including those who are LGBTQ and have disabilities
Career Exploration: • In Unit 9 there is a Career Exploration: Climatologist • In Unit 11 there is a Career Exploration: Astrophysicist

Interdisciplinary Connections

NJSLS.RST.11-12.1-Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-5) (HS-ESS1-6) (HS-ESS2-2) (HS-ESS3-1) (HS-ESS3-2) (HS-ESS3-3) (HS-ESS3-4) (HS-ESS3-5)

NJSLS.RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2) (HS-ESS3-5)

NJSLS.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ESS3-5)

NJSLS.RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS1-5) (HS-ESS1-6)

NJSLS.SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-ESS1-3)

NJSLS.SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-1) (HS-ESS2-3) (HS-ESS2-4)

NJSLS.WHST.9-12.1 Write arguments focused on discipline-specific content. (HS-ESS1-6) (HS-ESS2-7)

NJSLS.WHST .9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2) (HS-ESS1-3) (HS-ESS1-5)

NJSLS.WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)

These standards are met through the completion of the benchmark performances in all three units. For example in Unit 2, students will read texts and use media to evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

NJSLS.MP.2 Reason abstractly and quantitatively. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-3) (HS-ESS1-4) (HS-ESS1-5) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-2) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-6) (HS-ESS3-5)

NJSLS.MP.4 Model with mathematics. (HS-ESS1-1) (HS-ESS1-4) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-6)

NJSLS.HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-ESS1-1),(HS-ESS1-2) (HS-ESS1-4)

NJSLS.HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4)

NJSLS.HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4)HSS-ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. (HS-ESS1-6)

NJSLS.HSF-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. (HS-ESS1-6)

NJSLS.HSN-Q.A .1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-2) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-6) (HS-ESS3-5)

NJSLS.HSN-Q.A .2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4) (HS-ESS1-5) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-6) (HS-ESS3-5)

NJSLS.HSN-Q.A .3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1) (HS-ESS1-2) (HS-ESS1-4) (HS-ESS1-5) (HS-ESS1-6) (HS-ESS2-1) (HS-ESS2-2) (HS-ESS2-3) (HS-ESS2-4) (HS-ESS2-5) (HS-ESS2-6) (HS-ESS3-5)

These standards are met through the completion of the benchmark performance in Unit 1, students apply scientific reasoning, evidence and data from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.