EARTH AND SPACE SCIENCE
GRADES 9-12

EWING PUBLIC SCHOOLS
2099 Pennington Road
Ewing, NJ 08618

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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.

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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 Core
- 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

Resources - Text:

- Essentials – Glencoe Scientific: Earth Science
- Level 1 – Thompson and Turk: Earth Science and the Environment
- Honors – McDougal Littell: Earth Science

21st Century Life and Careers

In today's global economy, students need to be lifelong learners who have the knowledge and skills to adapt to an evolving workplace and world. To address these demands, Standard 9, 21st Century Life and Careers, which includes the 12 Career Ready Practices, establishes clear guidelines for what students need to know and be able to do in order to be successful in their future careers and to achieve financial independence.

Career Ready Practices

Career ready practices describe the career ready skills that all educators in all content areas should seek to develop in their students. These are practices that have been to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectations as a student advances through a program of study.

9.3 Career and Technical Education

This standard outlines what students should know and be able to do upon completion of a CTE Program of Study.

Architecture & Construction (AC)

- 9.3.12.AC.1: Use vocabulary, symbols and formulas common to architecture and construction.
- 9.3.12.AC.2: Use architecture and construction skills to create and manage a project.

Design/Pre-Construction (AC-DES)

- 9.3.12.AC-DES.1: Justify design solutions through the use of research documentation and analysis of data.

Finance (FN)

- 9.3.12.FN.1: Utilize mathematical concepts, skills and problem solving to obtain necessary information for decision making in the finance industry.

Science, Technology, Engineering & Mathematics (ST)

- 9.3.ST.1: Apply engineering skills in a project that requires project management, process control and quality assurance.

- 9.3.ST.6: Demonstrate technical skills needed in a chosen STEM field.

Technology Integration

8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.

- 8.1.12.A.2 Produce a multi-page digital portfolio for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
- 8.1.12.A.3 Participate in online courses, learning communities, social networks or a virtual world as resources for lifelong learners.
- 8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts, and data from all worksheets to convey the results.

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 (5 Days)

Why Is This Unit Important?

Introduction to Earth and Space Science helps students formulate answers to the questions: “What are the major fields of science that govern this discipline?” and “How do the major Earth systems interact?” Students can develop models and explanations for the ways that feedbacks between different Earth systems control the appearance of Earth’s surface. Students understand chemical cycles such as the carbon cycle. Students can examine the ways that human activities cause feedbacks that create changes to other systems. The crosscutting concepts of energy and matter; structure and function; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In this unit students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

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. (HS-ESS2-2)
- 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)
- 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)
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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.
- Earth & Space Science Test

Benchmark Assessment:

- Students will be able 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.
- Students will be able to plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- Students will be able to develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- What is your Earth Science IQ?
- Daily Essential Question
- Earth's 4 Spheres
- Open vs Closed Systems Reinforcement
- Layers of the Earth Graphic Organizer

In Class Activities and Laboratory Experiences:

- Connect the Spheres: Earth System Interaction Student Capture Activity
- Carbon Cycle Flow Chart (9.3.ST.6)
- Egg and Density Lab (8.1.12.A.2)
- Open and Closed Systems Activity
- Uniformitarianism & Catastrophism in the Grand Canyon Video

Closure and Reflection Activities:

- Exit ticket
- Google Classroom Questions

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- NJSLS.HS-ESS2-2
- NJSLS.HS-ESS2-5
- NJSLS.HS-ESS2-6

Unit 2: Earth's Core (3 Days)

Why Is This Unit Important?

The Earth's Core unit helps students formulate answers to the questions: "How do the layers of the Earth interact?" and "How do the properties and movements of the interior of the Earth affect the Earth's surface?" Students can develop models and explanations for the ways that feedbacks between different Earth layers control the appearance of Earth's surface. Central to this is the tension between internal systems, which are largely responsible for creating land at Earth's surface (e.g., volcanism and mountain building). The crosscutting concepts of energy and matter; structure and function; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the Earth's Core unit students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

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. (HS-ESS2-1)
- 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)
- 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)
- 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. (ESS2.B Grade 8 GBE) (HS-ESS2-1)
- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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.
- Earth's Core Test

Benchmark Assessment:

- Students will be able to 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.
- Students will be able to develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- KWL Chart
- Daily Essential Question

In Class Activities and Laboratory Experiences:

- Model the Earth's Interior
- Rock Type Identification Activity

Closure and Reflection Activities:

- Exit ticket
- Google Classroom Questions

Technology Connections:

- Google Education Tools
- Kahoot

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS2-1
- HS-ESS2-3

Unit 3: Plate Tectonics (8 Days)

Why Is This Unit Important?

The Plate Tectonics unit helps students formulate answers to the question “Why do the continents move?” Students can construct explanations for the scales of time over which Earth processes operate. A mathematical analysis of the rates of seafloor spreading is used to comprehend how ages of ocean floor are obtained. A key to Plate Tectonics is the interactions between the crust and uppermost mantle and how this has been responsible for changing surface of the Earth. The crosscutting concepts of patterns and stability and change are called out as organizing concepts for these disciplinary core ideas.

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‘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. (HS-ESS1-5)
- 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)
- 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. (secondary to HS-ESS1-5)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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.
- Plate Tectonics Test

Benchmark Assessment:

- Students will be able 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.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- KWL Chart
- Daily Essential Question
- Seafloor Spreading in Iceland

In Class Activities and Laboratory Experiences:

- Model Pangaea/Continental Drift :Lab
- Rates of Seafloor Spreading Activity
- Tectonic Plate Movement Activity
- (pHet) Plate Movement Simulation (8.1.12.A.3)
- Plate Tectonics Program (8.1.12.A.3)

Closure and Reflection Activities:

- Exit ticket
- Google Classroom Questions

Technology Connections:

- Google Education Tools
- Kahoot
- http://phet.colorado.edu/en/simulation/plate-tectonics

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS1-5

Unit 4: Earthquakes (12 Days)

Why Is This Unit Important?

The Earthquakes unit helps students formulate answers to the questions: "What causes the major shifts in tectonics plates?" and "What are the results of movement along plate boundaries?" Students can develop models and explanations for the ways that feedbacks between different tectonic plates and how this controls the appearance of Earth's surface. Central to this is the tension between internal systems, which are largely responsible for creating land at Earth's surface (e.g., volcanism and mountain building). The crosscutting concepts of energy and matter; structure and function; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the Earthquakes unit students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

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. (HS-ESS2-1)
- 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. *(ESS2.B Grade 8 GBE)* (HS-ESS2-1)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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.
- Earthquakes Test

Benchmark Assessment:

- Students will be able to 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.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- KWL Chart
- Measuring Seismic Waves Graphic Organizer
- What if YOU were in an earthquake?
- Travel Time Curve
- Virtual Earthquake Pre-lab

In Class Activities and Laboratory Experiences:

- Elastic Rebound Activity
- Types of Faults Models
- Seismic Waves Travel Times
- Seismic Waves Activity (8.1.12.A.4)
- Seismic Safe Structures Activity (8.1.12.A.4, 9.3.12.AC.1-2, 9.3.12.AC-DES.1, 9.3.12.FN.1, 9.3.ST.1, 6)
- Modify Model of Earth's Interior
- Virtual Earthquake Lab
- Epicenter Location Activity
- Modified Mercalli Scale Activity
- Earthquake Regions

Closure and Reflection Activities:

- Exit ticket
- Google Classroom Question (8.1.12.A.3)

Technology Connections:

- Google Education Tools
- Kahoot
- http://phet.colorado.edu/en/simulation/wave-on-a-string
- http://www.classzone.com/books/earth_science/terc/content/visualizations/es1009/es1009page01.cfm
- http://www.glencoe.com/sites/common_assets/science/virtual_labs/ES09/ES09.html
- https://www.khanacademy.org
- http://earthquake.usgs.gov/earthquakes/
- http://scedc.caltech.edu/recent/index.html

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS2-1

Unit 5: Volcanoes (9 Days)

Why Is This Unit Important?

The Volcanoes unit helps students formulate answers to the questions: "How do the layers of the interior of the Earth interact?" and "How does the eruption of volcanoes change the surface of the Earth?" Students can develop models and explanations for the ways that feedbacks between different Earth systems control the appearance of Earth's surface. Central to this is the tension between internal systems, which are largely responsible for creating land at Earth's surface (e.g., volcanism and mountain building). The crosscutting concepts of energy and matter; structure and function; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the Volcanoes unit, students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

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.
- Students will describe intrusive igneous rock features and how they form.

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. (HS-ESS1-6)
- 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.*(secondary to HS-ESS1-6)*
- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1)
- 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.*(ESS2.B Grade 8 GBE)* (HS-ESS2-1)

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
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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.
- Volcanoes Test

Benchmark Assessment:

- Students will be able to 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.
- Students will be able to 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..

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- Eruption of Mount St. Helens
- KWL Chart
- Where on Earth are Volcanoes?
- Volcanoes and Earth's Moving Plates
- Hawaiian Islands, Volcanoes and Legends
- Types of Volcanic Cones
- Magma Formation

In Class Activities and Laboratory Experiences:

- Eruption of Mount St. Helens Video
- Hawaiian Hotspots Lab
- Adopt an Active Volcano Project (9.3.ST.6)
- Volcanoes of the Deep Sea Video
- Build a Volcano Online Activity (8.1.12.A.3)
- Kilauea Video

Closure and Reflection Activities:

- Exit Ticket
- Google Classroom Question (8.1.12.A.3)

Technology Connections:

- Google Education Tools
- Kahoot
- Kilauea: Mountain of Fire – Nature
- 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/

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS2-1
- HS-ESS1-6

Unit 6: Earth's History (7 Days)

Why Is This Unit Important?

In the Earth's History unit help students formulate answers to the questions: "How do people reconstruct and date events in Earth's planetary history?" Students can construct explanations for the scales of time over which Earth processes operate. An important aspect of Earth and space science involves making inferences about events in Earth's history based on a data record that is increasingly incomplete that farther you go back in time. A mathematical analysis of radiometric dating is used to comprehend how absolute ages are obtained for the geologic record. A key to Earth's history is 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. The crosscutting concepts of patterns and stability and change are called out as organizing concepts for these disciplinary core ideas. In the Earth's History unit students are expected to demonstrate proficiency in developing and using models, constructing explanations, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

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.
- Students will 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 difference between weathering and erosion.
- What are the two types weathering?
- What are the different types of mechanical and chemical weathering?
- What is soil?
- What is organic matter?
- Identify soil forming factors.
- How long does it take for 1” of soil to form?
- Is the soil horizon formation rate the same throughout the world?
- What is soil texture?
- Why is soil texture important?
- What factors affect soil erosion rates?
- How does pH affect nitrogen, phosphorus and potassium in soil?
- What are some processes used to adjust pH levels?

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. (HS-ESS1-6)
- 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.*(secondary to HS-ESS1-6)*
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-7)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6)
- 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)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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.
- Earth's History Test

Benchmark Assessment:

- Students will be able to 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.
- Students will be able to construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- KWL Chart
- Major Events in the History of the Earth
- Earth's History Timeline Pre-lab
- Fossils Enrichment
- Half-life Practice
- Extinction of the Dinosaurs Video

In Class Activities and Laboratory Experiences:

- Relative Age of Rock Layers Activity
- Earth's History Timeline Lab
- Radioactive Decay: A Sweet Simulation
- Correlating Sedimentary Strata Lab (9.3.ST.6)
- Radioactive Dating Game
- Fossils Identification Activity
- Meteorite Impact Hypothesis (9.3.ST.6)
- Events in Geologic Time Project

Closure and Reflection Activities:

- Exit Ticket
- Google Classroom Questions

Technology Connections:

- Google Education Tools
- Kahoot
- 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
- http://www.glencoe.com/sites/common_assets/science/virtual_labs/E18/E18.html

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS1-6
- HS-ESS2-7

Unit 7: Oceanography (15 Days)

Why Is This Unit Important?

Oceanography helps students formulate answers to the questions: "What is the origin of water on Earth?" and "How do the oceans affect weather and climate?" Students can develop models and explanations for the ways that oceans interact with continents. Students understand the role that water plays in affecting weather. Students can understand how the analysis and interpretation of different kinds of geoscience data allow them to construct explanations for the flow of ocean currents. Students understand chemical cycles such as the carbon cycle. Students can examine the ways that human activities cause feedbacks that create changes to other systems. The crosscutting concepts of energy and matter; structure and function; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the Oceanography unit, students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas. The crosscutting concepts of cause and effect and stability and change are called out as organizing concepts for these disciplinary core ideas.

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.*(secondary to HS-ESS2-4)*
- 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)
- 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)(HS-ESS2-4)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-4)
- 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)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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:

- Students will be able to use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- Students will be able to 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.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- Features of the Ocean Floor
- Ocean Currents Reinforcement
- Daily Essential Questions
- Gulf Stream Enrichment

In Class Activities and Laboratory Experiences:

- Density Lab
- Mapping the Ocean Floor Lab
- Aquatic Autobiography Project (9.3.ST.6)
- Coriolis Effect Activity
- Volcanoes of the Deep Sea Video
- Tide Lab (8.1.12.A.1, 8.1.12.A.4)

Closure and Reflection Activities:

- Exit ticket
- Google Classroom Questions

Technology Connections:

- Google Education Tools
- Kahoot
- http://rjd.miami.edu/assets/pdfs/learning-tools/high-school/MODULE%201%20Ocean%20and%20Coastal%20Habitat%20-%20SECTION%201%20Ocean%20Zones.pdf
- Volcanoes of the Deep Sea Video

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS2-4
- HS-ESS3-5

Unit 8: Atmosphere (4 Days)

Why Is This Unit Important?

In the Atmosphere unit, students will formulate answers to the questions: "How did the Earth's atmosphere evolve over its history?" and "How does human interaction affect the concentration of certain gases in the atmosphere?" Earth's atmosphere contains nitrogen and oxygen, with small amounts of other gases. 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, with global consequences. A budget is a plan that shows how something enters and leaves a system and how much remains in a system. Systems on Earth are often described in terms of budgets. The energy budget of the Earth involves incoming solar energy, outgoing amounts of energy from the atmosphere into space, the amount of energy that remains atmosphere, and how the energy flows from one place to another. The crosscutting concepts of energy and matter; structure and function; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the Atmosphere unit, students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

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.*(secondary to HS-ESS2-4)*
- 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)
- 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)

- 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)
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6),(HS-ESS2-4)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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.

- Atmosphere Test

Benchmark Assessment:

- Students will be able to use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- Students will be able to plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- Students will be able to develop a quantitative model to describe the cycling of carbon

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- KWL Chart
- Daily Essential Question
- Good Ozone vs Bad Ozone
- Atmospheric Temperature Enrichment

In Class Activities and Laboratory Experiences:

- Structure of the Earth's Atmosphere Virtual Lab (8.1.12.A.3)
- Model Layers of the Atmosphere Activity
- Ozone in the Atmosphere Virtual Lab (8.1.12.A.3)
- Earth's Blanket of Gases Activity
- Atmosphere Riddles
- Angle of Insolation Lab (9.3.ST.6)
- Acid Rain Lab

Closure and Reflection Activities:

- Exit ticket
- Google Classroom Question (8.1.12.A.3)

Technology Connections:

- Google Education Tools
- Kahoot
- http://www.pbslearningmedia.org/resource/ess05.sci.ess.watcyc.ozonehole/ozone-hole/
- http://sunshine.chpc.utah.edu/Labs/OurAtmosphere/ozone_main.html
- http://www.classzone.com/books/earth_science/terc/content/investigations/es1706/es1706page01.cfm
- http://www.glencoe.com/sites/common_assets/science/virtual_labs/ES14/ES14.html

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS2-4.
- HS-ESS2-5.
- HS-ESS2-6.

Unit 9: Weather and Climate (6 Days)

Why Is This Unit Important?

The Weather and Climate unit help students formulate an answer to the question: "What regulates weather and climate?" and "How do people model and predict the effects of human activities on Earth's climate?" Students understand the system interactions that control weather and climate, with a major emphasis 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. Students can understand the analysis and interpretation of different kinds of geoscience data allow students to construct explanations for the many factors that drive climate change over a wide range of time scales. The crosscutting concepts of cause and effect and stability and change are called out as organizing concepts for these disciplinary core ideas. In the Weather and Climate unit students are expected to demonstrate proficiency in developing and using models and analyzing and interpreting data; and to use these practices to demonstrate understanding of the core ideas.

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.*(secondary to HS-ESS2-4)*
- 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)
- 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-ESS2-4)
- 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)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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:

- Students will be able to use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- HS Students will be able to use a computational representation to illustrate the relationships among.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- Daily Essential Question
- Weather vs Climate
- Climate Change Pre-quiz

In Class Activities and Laboratory Experiences:

- Latitude and Longitude
- Atmospheric Carbon vs Global Temperature Anomaly (9.3.ST.6)
- Climate of Doubt: Politics of Global Warming Video
- Global Sea-level Rise Activity
- Studying the Ice Ages Activity
- Ozone Hole Video

Closure and Reflection Activities:

- Climate Change Post Quiz
- Exit Ticket
- Google Classroom Question (8.1.12.A.3)

Technology Connections:

- Google Educational Tools
- http://sealevel.climatecentral.org/
- https://coast.noaa.gov/digitalcoast/tools/slr
- Kahoot
- Climate of Doubt: Politics of Global Warming – PBS Frontline
- http://phet.colorado.edu/en/simulation/legacy/greenhouse

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS2-4
- HS-ESS3-5

Unit 10: Rivers (5 Days)

Why Is This Unit Important?

The Rivers unit helps students formulate answers to the questions: "How does surface water shape the surface of the Earth?" and "How does water in rivers move through the hydrologic cycle?" Students can develop models and explanations for the ways that rivers control the appearance of Earth's surface. Central to this is the sun-driven surface systems that tear down the land through weathering and erosion. Students understand the role that water plays in affecting weather. Students understand chemical cycles such as the carbon cycle. Students can examine the ways that human activities cause feedbacks that create changes to other systems. The crosscutting concepts of energy and matter; structure and function; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the Rivers unit, students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas.

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. (HS-ESS2-5)

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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:

- Students will be able to plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- Daily Essential Question
- Groundwater Reinforcement
- Chemical vs Physical Weathering

In Class Activities and Laboratory Experiences:

- Water Cycle Video
- Stream Deposition Graphic Organizer (9.3.ST.6)
- Stream Erosion Lab
- Stages of Stream Development
- Measuring Stream Flow Virtual Lab (8.1.12.A.3)
- Groundwater Movement Activity
- Soil Formation Activity

Closure and Reflection Activities:

- Exit ticket
- Google Classroom Question (8.1.12.A.3)

Technology Connections:

- Google Education Tools
- Kahoot
- http://www.glencoe.com/sites/common_assets/science/virtual_labs/ES08/ES08.html
- http://www.geography.learnontheinternet.co.uk/topics/river_erosion.html
- http://www.sciencecourseware.com/virtualriver/

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS2-5

Unit 11: Space Systems (10 Days)

Why Is This Unit Important?

The performance expectations in Space Systems help students formulate answers to the questions: "What is the universe and what goes on in stars?" and "What are the predictable patterns caused by Earth's movement in the solar system?" High school students can examine the processes governing the formation, evolution, and workings of the solar system and universe. Some concepts studied are fundamental to science, such as understanding how the matter of our world formed during the Big Bang and within the cores of stars. Others concepts are practical, such as understanding how short-term changes in the behavior of our sun directly affect humans. Engineering and technology play a large role here in obtaining and analyzing the data that support the theories of the formation of the solar system and universe. The crosscutting concepts of patterns; scale, proportion, and quantity; energy and matter; and interdependence of science, engineering, and technology are called out as organizing concepts for these disciplinary core ideas. In the Space Systems unit performance expectations, students are expected to demonstrate proficiency in developing and using models; using mathematical and computational thinking, constructing explanations; and obtaining, evaluating, and communicating information; and to use these practices to demonstrate understanding of the core ideas.

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

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:

- Homework
- Do Nows
- Google Classroom Questions
- Exit Tickets
- Kahoot
- 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

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.
- Space System's Test

Benchmark Assessment:

- Students will be able to 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.
- Students will be able to construct an explanation of the Big Bang theory based on astronomical evidence of light spectra.
- Students will be able to communicate scientific ideas about the way stars, over their life cycle, produce elements.
- Students will be able to use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- KWL Charts
- Daily Essential Questions
- Rotation vs Revolution
- Black Holes Enrichment
- H-R Diagram Reinforcement
- The Sun Reinforcement
- Evidence for the Big Bang Reinforcement

In Class Activities and Laboratory Experiences:

- Reason for the Seasons
- Motions of the Moon Stations Lab (9.3.ST.6)
- Famous Astronomers Research
- Terrestrial vs Jovian Planets
- Dwarf Planets Activity
- H-R Diagram Activity (8.1.12.A.4)
- The Universe: Life and Death of a Star Video
- Paralax Activity (9.3.ST.6)
- Galaxies Identification Lab
- Black Holes: The Ultimate Abyss Video
- Modeling the Expansion of the Universe
- The Universe: Beyond the Big Bang

Closure and Reflection Activities:

- Exit Tickets
- Google Classroom Question (8.1.12.A.3)

Technology Connections:

- Google Educational Tools
- Black Holes: The Ultimate Abyss - Discovery Education
- The Universe: Life and Death of a Star - History
- The Universe: Beyond the Big Bang - History
- http://www.seasky.org/celestial-objects/stars.html
- Kahoot
- http://phet.colorado.edu/en/simulation/legacy/gravity-and-orbits

Suggested Learning Activities:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides, and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS1-1
- HS-ESS1-2
- HS-ESS1-3
- HS-ESS1-4

Sample Standards Integration

<u>21st Century Skills & Career Readiness Practices</u> **9.3.12.AC.1: Use vocabulary, symbols and formulas common to architecture and construction.** **9.3.12.AC.2: Use architecture and construction skills to create and manage a project. 9.3.12.AC-DES.1: Justify design solutions through the use of research documentation and analysis of data.** **9.3.12.FN.1: Utilize mathematical concepts, skills and problem solving to obtain necessary information for decision making in the finance industry.** **9.3.ST.1: Apply engineering skills in a project that requires project management, process control and quality assurance.** **9.3.ST.6: Demonstrate technical skills needed in a chosen STEM field.** For example in Unit 4, 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.
<u>8.1 Educational Technology</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.** • **8.1.12.A.2 Produce a multi-page digital portfolio for a commercial or professional audience and present it to peers and/or professionals in that related area for review.** • **8.1.12.A.3 Participate in online courses, learning communities, social networks or a virtual world as resources for lifelong learners.** • **8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts, and data from all worksheets to convey the results.** 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.

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