EARTH AND SPACE SCIENCE
GRADE 6

EWING PUBLIC SCHOOLS
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Course Description and Rationale

Students in this course will learn to explain phenomena central to earth and space science. The Next Generation Science Standards (NGSS) performance expectations rely on three dimensions of learning to develop student understanding of scientific concepts. Core conceptual ideas are learned by engaging in scientific and engineering practices and considering crosscutting concepts. These three dimensions support students in developing useable knowledge to explain real world phenomena in the earth and space sciences.

In the earth and space sciences, performance expectations at the middle school level use three dimensional learning to foster student understanding of earth and space science concepts. Students will use the following eight NGSS Science and Engineering Practices to demonstrate understanding of the disciplinary core ideas and develop critical thinking skills:

- 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 cross-cutting concepts support the development of a deeper understanding of the disciplinary core ideas:

- Patterns
- Cause and effect: mechanism and explanation
- Scale, proportion and quantity
- Systems and system models
- Energy and matter: flows, cycles and conservation
- Structure and function

This is a semester-long course that meets for 82 minutes per day. The course uses a project-based approach to exploring many concepts. Many of the core ideas will be applied to engineering problems, allowing students to also develop an understanding of the engineering design process. This will further develop problem-solving and critical thinking skills as students work to design, test, solve and revise solutions to problems. The crosscutting concepts of patterns and structure and function are used as organizing concepts for these disciplinary core ideas. These performance expectations focus on students demonstrating proficiency in developing and using models, using mathematical thinking and obtaining, evaluating and communicating information; and to use these practices to demonstrate understanding of the core ideas.

The course content is arranged into four units of study:

- Water
- Weather and Climate
- Earth's Changing Surface
- Astronomy

Career Readiness, Life Literacies, and Key Skills

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

Disciplinary Concepts:

- Career Awareness and Planning
  - An individual's strengths, lifestyle goals, choices, and interests affect employment and income.
  - Developing and implementing an action plan is an essential step for achieving one's personal and professional goals.
  - Communication skills and responsible behavior in addition to education, experience, certifications, and skills are all factors that affect employment and income.
- Creativity and Innovation
  - Gathering and evaluating knowledge and information from a variety of sources, including global perspectives, fosters creativity and innovative thinking.
- Critical Thinking and Problem-solving
  - Multiple solutions exist to solve a problem.
  - An essential aspect of problem solving is being able to self reflect on why possible solutions for solving problems were or were not successful.
- Digital Citizenship
  - Detailed examples exist to illustrate crediting others when incorporating their digital artifacts in one's own work.
  - Digital communities are used by Individuals to share information, organize, and engage around issues and topics of interest.
  - Digital technology and data can be leveraged by communities to address effects of climate change.
- Global and Cultural Awareness
  - Awareness of and appreciation for cultural differences is critical to avoid barriers to productive and positive interaction.
- Information and Media Literacy
  - Increases in the quantity of information available through electronic means have heightened the need to check sources for possible distortion, exaggeration, or misrepresentation.
  - Digital tools make it possible to analyze and interpret data, including text, images, and sound. These tools allow for broad concepts and data to be more effectively communicated.

    - Sources of information are evaluated for accuracy and relevance when considering the use of information.
    - There are ethical and unethical uses of information and media.

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

Technology Integration

<u>Computer Science and Design Thinking</u>

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

Disciplinary Concepts and Core Ideas:

- Data & Analysis
    - People use digital devices and tools to automate the collection, use, and transformation of data.
    - The manner in which data is collected and transformed is influenced by the type of digital device(s) available and the intended use of the data.
    - Data is represented in many formats. Software tools translate the low-level representation of bits into a form understandable by individuals. Data is organized and accessible based on the application used to store it.
    - The purpose of cleaning data is to remove errors and make it easier for computers to process.
    - Computer models can be used to simulate events, examine theories and inferences, or make predictions.
- Engineering Design
    - Engineering design is a systematic, creative and iterative process used to address local and global problems.
    - The process includes generating ideas, choosing the best solution, and making, testing, and redesigning models or prototypes.
    - Engineering design requirements and specifications involve making trade-offs between competing requirements and desired design features.
- Interaction of Technology and Humans
    - Economic, political, social, and cultural aspects of society drive development of new technological products, processes, and systems.

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

ELA Integration:

NJSLS.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5) (MS-ESS3-5)
NJSLS.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3) (MS-ESS2-3)
NJSLS.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-5)
NJSLS.WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts and information through the selection, organization and analysis of relevant content. (MS-ESS1-4),(MS-ESS2-2)
NJSLS.WHST.6-8.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ESS2-5)
NJSLS.WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection and research. (MS-ESS3-1)
NJSLS.SL.8.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-2) (MS-ESS2-6)

Math Integration:

NJSLS.MP.2 Reason abstractly and quantitatively. (MS-ESS2-5),(MS-ESS3-5)
NJSLS.MP.4 Model with mathematics. (MS-ESS1-1) (MS-ESS1-2)
NJSLS.6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2) (MS-ESS3-5)
NJSLS.6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)
NJSLS.6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1) (MS-ESS1-2) (MS-ESS1-3)

Unit 1: Weather and Climate

Why Is This Unit Important?

This unit targets three major areas of weather and climate:

1. Severe weather phenomenon, such as tornadoes, floods and hurricanes, negatively impact our society. Understanding the causes of these events helps students plan for the future and make decisions. Understanding observable short term weather phenomenon helps students recognize the predictable changes in daily weather events and their causes.
2. Climate has changed in the past, but over the long term. As scientists observe and forecast short term changes, students must understand how to read data and ask questions about these findings. Students may need to make societal decisions as adults that could have global impacts.
3. Water is a natural resource that travels in various forms, in many pathways around Earth. The amount of water on Earth will not change, but its distribution is crucial to humans. Students should recognize that humans depend on water and our use and engineering strategies will determine how much water is accessible in the future.

Disciplinary Core Ideas:

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

- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)

ESS2.D: Weather and Climate

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)
- Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)

ESS3.D: Global Climate Change

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

ESS3.B: Natural Hazards

- Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)

ESS3.C: Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)

Science and Engineering Practices:

Asking Questions and Defining Problems

Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS2-6)

Planning and Carrying Out Investigations

Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3)

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)

Cross Cutting Concepts:

Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3)
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)

Stability and Change

- Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

Patterns

- Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)

Enduring Understandings:

- The sun is the source of Earth's heat.
- Air moves from areas of high pressure to areas of low pressure.
- Air masses come from places that are different temperatures and humidities. Wind moves air masses and when different air masses meet, they interact and create fronts. Fronts are areas of changing weather.
- Meteorologists study the movement of air masses and changes in temperature, air pressure, etc., to predict where fronts and weather systems will occur.
- The water cycle has many different pathways, including evaporation, condensation, precipitation and transpiration. Water does not take a singular pathway as it travels around the Earth.
- Heat and gravity make water move and change.
- Water resources, such as rivers, lakes and groundwater are unevenly distributed.
- Humans use water and can negatively impact them by overconsumption and pollution.
- Altitude is the height above or below sea level. Latitude is the distance north or south of the equator. High altitude locations have colder climates. Tropical zone climates are warmer year round. Polar zone climates are colder year round. Temperate zones climates have seasons.

- Ocean currents curve as they move around the Earth. They swirl in some places and move along coasts of continents. Warm currents are near the equator and generally move away from the equator. Cold currents are near the poles and generally move towards the equator.
- Ocean water varies in density and these density variations cause the water to circulate.
- Ocean currents influence the climate of the land near the coast; making it warmer, cooler, humid, etc.
- The Earth is heated unevenly because ocean and land do not heat and cool at the same rate. The Earth also heats differently due to the angle of incoming sunlight.
- The Greenhouse Effect regulates the Earth's temperature.
- Possible causes of global warming include human impact (the burning of fossil fuels), increasing solar radiation (sunspots) and increased volcanic activity.
- Global temperature has risen and fallen several times in Earth's history.
- Global warming is controversial because scientists cannot be sure of the exact cause of the temperature rise, although most agree that it is due to the increased release of CO_2 into the atmosphere.

Essential Questions:

- What is the source of Earth's heat?
- How does wind move in terms of temperature and air pressure?
- Where do air masses come from? How do they influence weather?
- Why does Tornado Alley get so many tornadoes?
- How do meteorologists predict weather?
- How would you describe the water cycle?
- What drives the water cycle?
- What are some water resources? How are water resources distributed?
- How do humans impact the distribution and consumption of water resources?
- What is the difference between altitude and latitude? How do they affect climate?
- How would you describe the movement of ocean currents? Where are the hot/cold currents? Where do they move?
- Why would it be warmer at a Florida beach than it is at a California Beach? How do ocean currents affect climate near the coasts?
- Why does the Earth have varying temperatures? What causes areas of the Earth to heat differently?
- What are some possible causes of global temperature rise?
- How has climate changed over its 4.5+ billion years? How about changes in the global temperatures?
- Why is global warming so controversial?
- What are greenhouse gases?
- How can the 'greenhouse effect' be a good thing for Earth? Why is it important to have balanced amount?
- Describe two ways society can minimize the amount of greenhouse gases in our atmosphere.

Acquired Knowledge:

- Students will be able to explain the difference between weather and climate.
- Students will be able to classify major climate types such as tropical, dry, temperate, cold and polar climates.
- Students will be able to explain ocean currents' effects on climate.
- Students will be able to describe the processes that cause water to cycle around Earth. (evaporation, condensation, precipitation)
- Students will be able to recognize that natural resources are limited and that conservation of these resources is necessary in order to ensure their availability for future generations, through various activities that reference conservation and 'green' initiatives.
- Students will be able to identify places where salt and freshwater is distributed.

Acquired Skills:

- Students will be able to define and apply temperature, atmospheric pressure, wind and humidity using maps, diagrams and visual representations.
- Students will able to compare/contrast different air masses and assess their effects on weather using models.
- Students will be able to connect cloud formation to barometric pressure and temperature as it relates to the various forms precipitation using models.
- Students will recognize that weather changes quickly and climate naturally changes slowly over thousands/millions of years by comparing textual evidence and comparison charts.
- Students will be able to explain the effect greenhouse gases, such as carbon dioxide, can have on global warming and climate change using charts and diagrams.
- Students will identify various stages and pathways of the water cycle through modeling activities and textual evidence.
- Students will identify the driving force of water changes (Sun and gravity) using graphic organizers or diagrams.
- Students will be able to relate human activity to atmospheric CO_2 levels using graphic representations.

Assessments:

Formative Assessment:

- 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:

- Global Warming Questions (Interpret graphs showing global temperature rise and possible causes. Ask relevant questions about the data.) Performance-Based Task
- Water Cycle Models (Develop a model of the water cycle, utilize another model [station activity] and revise the original model to show pathways and driving forces. Performance-Based Task
- Will Your House Flood? Project (Use elevation and storm surge height to develop a map of a flood zone for a hurricane; identify ways to mitigate effects in the future) Performance-Based Task
- Tornado Alley Essay (Explain how air mass interactions can lead to weather interactions [temp., air pressure, fronts, winds] resulting in tornadoes) Performance-Based Task
- Water Island (Design a plan to provide cities based on the distribution of water on an island; solve problems when changes occur) Project/Performance-Based Task
- Unit Test

Benchmark Assessment:

- Students will be assessed on their ability to collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
- Students will be assessed on their ability to develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
- Students will be assessed on their ability to ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
- Students will be assessed on their ability to develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- Students will be assessed on their ability to construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy and groundwater resources are the result of past and current geoscience processes.
- Students will be assessed on their ability to construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems.

Alternative Assessments:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- Listing weather/water/climate phenomenon
- Water cycle puzzles/conundrums
- Air mass/front predictions

In Class Activities and Laboratory Experiences:

- Ocean Currents Simulation video
- Heating Earth's Surface
- Understanding Altitude
- Latitude and Climate/Ocean Currents and Climate
- Convection Currents and Air Masses
- How can we show that air has weight?
- Coriolis Effect Balloon activity
- Weather vs. Climate
- What are glaciers?
- Water Island
- Career Exploration: Meteorologist

Closure and Reflection Activities:

- Closing discussions
- Review questions
- Whiteboard reviews

Instructional Materials:

- Sink
- Projector
- Laptop

Technology Connections:

- BrainPop and Study Jams
- Discovery DVDs
- Ocean Currents Simulation video
- Satellite data/maps
- Engineering and Design - Water Island Project

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

- MS-ESS2-5
- MS-ESS2-6
- MS-ESS3-5
- MS-ESS2-4
- MS-ESS3-1
- MS-ESS3-4

Unit 2: Tectonics

Why Is This Unit Important?

Plate tectonics are the cause of the past and current structures of the earth's crust. Slow moving plates are responsible for catastrophic events, such as earthquakes and volcanic eruptions. The mitigation and prediction of these events is dependent on our understanding of their causes. Students should recognize the evidence for the movement of the continents and ocean floors. Predicting future events and protecting humans is dependent on understanding the phenomenon.

Disciplinary Core Ideas:

ESS1.C: The History of Planet Earth

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)
- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. *(HS.ESS1.C GBE),(secondary to MS-ESS2-3)*

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

- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3)

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

- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)

Science and Engineering Practices:

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to provide evidence for phenomena. (MS-ESS2-3)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe nature operate today as they did in the past and will continue to do so in the future. (MS-ESS1-4),(MS-ESS2-2)

Cross Cutting Concepts:

<u>Patterns</u>

- Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3)

<u>Scale Proportion and Quantity</u>

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-4),(MS-ESS2-2)

Enduring Understandings:

- Wegener used fossils of plants and animals, rock samples, shapes of continents to support his theory that the continents have moved.
- The plates move slowly and are responsible for earthquakes, tsunamis, volcanoes, trenches, mountains.
- Plate boundaries are convergent (colliding), divergent (separating), or transform (slide past). The plates move very slowly; landscaping formations, such as mountain formations, occur over long periods of time, however, earthquakes and volcanic eruptions happen 'fast'.
- Earthquakes cannot be predicted, but locating past epicenters and monitoring faults can help.
- Earthquakes and volcanoes are most common near plate boundaries,
- The sea floor is not flat; it has mountains, plains and trenches. It spreads at mid-ocean ridges.

Essential Questions:

- What evidence did Wegener have to support his theory that the continents have moved?
- If Wegener had solid evidence (fossils, climate, shapes, geographic features), how come the scientific community rejected his hypothesis?
- Describe the three types of plate boundaries and the phenomenon that occurs at each as a result of their slow movement.
- Is there any connection between the location of volcanoes and earthquakes? Explain.
- How well can earthquakes be predicted?
- What is the sea-floor like? (topographically)
- What features and events happen because of plate movement?

Acquired Knowledge:

- Students will be able to explain how geologic phenomena, such as earthquakes and volcanic activity, have changed Earth’s surface through textual evidence and through the construction of models.
- Students will be able to provide evidence of Wegener's original Theory of Continental Drift by analyzing map evidence, such as fossil distribution. Students will assemble a map based on the evidence found by Wegener.

Acquired Skills:

- Students will be able to analyze the effects of catastrophic events including: earthquakes, volcanic activity, hurricanes, tsunamis, tornadoes and coastal erosion through means of visuals, textual evidence, interactive readings and models.
- Students will be able to evaluate the impact of technology mitigating the effects of catastrophic events using models and diagrams.

Assessments:

Formative Assessments:

- 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:

- Mini Unit - How well can earthquakes be predicted? (Argument using Claim Evidence Reasoning (CER) Model/Essay)
- Tectonics Quiz (Quiz)
- Pangea Map and CER (Argument using Claim Evidence Reasoning (CER) Model)
- Plate Boundary Models (activity and worksheet)
- “Did it happen fast or slow?” (worksheet)
- Where do volcanoes occur? (Argument using Claim Evidence Reasoning (CER) Model/Essay)
- Volcanoes CER (Argument using Claim Evidence Reasoning (CER) Model/Essay)

Benchmark Assessment:

- Students will be assessed on their ability to construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
- Students will be assessed on their ability to analyze and interpret data on the distribution of fossils and rocks, continental shapes and seafloor structures to provide evidence of the past plate motions.
- Students will be assessed on their ability to analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

Alternative Assessments:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets**:**

- How is the Earth like an egg?
- What happens during an earthquake?
- Would you ever live in a place that gets earthquakes?

In Class Activities and Laboratory Experiences:

- How do we study the inside of Earth? Plastic egg activity
- Layers of Earth diagram/notes
- Who was Alfred Wegener slideshow
- Curious Case of Mesosaurus
- Evidence of Continental Drift
- Sea-floor spreading - ocean floor maps/diagrams
- Plotting Earthquakes and Volcanoes/Dynamic Planet Map
- Tsunami DVD
- Earthquake Choice Activities
- Career Exploration: Seismologist

Closure and Reflection Activities:

- Closing discussions
- Review questions
- Whiteboard reviews

Instructional Materials:

- Sink
- Projector
- Laptop

Technology Connections:

- BrainPop/Study Jams
- Discovery DVDs
- Tsunami Documentaries
- Volcanic Eruption Documentaries
- Earthquake Technology (satellites, seismometers, etc.)

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

- MS-ESS2-2
- MS-ESS2-3
- MS-ESS3-2

Unit 3: History of Earth

Why Is This Unit Important?

Changes occur on the Earth's surface, as well as below the surface. These changes create processes that impact humans and their structures. For example, slow processes of weathering beneath the surface can create drastic events such as sinkholes. Minerals and rocks are made by Earth processes over long periods of time, and therefore these resources can run out (Precious minerals, coal, etc.)

Students should understand the evidence for the estimated age of the Earth. They should also recognize that major catastrophic events have occurred in Earth's history and that changes should be expected in the future. Understanding time scales helps students recognize that events can occur within their lifetimes, while other events can occur millions and billions of years before and after their lifetimes.

Disciplinary Core Ideas:

ESS2.A: Earth's Materials and Systems

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)

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

- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)
- Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)

ESS3.A: Natural Resources

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)

Science and Engineering Practices:

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS2-1)
- Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1)

Cross Cutting Concepts:

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1)

Energy and Matter

- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)

Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1)

Enduring Understandings:

- The oldest rocks found have been dated to 4.6 billion years.
- Scientists use rock layers and the fossils found in them to tell the story of Earth's past.
- The Geologic Time Scale is used to show the age of the Earth and events in the past because human time scales are too small.
- Weathering wears down rocks, erosion moves sediments and deposition drops them in a new location. These processes work together to change and shape the surface over varying time scales; Landslides are fast, the Grand Canyon formed slowly.
- Rocks can change due to processes such as melting, heat and pressure, erosion and deposition. Rocks change form due to processes on and below the surface.
- Minerals are formed from magma/solutions and crystallize over time.
- Minerals and rocks are formed within the Earth and are not renewable by humans.
- Coal is a fossil fuel, a non-renewable resource.

Essential Questions:

- Why do scientists think the Earth is 4.6 billion years old?
- How do scientists study the 4.6 billion year history of Earth?
- Put rock layers in order from oldest to youngest. Is this actual age or relative?
- Why do we use a Geologic Time Scale instead of a timeline with years on it?
- Describe the processes of weathering, erosion and deposition and how they work together to shape Earth's surface.
- What features on Earth were formed quickly? Which ones formed slowly?
- How can a rock change into another rock type?
- How do scientists categorize rocks?
- How do weathering, erosion and deposition work together to break down and build up Earth's surface?
- Why is coal called a fossil fuel? Will it be around forever?

Acquired Knowledge:

- Students will be able to describe the scale of geologic time by modeling events in Earth's history on a timeline.
- Students will be able to understand, through textual evidence and rock strata diagrams, the relation between various rock and geologic components to Earth's 4.6-billion-year-old history.
- Students will be able to explain the rock cycle and the roles that heat, pressure, erosion, and volcanic activity play in building and changing rocks on Earth's surface by using textual evidence.
- Students will recognize that resources, such as coal, come from past environments and processes through textual readings, maps and visual representations.

Acquired Skills:

- Students will be able to generalize the roles that weathering and erosion play in shaping Earth's surface using evidence to support their claims.
- Students will be able to explain key concepts about rocks and minerals, including igneous, sedimentary and metamorphic rocks and how they are formed by using information from various sources. (Models, text, experiments, rock cycle diagrams, etc.)
- Students will identify various pathways in which rocks are cycled on the Earth's surface by analyzing rock cycle diagrams.

Assessments:

Formative Assessment:

- 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:

- Quartz Question (Project)
- Rock Cycle Diagrams (Performance-Based Task)
- Minerals/Rocks Quiz
- Did it happen fast or slow? (Performance-Based Task)
- W.E.D. project (Project)
- Finding Clues to Rock Layers (Lab)
- Geologic Timeline (Project)
- The End of an Era (Argument using Claim Evidence Reasoning (CER) Model/Essay)
- Unit Test

Benchmark Assessment:

- Students will be assessed on their ability to construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.
- Students will be assessed on their ability to construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
- Students will be assessed on their ability to analyze and interpret data on the distribution of fossils and rocks, continental shapes and seafloor structures to provide evidence of the past plate motions.
- Students will be assessed on their ability to develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

Alternative Assessment:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- Rock Cycle Diagrams
- W.E.D. matching game
- Tic-Tac-Toe activities

In Class Activities and Laboratory Experiences:

- Diamond Studded Pipes in the Crust
- Igneous rock samples/packet
- Sedimentary rock samples
- Formation of Coal
- Metamorphic rock samples/packet
- Fossil observations and inferences
- Fossils Guided Reading
- Relative Age of Rocks
- Career Exploration: Geologist

Closure and Reflection Activities:

- Closing Discussions
- Review questions
- Whiteboard reviews

Instructional Materials:

- Sink
- Projector
- Laptop

Technology Connections:

- BrainPop/Study Jams
- Discovery DVDs

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

- MS-ESS1-4
- MS-ESS2-2
- MS-ESS2-3
- MS-ESS2-1

Unit 4: Space Systems

Why Is This Unit Important?

In order to understand and make informed decisions regarding our exploration of the solar system, galaxy and universe, students need to understand our place in the universe. Students need to understand the Earth, sun, moon system in order to explain the patterns of moon phases, seasons, tides, eclipses, etc. Understanding these systems allows for understanding future space exploration and the basic understanding of observable phenomenon.

Disciplinary Core Ideas:

ESS1.A: The Universe and Its Stars

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1)
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)

ESS1.B: Earth and the Solar System

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3)
- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)

Science and Engineering Practices:

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS1-1),(MS-ESS1-2)

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)

Cross Cutting Concepts:

Patterns

- Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1)

Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3)

Systems and System Models

- Models can be used to represent systems and their interactions. (MS-ESS1-2)

Enduring Understandings:

- Rotation is spinning on an axis. Revolution is moving around or orbiting another object:
  - The Moon revolves around the Earth (phases).
  - The Earth and Moon revolve around the Sun (year).
  - The Earth rotates (day and night).
- The moon looks like it changes shape because of the relative angle of the moon, Earth, and sun as the moon revolves around the Earth. We only see the lighted part of the moon from Earth.
- The moon revolves around Earth and is sometimes on the 'daytime' side of the Earth.
- The moon is between the Earth and the Sun during a solar eclipse. The moon is in Earth’s shadow during a lunar eclipse.
- Seasons are caused by the tilt of Earth’s axis as it orbits the sun. The northern and southern hemispheres have opposite seasons.
- The force of gravity keeps the planets and celestial objects (within the galaxy and solar system) in orbit around larger objects.
- Identify the scale properties of objects in the solar system and distances between objects.
- Our galaxy is made of billions of stars, but we orbit only one star.
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.
- Space technology is developed and used to study objects in the solar system because the solar system and space are so huge that we cannot observe them from Earth based technology.

Essential Questions:

- What is the difference between rotation and revolution?
- Why do we have day and night?
- Describe the Earth, Moon, Sun system in terms of what revolves around what; emphasis is on the cause of day and night, versus the cause of a year.
- Why does it look like the moon changes shape each night?
- Why is the moon sometimes seen during the day?
- How are the Earth, Sun and Moon aligned during lunar eclipses? During solar eclipses?
- What causes seasons?
- Where did the planets, moons and sun come from?
- How did our solar system form?
- How does gravity affect our solar system and the objects within it?
- What is an accurate way to illustrate the solar system to scale?
- What is our galaxy and where are we in it?
- Why are space based telescopes (like the Hubble) and spacecraft (like New Horizons) so important to learning about objects in the solar system?

Acquired Knowledge:

- Students will be able to identify gravity as the force that causes objects in the solar system to orbit the Sun, or planets (moons).
- Students will have an understanding, through textual evidence, of how many planets there are in the solar system as well as their sizes and general properties.
- Students will be able to explain the orbits of the planets and their relative distance from the sun through various models and texts. Acquired Skills:
- Students will be able to model the Earth, Sun, and Moon system in terms of phases, tides, and eclipses using visual representations and/or physical models.
- Students will be able to model the cause of Earth's seasons using visual representations and physical models.
- Students will be able to model the relative revolution of the Moon, Earth and Sun due to gravitational attraction.

Assessments:

Formative Assessments:

- 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:

- Space Portfolio (Performance-Based Task)
- Solar System Scale (worksheet)
- Moon Phases (Lab/Performance-Based Task)
- Reasons for Seasons (Lab)
- Gravity Simulation Questionnaire (worksheet)

Benchmark Assessment:

- Students will be assessed on their ability to develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon and seasons.
- Students will be assessed on their ability to develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
- Students will be assessed on their ability to analyze and interpret data to determine scale properties of objects in the solar system.

Alternative Assessments:

- Modified project requirements and rubrics

Suggested Learning Experiences and Instructional Activities:

Anticipatory Sets:

- Listing space phenomenon
- Cosmology bodies differentiation puzzle
- This island Earth

In Class Activities and Laboratory Experiences:

- “To Scale, the Solar System” web video
- Black holes, no escape
- Gravity Simulation computer model
- Models for seasons
- Models for eclipses
- Career Exploration: Astronomer
- Earth & Space Scientist Report Project

Closure and Reflection Activities:

- Closing discussions
- Review questions
- Whiteboard reviews

Instructional Materials:

- Sink
- Projector
- Laptop

Technology Connections:

- Computer simulations for gravity
- Web movie for solar system scale
- BrainPop/Study Jams
- Discovery DVDs

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

- MS-ESS1-1
- MS-ESS1-2
- MS-ESS1-3

Sample Standards Integration

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<u>**Career Readiness, Life Literacies, and Key Skills**</u>

9.4.8.CI.1:

For example, in Unit 1, students need to analyze data regarding varying perspectives of climate change.

9.4.8.CT.2:

For example, in Unit 2, students will generate and compare multiple solutions to solutions designed to mitigate natural disasters.

9.4.8.IML.7:

For example in Unit 3, students analyze information from multiple sources to develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

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<u>**8.1 Computer Science and Design Thinking**</u>
All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and create and communicate knowledge.

For example in Unit 4, students will access, manage, evaluate, and synthesize information to develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon and seasons.

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LGBT and Disabilities Law:

In Unit 4 the Earth & Space Scientists Report Project has students explore the contributions of Earth & Space Scientists from varying minorities including those who are LGBTQ and have disabilities

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Career Exploration:

In each unit there is a career Exploration project:

- Unit 1 – Meteorologist
- Unit 2 – Seismologist
- Unit 3 – Geologist
- Unit 4 - Astronomer

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Interdisciplinary Connections

NJSLS.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5) (MS-ESS3-5)

NJSLS.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3) (MS-ESS2-3)

NJSLS.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-5)

NJSLS.WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts and information through the selection, organization and analysis of relevant content. (MS-ESS1-4),(MS-ESS2-2)

NJSLS.WHST.6-8.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ESS2-5)

NJSLS.WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection and research. (MS-ESS3-1)

NJSLS.SL.8.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-2) (MS-ESS2-6)

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 analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

NJSLS.MP.2 Reason abstractly and quantitatively. (MS-ESS2-5),(MS-ESS3-5)

NJSLS.MP.4 Model with mathematics. (MS-ESS1-1) (MS-ESS1-2)

NJSLS.6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2) (MS-ESS3-5)

NJSLS.6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)

NJSLS.6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1) (MS-ESS1-2) (MS-ESS1-3)

These standards are met through the completion of the benchmark performance in Unit 4, students analyze and interpret data to determine scale properties of objects in the solar system.