CURRICULUM

FOR ENVIRONMENTAL SCIENCE

GRADE 9

This curriculum is part of the Educational Program of Studies of the Rahway Public Schools.

ACKNOWLEDGMENTS

Dr. Susan Dube, Program Supervisor of Math, Science, and Technology Education

The Board acknowledges the following who contributed to the preparation of this curriculum.

Chelsea Russell

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Subject/Course Title:
Environmental Science
Grade 9

Date of Board Adoption:
September 19, 2023

RAHWAY PUBLIC SCHOOLS CURRICULUM

Environmental Science: Grade 9

PACING GUIDE

Unit	Title	Pacing
1	Scientific Inquiry Processes	8 weeks
2	History and Formation of the Earth	8 weeks
3	Interactions of Earth's Spheres	8 weeks
4	Populations, Communities, and Biodiversity	8 weeks
5	Human Impact and Global Citizenship	8 weeks

ACCOMMODATIONS

504 Accommodations:

- Provide scaffolded vocabulary and vocabulary lists.
- Provide extra visual and verbal cues and prompts.
- Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials.
- Provide links to audio files and utilize video clips.
- Provide graphic organizers and/or checklists.
- Provide modified rubrics.
- Provide a copy of teaching notes, especially any key terms, in advance.
- Allow additional time to complete assignments and/or assessments.
- Provide shorter writing assignments.
- Provide sentence starters.
- Utilize small group instruction.
- Utilize Think-Pair-Share structure.
- Check for understanding frequently.
- Have student restate information.
- Support auditory presentations with visuals.
- Weekly home-school communication tools (notebook, daily log, phone calls or email messages).
- Provide study sheets and teacher outlines prior to assessments.
- Quiet corner or room to calm down and relax when anxious.
- Reduction of distractions.
- Permit answers to be dictated.
- Hands-on activities.
- Use of manipulatives.
- Assign preferential seating.
- No penalty for spelling errors or sloppy handwriting.
- Follow a routine/schedule.
- Provide student with rest breaks.
- Use verbal and visual cues regarding directions and staying on task.
- Assist in maintaining agenda book.

IEP Accommodations:

- Provide scaffolded vocabulary and vocabulary lists.
- Differentiate reading levels of texts (e.g., Newsela).
- Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials.
- Provide extra visual and verbal cues and prompts.
- Provide links to audio files and utilize video clips.
- Provide graphic organizers and/or checklists.
- Provide modified rubrics.
- Provide a copy of teaching notes, especially any key terms, in advance.
- Provide students with additional information to supplement notes.
- Modify questioning techniques and provide a reduced number of questions or items on tests.
- Allow additional time to complete assignments and/or assessments.
- Provide shorter writing assignments.
- Provide sentence starters.
- Utilize small group instruction.
- Utilize Think-Pair-Share structure.
- Check for understanding frequently.
- Have student restate information.
- Support auditory presentations with visuals.
- Provide study sheets and teacher outlines prior to assessments.
- Use of manipulatives.
- Have students work with partners or in groups for reading, presentations, assignments, and analyses.
- Assign appropriate roles in collaborative work.
- Assign preferential seating.
- Follow a routine/schedule.

Gifted and Talented Accommodations:

- Differentiate reading levels of texts (e.g., Newsela).
- Offer students additional texts with higher lexile levels.
- Provide more challenging and/or more supplemental readings and/or activities to deepen understanding.
- Allow for independent reading, research, and projects.
- Accelerate or compact the curriculum.
- Offer higher-level thinking questions for deeper analysis.
- Offer more rigorous materials/tasks/prompts.
- Increase number and complexity of sources.

ML Accommodations:

- Provide extended time.
- Assign preferential seating.
- Assign peer buddy who the student can work with.
- Check for understanding frequently.
- Provide language feedback often (such as grammar errors, tenses, subject-verb agreements, etc…).
- Have student repeat directions.
- Make vocabulary words available during classwork and exams.
- Use study guides/checklists to organize information.
- Repeat directions.

● Assign group research and presentations to teach the class. ● Assign/allow for leadership roles during collaborative work and in other learning activities.	● Increase one-on-one conferencing. ● Allow student to listen to an audio version of the text. ● Give directions in small, distinct steps. ● Allow copying from paper/book. ● Give student a copy of the class notes. ● Provide written and oral instructions. ● Differentiate reading levels of texts (e.g., Newsela). ● Shorten assignments. ● Read directions aloud to student. ● Give oral clues or prompts. ● Record or type assignments. ● Adapt worksheets/packets. ● Create alternate assignments. ● Have student enter written assignments in criterion, where they can use the planning maps to help get them started and receive feedback after it is submitted. ● Allow student to resubmit assignments. ● Use small group instruction. ● Simplify language. ● Provide scaffolded vocabulary and vocabulary lists. ● Demonstrate concepts possibly through the use of visuals. ● Use manipulatives. ● Emphasize critical information by highlighting it for the student. ● Use graphic organizers. ● Pre-teach or pre-view vocabulary. ● Provide student with a list of prompts or sentence starters that they can use when completing a written assignment. ● Provide audio versions of the textbooks. ● Highlight textbooks/study guides. ● Use supplementary materials. ● Give assistance in note taking ● Use adapted/modified textbooks. ● Allow use of computer/word processor. ● Allow student to answer orally, give extended time (time-and-a-half). ● Allow tests to be given in a separate location (with the ESL teacher). ● Allow additional time to complete assignments and/or assessments. ● Read question to student to clarify. ● Provide a definition or synonym for words on a test that do not impact the validity of the exam. ● Modify the format of assessments. ● Shorten test length or require only selected test items. ● Create alternative assessments. ● On an exam other than a spelling test, don’t take points off for spelling errors.

UNIT ONE OVERVIEW

Content Area: Earth/Physical Science & Engineering

Unit Title: Scientific Inquiry Processes

Target Course/Grade Level: 9th grade

Unit Summary: Students will identify, define, and explain the process of modern scientific inquiry through experimentation and data analysis. Students will design and perform their own experiments using scientific techniques and develop mathematical and graphical skills necessary for data analysis and solutions based on experimental conclusions.

Approximate Length of Unit: 8 weeks

LEARNING TARGETS

NJ STUDENT LEARNING STANDARDS:

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

DISCIPLINARY CORE IDEAS

Delimiting Engineering Problems
Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)

ETS1.B: Developing Possible Solutions
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

ETS1.C: Optimizing the Design Solution
Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade offs) may be needed. (HS-ETS1-2)

CROSS CUTTING CONCEPTS

Influence of Science, Engineering, and Technology on Society and the Natural World

New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1), (HS-ETS1-3)

SCIENCE & ENGINEERING PRACTICES

Asking Questions and Defining Problems
Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Constructing Explanations and Designing Solutions
Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-2)

Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-3)

CAREER READINESS, LIFE LITERACIES, AND KEY SKILLS:

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.
9.4.12.IML.8: Evaluate media sources for point of view, bias, and motivations.
9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task.
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

INTERDISCIPLINARY CONNECTIONS & STANDARDS:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.9-10.7. 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.
RST.9-10.8. 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.
RST.9-10.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.1. Write arguments focused on discipline-specific content.

A. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

B. Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

Unit Understandings:

Students will understand that…

- Scientific inquiry is the foundation of our understanding of the natural world.
- Good experimental design involves clearly defined variables, consideration of control groups and confounding variables, comprehensive data collection, and deep analysis towards answering a testable hypothesis.
- Modern technology has greatly improved the rate and scope of understanding of natural phenomena.
- All aspects of society have been affected by discoveries made through scientific inquiry.
- The process of scientific inquiry can apply to many fields of study towards solving a variety of problems.
- Scientific inquiry is a constantly evolving process dependent on frequent input and analysis of new data.

Unit Essential Questions:

- What is the purpose of scientific inquiry?
- How does modern technology shape the process of scientific inquiry?
- What makes for good experimental design?
- What is a scientific hypothesis?
- What is a scientific theory?
- What is a scientific law?
- How are independent, dependent, and control variables defined in an experiment?
- What are the mathematical, graphical, and empirical relationships between variables of an experiment?
- How do scientists evaluate the accuracy and precision of experimental data to create models of natural phenomena?
- How are experimental models used to identify, analyze, and find solutions to real-world problems?

Knowledge and Skills:

Students will know...

- The differences between historical and modern scientific processes.
- How technology has affected the scientific inquiry process.
- What are scientific hypotheses, theories, and laws.
- What are independent, dependent, and control variables.
- How accuracy and precision are determined through various data collection methods.

Students will be able to...

- Evaluate how technology has impacted scientific inquiry.
- Compare, contrast, and identify scientific hypotheses, theories, and laws.
- Define the variables of an experiment.
- Design an experiment using scientific inquiry principles and techniques.
- Use mathematical and graphical analysis skills to draw conclusions based on experimental data.
- Evaluate the accuracy and precision of experimental data and scientific models of natural phenomena.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?

- **End of Unit Assessment**: Comprehensive lab report of student lima bean experiments including experimental design, data collection, analysis, and conclusions.
- Do Now questions
- Exit ticket questions
- Daily homework
- Claim, Evidence, Reasoning activities
- Graphical/mathematical data analysis quizzes
- Experimental design analysis quizzes

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Vocabulary worksheets
- PowerPoint/Slides presentations
- GUESS method activities
- Experimental design analysis worksheets
- Graphical data analysis practice problems
- Experimental design graphic organizer worksheets
- Accuracy vs. Precision activity
- Graphing Skills GIZMO lab
- Claim, Evidence, Reasoning practice worksheets

RESOURCES

Teacher Resources:

- Textbook- Pearson's Environmental Science
- Chromebooks – online resources

Equipment Needed:

- Projector/TV
- Chromebooks
- Google Docs, Sheets, Slides
- Lima beans, soil, cups, lamps
- Lab glassware & measurement tools

UNIT TWO OVERVIEW

Content Area: Physical & Earth Science

Unit Title: History and Formation of the Earth

Target Course/Grade Level: 9th grade

Unit Summary: Students will learn how Earth's formation, geologic history, and ecosystems are directly influenced by its place in the universe and the nuclear processes of the Sun. Students will study the age of the Earth and how geologic processes shape the continents and oceans and utilize data and models to understand how energy from the Sun affects biogeochemical cycles and the biosphere on Earth.

Approximate Length of Unit: 8 weeks

LEARNING TARGETS

NJ STUDENT LEARNING STANDARDS:

HS-ESS1-2 Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.

HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS1-6 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

HS-ESS2-3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

DISCIPLINARY CORE IDEAS

ESS1.A: The Universe and Its Stars
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)

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.C: The History of Planet Earth

Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (secondary to MS-ESS2-3)

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

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)

ESS2.A: Earth's Materials and Systems
The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)

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

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)

PS1.C: Nuclear Processes
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), (secondary to HS-ESS1-6)

PS4.B Electromagnetic Radiation
Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2)

CROSS CUTTING CONCEPTS

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

Energy and Matter
Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2)

In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-ESS1-3)

Stability and Change
Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6)

Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)

Interdependence of Science, Engineering, and Technology
Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2), (HS-ESS2-3)

SCIENCE & ENGINEERING PRACTICES

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

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)

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) 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)

Developing and Using Models
Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1), (HS-ESS2-3)

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

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

CAREER READINESS, LIFE LITERACIES, AND KEY SKILLS:

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A. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

B. Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

Unit Understandings:

Students will understand that…

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.
- Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.
- Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history.
- Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.
- 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.
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.
- The history of multicellular life of Earth is a relatively short portion of the total geologic history of the Earth based on fossil, tectonic, radioactive, and genetic evidence.
- Though the motion of tectonic plates is very slow to human perception, understanding and predicting geologic activity has direct relevance to human society (e.g. earthquakes, volcanic activity).

Unit Essential Questions:

- What is the universe and what is Earth's place in it?
- How did the formation of the universe and our Solar System impact the development of life on Earth?
- How does the Sun produce energy?
- How can we determine the lifespan of stars like the Sun?

- Where do the elements that make up the Earth originate?
- How do we determine the age of the Earth?
- How did scientists come to understand the existence and motion of tectonic plates?
- How does tectonic activity shape the continents and oceans?

Knowledge and Skills:

Students will know...

- The nuclear processes that power the Sun and the development of heavier elements, including those which exist on Earth.
- How electromagnetic radiation can be measured to determine the chemical composition and motion of the stars.
- Helium and energy as the products of fusion processes in the sun.
- That the sun, like all stars, has a life span based primarily on its initial mass, and that the Sun's lifespan is about 10 billion years.
- The scale of the energy released by the fusion process is much larger than the scale of the energy released by chemical processes.
- Identify that chemical processes are unable to produce the amount of energy flowing out of the Sun over long periods of time, thus requiring fusion processes as the mechanism for energy release in the Sun.
- Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and formation of new rocks from magma rising where plates are moving apart.
- Evidence such as measurement of the ratio of parent to daughter atoms produced during radioactive decay as a means for determining the ages of rocks; ages and locations of continental rocks; ages and locations of rocks found on opposite sides of mid-ocean ridges; type and location of plate boundaries relative to the type, age, and location of crustal rocks.
- The pattern of the continental crust being older than the oceanic crust.
- The pattern is that the oldest continental rocks are located at the center of continents, with the ages decreasing from their centers to their margin.
- The pattern is that the ages of oceanic crust are greatest nearest the continents and decrease in age with proximity to the mid-ocean ridges.
- At boundaries where plates are moving apart, such as mid-ocean ridges, material from the interior of the Earth must be emerging and forming new rocks with the youngest ages.
- The regions furthest from the plate boundaries (continental centers) will have the oldest rocks because new crust is added to the edge of continents at places where plates are coming together, such as subduction zones.
- The oldest crustal rocks are found on the continents because oceanic crust is constantly being destroyed at places where plates are coming together, such as subduction zones.
- 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.
- Erosion and plate tectonics on Earth have destroyed much of the evidence of this bombardment, explaining the relative scarcity of impact craters on Earth.
- Descriptions, location, and changes of specific continental features and specific ocean-floor features.

Students will be able to...

- Model the relationships between the components, including a description of the process of radiation, and how energy released by the sun reaches Earth's system.
- Predict how the relative proportions of hydrogen to helium change as the sun ages.
- Evaluate the reliability, strengths, and weaknesses of the given evidence along with its ability to support logical and reasonable arguments.
- Analyze stellar spectroscopic data to determine the elemental composition of stars (including the Sun).
- Use the Hertzsprung-Russell diagram to determine the evolution of stars (including the Sun) based on the relationships between mass, luminosity, and spectral classification.
- Model to illustrate the relationship between the formation of continental and ocean floor features and Earth's internal and surface processes operating on different temporal or spatial scales.
- Describe how heat moves, particularly how convection takes place in the mantle.
- Use logic and evidence to reconstruct the position of large islands and continents as they appeared 220 million years ago.

- Describe how scientists use different kinds of evidence to form theories.
- Identify, describe, and analyze patterns in data collected on earthquakes and volcanoes.
- Apply mathematical models and analysis to quantitatively describe and predict the behavior of Earth phenomena.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?

- **End of Unit Assessment**: Copy of Earth's History & Processes: Analyzing Data
- Students will utilize topological maps, fossil evidence, radioactive dating, and seismological data to evaluate and explain the age of islands and other geologic formations as a consequence of tectonic motion.
- Common Assessment Earth's Processes: Tectonics
- Do Now questions
- Exit ticket questions
- Daily homework
- Claim, Evidence, Reasoning activities

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Vocabulary worksheets
- PowerPoint/Slides presentations
- Claim, Evidence, Reasoning practice worksheets
- Stellar spectroscopy lab activity
- HR diagram identification GIZMO lab
- Graphical data analysis practice problems
- Recreating Pangea through evidence
- Age of the Islands lab (mapping the Galapagos Islands)
- Plotting Earthquakes and Volcanoes activity
- Radioactive dating GIZMO lab

RESOURCES

Teacher Resources:

- Textbook- Pearson's Environmental Science
- Chromebooks – online resources

Equipment Needed:

- Projector/TV
- Chromebooks
- Google Docs, Sheets, Slides

UNIT THREE OVERVIEW

Content Area: Earth Science

Unit Title: Interactions of Earth's Spheres

Target Course/Grade Level: 9th grade

Unit Summary: Students will investigate the interactions between Earth's geosphere, atmosphere, hydrosphere, and biosphere as interconnected and inseparable systems, with a focus on global climate change. Students will use historical and modern data collection to analyze how these systems have changed over time and make predictions on future change using mathematical modeling and experimental investigation.

Approximate Length of Unit: 8 weeks

LEARNING TARGETS

NJ STUDENT LEARNING STANDARDS:

HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change).

DISCIPLINARY CORE IDEAS

ESS1.B: Earth and the Solar System
Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

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

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

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

ESS2.D: Weather and Climate
The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space. (HS-ESS2-2), (HS-ESS2-4)

Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6), (HS-ESS2-7)

Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6), (HS-ESS2-4)

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

Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

CROSS CUTTING CONCEPTS

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

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

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

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

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

Systems and System Models
When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)

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

SCIENCE & ENGINEERING PRACTICES

Analyzing and Interpreting 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)

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

Developing and Using Models
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)

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

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

Using Mathematics and Computational Thinking
Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

CAREER READINESS, LIFE LITERACIES, AND KEY SKILLS:

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.
9.4.12.IML.8: Evaluate media sources for point of view, bias, and motivations.
9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the

data.
9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

INTERDISCIPLINARY CONNECTIONS & STANDARDS:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

RST.9-10.7. 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.

RST.9-10.8. 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.

RST.9-10.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.1. Write arguments focused on discipline-specific content.

A. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

B. Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

Unit Understandings:

Students will understand that…

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- All of Earth's spheres interact through a variety of mechanisms and cycles.
- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy is radiated into space.
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- 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.
- Quantitative measurements of various physical, chemical and biological properties of the Earth can be used to analyze, explain, and predict past and future trends in Earth's spheres.
- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. 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.
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.

Unit Essential Questions:

- What are the four major "spheres" that encompass all of Earth's systems?
- How do Earth's spheres interact with one another to create Earth's various environments?
- Where does energy on Earth originate, and how does it flow between Earth's spheres?
- What was Earth's climate throughout its history, and how has it changed over time?

- How have humans affected and been affected by changes in Earth's spheres?
- How do scientists uncover, research, and solve environmental problems?
- How does environmental science help us understand the natural world?

Knowledge and Skills:
Students will know...
- Factors that affect 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 of Earth and the atmosphere.
- The properties of water that allow geological change and life.
- Relative concentrations of carbon present in the hydrosphere, atmosphere, geosphere, and biosphere; represent carbon cycling from one sphere to another.
- The specific example of how certain chemicals are affecting the ozone layer and how the scientific community found out.

Students will be able to...
- Model the relationships between the components, including a description of the process of radiation, and how energy released by the sun reaches Earth's system.
- Model the input, output, storage, and redistribution of energy within Earth's systems.
- Model to identify the conservation of matter as carbon cycles through various components of Earth's systems.
- Describe major ways that Earth's spheres, cycles, and systems interact.
- Apply mathematical models and analysis to quantitatively describe and predict the behavior of Earth phenomena.
- Describe, analyze, evaluate, and predict historical and modern changes in global climate as a result of natural processes and human activity.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?
- **End of Unit Assessment**: https://docs.google.com/document/d/1h7LVpzQQo9kAJiWw0xUVEd-2_w7XKcsnfBqerP0Dmd8/edit?usp=sharing
- Do Now questions
- Exit ticket questions
- Daily homework
- Claim, Evidence, Reasoning activities
- Graphical/mathematical data analysis quizzes

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?
- Vocabulary worksheets
- PowerPoint/Slides presentations
- Claim, Evidence, Reasoning practice worksheets
- Graphical data analysis practice problems
- Carbon Cycle Game (carbon sink simulation activity)
- Carbon Cycle GIZMO lab
- Stream table lab investigation
- Erosion and Weathering GIZMO labs
- PhET simulations for climate change/greenhouse effect

RESOURCES

Teacher Resources:

- Textbook- Pearson's Environmental Science
- Chromebooks – online resources

Equipment Needed:

- Projector/TV
- Chromebooks
- Google Docs, Sheets, Slides
- Stream table buckets, sand, water

UNIT FOUR OVERVIEW

Content Area: Life Science

Unit Title: Populations, Communities, and Biodiversity

Target Course/Grade Level: 9th grade

Unit Summary: Students will investigate the interactions between organisms and their environment and how populations, communities, and ecosystems change over time. Students will analyze population data to identify trends, identify the possible causes and effects of various environmental factors on species growth and decline, and evaluate how even small biodiversity changes can cause long-term cascades to entire ecosystems. Students will identify and describe biomes and how the condition of each biome influences the niches of organisms that live there.

Approximate Length of Unit: 8 weeks

LEARNING TARGETS

NJ STUDENT LEARNING STANDARDS:

HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem**.**

HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

DISCIPLINARY CORE IDEAS

LS2.A: Interdependent Relationships in Ecosystems
Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1), (HS-LS2-2)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6)

LS4.D: Biodiversity and Humans
Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)

CROSS CUTTING CONCEPTS

Cause and Effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)

Scale, Proportion, and Quantity
The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)

Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

Energy and Matter
Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)

SCIENCE & ENGINEERING PRACTICES

Using Mathematics and Computational Thinking
Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)

Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

CAREER READINESS, LIFE LITERACIES, AND KEY SKILLS:

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.
9.4.12.IML.8: Evaluate media sources for point of view, bias, and motivations.
9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task.
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

INTERDISCIPLINARY CONNECTIONS & STANDARDS:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.9-10.7. 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.
RST.9-10.8. 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.
RST.9-10.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.9-10.1. Write arguments focused on discipline-specific content.

A. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

B. Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

Unit Understandings:
Students will understand that…

- Ecologists study levels of organization to understand how populations interact and their effects on one another.
- Population size, density and distribution all contribute to the survival of organisms.
- Human population and consumption of resources are directly related.
- Species interactions affect the resource use and population sizes of the species found in an ecosystem.
- No population can grow indefinitely because of limiting factors.
- An organism's niche is affected by both its tolerance and competitive interaction.

- Altering one component of an ecosystem can have long-term cascading effects on the rest of the ecosystem's biodiversity.
- Feeding relationships have both direct and indirect effects on organisms in the community.
- Only about 10% of energy is transferred from one trophic level to the next. (Trophic levels)
- Biomes are characterized by their climates as well as typical plant and animal life.

Unit Essential Questions:

- How do life and the physical environment interact?
- What is biodiversity and why does it matter?
- How can we measure biodiversity and what does it tell us about the health of ecosystems?
- How do populations grow, how can we predict growth, and what limits growth?
- Why does overpopulation deplete resources and create vast amounts of waste/pollutants?
- How do organisms affect one another's survival and environment?
- How do energy and nutrients move through communities?
- How does the environment affect where and how an organism lives?
- How do populations in a community affect each other?
- How can biodiversity change when humans intervene?
- What factors are used to classify biomes?
- What conditions and organisms characterize each individual biome?

Knowledge and Skills:

Students will know...

- The difference between biotic and abiotic factors.
- The levels of biological organization that ecologists focus on when discussing effects on the environment (primarily populations, communities, and ecosystems).
- The factors that influence the growth rate of populations and mathematical growth patterns such as exponential vs. logistic growth.
- How human growth has progressed over time.
- The three major types of species survivorship curves.
- The difference between a producer and a consumer.
- How an organism's niche is determined through its trophic role, habitat, and species interactions.
- The different ways organisms interact through symbiotic relationships (mutualism, commensalism, predation/herbivory, parasitism).
- How energy flows through an ecosystem and how the inefficient flow of energy directly relates to the trophic structure of the ecosystem.
- The relationship between energy and biomass in ecosystems.
- How biomes become classified.
- Characteristics of individual biomes.

Students will be able to...

- Discuss how an organism's habitat relates to its survival.
- Draw out, act out, and describe the three ways populations can be distributed.
- Read graphs showing exponential and logistic growth and determine which is which.
- Relate rising population density to the proportional increase in imperviousness in our environment as well as the negative environmental impacts that accompany it.
- Discuss how an organism's habitat relates to its survival.
- Explain the usefulness of tracking population size and define population density.
- Graphically and mathematically calculate and analyze population growth curves in response to a trophic cascade.
- Explain the effect of inefficient energy transfer on community structure.
- Create, describe, and analyze changes in food webs/chains and trophic structure.
- Calculate loss of energy using the 10% rule.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?

- **End of Unit Assessment**: Populations, Communities, and Biodiversity Common Assessment
- Do Now questions
- Exit ticket questions
- Daily homework
- Claim, Evidence, Reasoning activities
- Population growth quizzes
- Predator vs. Prey population tracking lab

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Introduce historical and cultural contexts related to environmental challenges. For example, discuss how specific communities, such as Asian Pacific Islanders, have been affected by issues like deforestation, pollution, and climate change.
- Explore how marginalized groups, including LGBTQ individuals, have unique experiences and perspectives on environmental issues. Discuss how factors like discrimination and access to resources can intersect with environmental concerns.
- Vocabulary worksheets
- PowerPoint/Slides presentations
- Claim, Evidence, Reasoning practice worksheets
- Graphical data analysis practice problems
- Age Structure Diagram activity
- Sunflower Random Sampling activity
- Yellowstone Population Investigation labs
- Biodiversity Tracking activity
- Levels of Organization booklets
- Biome flipcharts

RESOURCES

Teacher Resources:

- Textbook- Pearson's Environmental Science
- Chromebooks – online resources

Equipment Needed:

- Projector/TV
- Chromebooks
- Google Docs, Sheets, Slides

UNIT FIVE OVERVIEW

Content Area: Earth & Life Science

Unit Title: Human Impact and Global Citizenship

Target Course/Grade Level: 9th grade

Unit Summary: Students will investigate how humans have affected global environments in both positive and negative ways, and use historical and modern data to analyze, evaluate, and propose solutions to global concerns such as climate change, pollution, conservation, and geopolitical issues involving the environment at various scales from individual action to large-scale collective movements.

Approximate Length of Unit: 8 weeks

LEARNING TARGETS

NJ STUDENT LEARNING STANDARDS:

HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.

HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change).

DISCIPLINARY CORE IDEAS

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. HS-LS2-6)

ESS2.D: Weather and Climate

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-ESS2-4)

Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. 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. (secondary to HS-ESS36)

ESS2.E: Biogeology

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

ESS3.A: Natural Resources

Resource availability has guided the development of human society. (HS-ESS3-1)

All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

ESS3.B: Natural Hazards

Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)

ESS3.C: Human Impacts on Earth Systems

The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

ESS3.D: Global Climate Change

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

Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

ETS1.B: Developing Possible Solutions
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-ESS32), (secondary HS-ESS3-4)

CROSS CUTTING CONCEPTS

Cause and Effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4), (HS-ESS3-1)

Systems and System Models
When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7), (HS-ESS2-7)

Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3), (HS-ESS3-5)

Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

Influence of Engineering, Technology, and Science on Society and the Natural World
Modern civilization depends on major technological systems. (HS-ESS3-1), (HS-ESS3-3)

Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2), (HS-ESS3-4)

New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3)

Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2)

Science is a Human Endeavor
Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Science Addresses Questions About the Natural and Material World
Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2)

Science knowledge indicates what can happen in natural systems— not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)

Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

Scientific Investigations Use a Variety of Methods
Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)

New technologies advance scientific knowledge. (HS-ESS3-5)

Scientific Knowledge is Based on Empirical Evidence
Science knowledge is based on empirical evidence. (HS-ESS3-5)

Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)

Scientific Knowledge is Open to Revision in Light of New Evidence
Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6)

SCIENCE & ENGINEERING PRACTICES

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

Using Mathematics and Computational Thinking
Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)

Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

Constructing Explanations and Designing Solutions
Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, 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-ESS3-1)

Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)

Engaging in Argument from Evidence
Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS2-7), (HS-ESS3-2)

CAREER READINESS, LIFE LITERACIES, AND KEY SKILLS:

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.
9.4.12.IML.8: Evaluate media sources for point of view, bias, and motivations.
9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

INTERDISCIPLINARY CONNECTIONS & STANDARDS:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.9-10.7. 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.
RST.9-10.8. 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.
RST.9-10.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.9-10.1. Write arguments focused on discipline-specific content.

A. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

B. Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

Unit Understandings:
Students will understand that…

- Resource availability has guided the development of human society.
- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.
- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
- Anthropogenic changes (induced by human activity) in the environment — including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change — can disrupt an ecosystem and threaten the survival of some species.
- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.
- Though individual action alone is not enough to enact major change towards preserving the stability of our environment, smaller organized efforts can lead to greater impact through social, economic, and political involvement and collective pressure.
- Rapidly advancing technology has directly caused instability in the global environment but can also provide solutions towards creating more sustainable ecosystems.

Unit Essential Questions:

- What are the impacts of human population growth on environmental health? Are those impacts equally distributed?
- How can we reduce the impacts of urban human population growth on biodiversity?
- What is the difference between renewable and nonrenewable energy?
- How did fossil fuels form, and how are they obtained and used?
- What problems are associated with fossil fuel use?
- What are the potential uses and limitations of renewable energy sources?
- How can water be used to address energy needs?
- How can we rely on the sun and wind for power?
- What are the roles humans play in the environment?
- What are the solutions humans have created to lessen the impact on different ecosystems?
- What are the social, economic, and political barriers to creating a more sustainable environment?
- How does technology play a role in both causing and solving environmental instability?

Knowledge and Skills:

Students will know...

- How nonrenewable resources (e.g. fossil fuels, nuclear energy) are produced, extracted, and used, and how these processes impact the environment.
- How renewable resources (e.g. solar, wind, hydro power) are produced, extracted, and used, and how these processes impact the environment.
- Why energy conservation is important.
- The role the individual plays in creating sustainable environments vs. the role of larger entities/organizations.
- Specific cause and effect relationships between environmental factors (natural hazards, changes in climate, and the availability of natural resources) and features of human societies including population size and migration patterns.
- The relevant components of each of the Earth systems modeled in the given computational representation, including system boundaries, initial conditions, inputs and outputs, and relationships that determine the interaction (e.g., the relationship between atmospheric CO2 and production of photosynthetic biomass and ocean acidification.
- How human activity could affect the relationships between the Earth's systems under consideration.
- The negative effects of human activities on the environment and biodiversity, and that rely on scientific knowledge of the factors affecting changes and stability in biodiversity such as HIPPCO.

Students will be able to...

- Explain the connection between pollutants released by fossil fuels and the damage they cause to organisms and their environment.
- Compare and contrast the consumption vs. generation of renewable energy in the United States and other countries.
- Analyze the benefits and costs of wind energy and solar energy.
- Explain how using solar energy in homes, buildings, etc. works.
- Use data and geological location to evaluate, plan, and revise the best energy source to power a local factory.

- Research using a variety of valid and reliable sources for the evidence, potentially including theories, simulations, peer review, or students' own investigations.
- State claim, evidence, and reasoning that connects the evidence, along with 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.
- Create a computational simulation (using a spreadsheet) that contains representations of the relevant components, including a natural resource in a given ecosystem, the sustainability of human populations in a given ecosystem, biodiversity in a given ecosystem and the effect of a technology on a given ecosystem.
- Compare the simulation results to a real-world example(s) and determine if the simulation can be viewed as realistic.
- Generate several possible refinements to a given technological solution that reduces human impact on natural systems.
- Propose a solution that decreases the negative effects of human activity on the environment and biodiversity.
- Evaluate the cost, safety, and reliability, as well as social, cultural, and environmental impacts, of the proposed solution for a select human activity that is harmful to an ecosystem.
- Use logical and realistic inputs for the simulation that show an understanding of the reliance of ecosystem function and productivity on biodiversity, and that consider the constraints of cost, safety, and reliability as well as cultural, and environmental impacts.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?

- **Common Assessment: Human Impact & Global Citizenship Common Assessment**
- **End of Unit Assessment**: Students will create a presentation/poster based on research about one or more sustainability technologies using the HIPPCO framework to evaluate the scale of impact on the environment and analyze the costs vs. benefits of implementing the technology in light of social, economic, and political barriers.
- Do Now questions
- Exit ticket questions
- Daily homework
- Claim, Evidence, Reasoning activities
- Endangered vs. Invasive Species project
- Habitat Corridor project

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Highlight environmental justice case studies involving different communities. Explore how the Holocaust and other genocides have impacted landscapes and ecosystems, underscoring the connection between human history and the environment.
- Discuss instances where African American and Asian Pacific Islander communities and others have been disproportionately affected by environmental hazards, such as exposure to pollutants and lack of access to green spaces.
- Vocabulary worksheets
- PowerPoint/Slides presentations
- Claim, Evidence, Reasoning practice worksheets
- Graphical data analysis practice problems
- HIPPCO analysis graphic organizer
- Renewable vs. Nonrenewable Energy comparison activity
- Ecological Footprint activity
- Wind/Solar/Wave pattern maps for energy production analysis
- Household Energy GIZMO lab

- Water Pollution GIZMO lab
- Greenhouse Effect GIZMO lab

RESOURCES

Teacher Resources:

- Textbook- Pearson's Environmental Science
- Chromebooks – online resources

Equipment Needed:

- Projector/TV
- Chromebooks
- Google Docs, Sheets, Slides