Cedar Grove School District

Cedar Grove, NJ

2017 | Grades 10-12

Earth, Space & the Environment

Approved by the Cedar Grove Board of Education

Earth, Space & the Environment

Course description

This course is designed to cover three distinct topics: astronomy, earth science, and environmental science. The curriculum is constructed to provide a basic understanding of each of these disciplines.

This curriculum was written in accordance with the
NEW JERSEY STUDENT LEARNING STANDARDS
for SCIENCE

and the

NEW JERSEY STUDENT LEARNING STANDARDS
for Mathematics

The standards can be viewed at http://www.state.nj.us/education/cccs/

Earth, Space & the Environment

Unit 1: The Universe — Instructional Time: 4 Weeks

This unit provides an introduction to the basics of modern astronomy by exploring our current view of the universe. A modern explanation for the relative motion of planets, stars, and galaxies is contrasted with previous theories. Size and scale of the solar system, galaxy, and universe are discussed as well as their motions.

Student Learning Objectives

New Jersey Student Learning Standards for Science/NGSS

HS-ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation
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-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system

Enduring Understandings

- The same basic rules govern the motion of all bodies, from planets and stars to birds and billiard balls.
- Mathematics is a tool used to model objects, events, and relationships in the natural and designed world.
- Understanding the development of scientific ideas is essential for building scientific knowledge.
- Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

Essential Questions

- How did the universe form?
- Why does the sun shine?
- Why do we have seasons?
- Why does the moon change in appearance?

Concepts

- The Big Bang Theory explains the formation of the universe.
- The sun is powered by nuclear fusion
- Stars change in size and color as they progress through their life cycle.
- The elements produced by nucleosynthesis within a star differ based upon the materials used as fuel
- The motion of orbiting bodies in the solar system can be modeled by Kepler's Laws of Planetary Motion.
- The tilt of the Earth's axis as it orbits around the sun is responsible for the seasons.
- The phases of the moon are determined by the position of the moon in its orbit.
- An eclipse takes place when one heavenly body such as a moon or planet moves into the shadow of another heavenly body.

Formative Assessment

Students who understand the concepts are able to:

- Explain the big bang theory
- Understand the difference between a universe, galaxy, and solar system
- Explain what causes the seasons
- Explain and model the moon phases

Suggested Learning Activities

Students will be asked to consider the creation of the universe and organization of space. Basic nuclear physics concepts will be introduced while examining the life cycle of a star and its impact on the surrounding space. The motion of objects in space will be analyzed and calculated using Kepler's Laws of motion.

Students will examine the lunar and the solar calendar and investigate these calendars influence on civilizations. Students will investigate the Earth's orbit and how it corresponds to the seasons in the northern and southern hemisphere.

1. Formation of the Universe

        a. Big bang
        b. Hierarchy of space
            i. Universe
            ii. Galaxy
            iii. Solar system
2. Stars
    a. Nuclear fusion
        i. Activity: Compare the energy from a fission reaction to the energy released from fusion
        ii. Activity: explore the current designs for fusion reactors
    b. Life cycle
3. Planetary motion
    a. Kepler's laws
    b. Earths seasons
        i. Activity: compare earths proximity to the sun vs. the angle of tilt at each season
    c. Phases of the moon
        i. Activity: compare the lunar calendar to the regular calendar
    d. Eclipse

Performance Expectations		
Science and Engineering Practices	**DCI**	**Crosscutting Concepts**
<u>Planning and Carrying Out Investigations</u> • Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (**HS-PS2-5)** **<u>Analyzing and Interpreting Data</u>** • Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design	**<u>ESS1.A: The Universe and Its Stars</u>** • The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (**HS-ESS1-1**) • The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (**HS-ESS1-2),(HS-ESS1-3**) • The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (**HS-ESS1-2**) • Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. **(HS-ESS1-2),(HS-ESS1-3**) **<u>ESS1.B: Earth and the Solar System</u>** • Kepler's laws describe common	**<u>Patterns</u>** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (**HS-PS2-4**) **<u>Cause and Effect</u>** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (**HS-PS2-1),(HS-PS2-5)** • Systems can be designed to cause a desired effect. (**HS-PS2-3**) **<u>Systems and System Models</u>** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (**HS-PS2-2**)

solution. (**HS-PS2-1**) **<u>Using Mathematics and Computational Thinking</u>** • Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (**HS-PS2-2),(HS-PS2-4**) **<u>Constructing Explanations and Designing Solutions</u>** • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (**HS-PS2-3**) **<u>Obtaining, Evaluating, and Communicating Information</u>** • Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about 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-PS2-6)**	features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (**HS-ESS1-4**)	

Cross-Curricular Connections	
English/Language Arts Standards	**Mathematics Standards**
• Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to	• Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) **MP.2** • Model with mathematics. (HS-ETS1-1),(HS-ETS1-

address a question or solve a problem. (HS-PS2-1) **RST.11-12.7** • 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. (HS-ETS1-3) **RST.11-12.9** • Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.9** • Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) **SL.11-12.5**	2),(HS-ETS1-3),(HS-ETS1-4) **MP.4** • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3) **HSN-Q.A.1**

21st Century Career Ready Practices
• **CRP2.** Apply appropriate academic and technical skills. • **CRP4.** Communicate clearly and effectively and with reason. • **CRP6.** Demonstrate creativity and innovation. • **CRP8.** Utilize critical thinking to make sense of problems and persevere in solving them. • **CRP12.** Work productively in teams while using cultural global competence.

Earth, Space & the Environment

Unit 2: Space Exploration	**Instructional Time: 4 weeks**

This unit covers the tools of astronomy with an emphasis on how we know what we currently understand about the universe around us. Students will be taught how to locate and identify the most prominent constellations in the northern sky as well as their associated mythology. Electromagnetic radiation and the properties of light will be discussed with an emphasis on the differing information that can be obtained in various regions of the spectrum. Refractor and reflector telescopes will be explored. The tools of the modern space age will be covered, including manned and unmanned missions, orbital telescopes, infrared and radio telescopes. The creation and purpose of NASA during the initial Space Race will be compared to its current operations and the proliferation of private spaceflight companies.

Student Learning Objectives

New Jersey Student Learning Standards for Science/NGSS

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-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media

Enduring Understandings	**Essential Questions**
• The same basic rules govern the motion of all bodies, from planets and stars to birds and billiard balls. • Mathematics is a tool used to model objects, events, and relationships in the natural and designed world. • Understanding the development of scientific ideas is essential for building scientific knowledge. • Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations. • Safety first!	• What do constellations mean? • How do we know stars are moving? • How do telescopes work? • How does man explore space? • What is he future of space exploration?

Concepts	**Formative Assessment**
• Man has watched and tracked the motion of celestial bodies throughout history • Visible light is a small part of the electromagnetic spectrum • Movement of stars can be measured with the Doppler Effect • Refraction and reflection telescopes redirect light to magnify an image • Orbital satellites and space probes are used for exploration • Manned space flights were a product of the cold war • Private companies are developing “space tourism” and other space related services	Students who understand the concepts are able to: • Identify common constellations and explain the meaning • Explain how a refraction telescope functions • Explain how a reflection telescope functions • Explain why “Red Shift” occurs • List the purpose of various manned space flights and probes • Explain the history of the US space program • Explain the role of private companies in space

Suggested Learning Activities

Students will examine the position of the stars in the night sky and research how civilizations have studied the positions of the stars. Basic theories of light will be studied and then applied to measuring the movement of stars via red-shift analysis and applied to the operation of optical telescopes. Students will also study more modern methods of space research and exploration.

Students will investigate the function of lenses by reading an eye chart unaided and comparing it to the results or reading the eye chart with a pair of binoculars. Students will compare data retrieved from the mars rovers and compare it to information gather from more primitive Earth based exploration methods.

1. History of starwatching
    a. Constellations
        i. Activity: identify constellations that are visible in the night sky. Research the meaning of the constellation.
    b. Mythology
    c. Mayans
2. Light
    a. Wave vs. particle theory of light
    b. Doppler effect
        i. Activity: use a moving sound source to demonstrate the Doppler effect on the pitch of the sound
    c. Red shift
3. Telescopes
    a. Optical
        i. Lens
        ii. Mirrors
        iii. Activity: use binoculars and an eye chart to determine the magnification of the binoculars
    b. Radio
    c. Orbital telescopes
4. Space exploration
    a. Probes
        i. Activity: review information received from the mars rovers. Discuss the technical difficulties of delivering and remotely operating the rovers
    b. Space tourism

Performance Expectations		
Science and Engineering Practices	**DCI**	**Crosscutting Concepts**
<u>Planning and Carrying Out Investigations</u> • Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable	**<u>ESS1.A: The Universe and Its Stars</u>** • 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**) **<u>PS4.A: Wave Properties</u>** • The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.	**<u>Patterns</u>** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (**HS-PS2-4**) **<u>Cause and Effect</u>** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (**HS-PS2-1),(HS-PS2-5)** • Systems can be designed to cause a desired effect. (**HS-PS2-3**)

measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (**HS-PS2-5)** **<u>Analyzing and Interpreting Data</u>** • Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (**HS-PS2-1**) **<u>Using Mathematics and Computational Thinking</u>** • Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (**HS-PS2-2),(HS-PS2-4**) **<u>Constructing Explanations and Designing Solutions</u>** • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (**HS-PS2-3**) **<u>Obtaining, Evaluating, and</u>**	(**HS-PS4-1**) **<u>PS4.B: Electromagnetic Radiation</u>** • Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (**HS-PS4-3**)	**<u>Systems and System Models</u>** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (**HS-PS2-2**)

Communicating Information • Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about 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-PS2-6)**		

Cross-Curricular Connections	
English/Language Arts Standards	**Mathematics Standards**
• Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1) **RST.11-12.7** • 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. (HS-ETS1-3) **RST.11-12.9** • Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.9** • Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) **SL.11-12.5**	• Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) **MP.2** • Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) **MP.4** • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3) **HSN-Q.A.1**

21st Century Career Ready Practices
• **CRP2.** Apply appropriate academic and technical skills. • **CRP4.** Communicate clearly and effectively and with reason. • **CRP6.** Demonstrate creativity and innovation. • **CRP8.** Utilize critical thinking to make sense of problems and persevere in solving them. • **CRP12.** Work productively in teams while using cultural global competence

Earth, Space & the Environment

Unit 3: Geology — Instructional Time: 4 Weeks

This unit will focus on the geological properties and process of the planet Earth. The layers of the Earth will be examined as well as plate tectonics. The formation of mountains, formation of rock, and function of volcanos will be explored. The process of erosion and soil formation will be explained.

Student Learning Objectives

New Jersey Student Learning Standards for Science/NGSS

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-ESS2-2	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-ESS2-3	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection

Enduring Understandings

- The same basic rules govern the motion of all bodies, from planets and stars to birds and billiard balls.
- Mathematics is a tool used to model objects, events, and relationships in the natural and designed world.
- Understanding the development of scientific ideas is essential for building scientific knowledge.
- Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

Essential Questions

- Why are there mountains?
- How did the Grand Canyon form?
- Why do volcanos erupt?
- Why are there earthquakes?

Concepts

- The Earth's surface is made up of tectonic plates
- A subduction zone is where tectonic plates collide, one slides over top of the other
- There are three main types of mountains: volcanic, fold, block
- Volcanos are how the Earth cools off and releases natural pressure
- Erosion is the action of surface processes that remove soil, rock, or dissolved material
- There are 3 main types of rock: igneous, metamorphic, sedimentary
- Sand, silt, and clay are three main types of soil
- Surface soil can be separated in to horizons: O, A, B, C

Formative Assessment

Students who understand the concepts are able to:

- Identify the layers of the earth
- Explain what occurs at subduction zones
- Explain how the 3 different types of mountains are formed
- Explain the process of erosion
- Identify the surface horizons
- Explain the formation of the 3 types of rock

Suggested Learning Activities

Students will learn the layers of the Earth and how the movement of these layers affects the surface of the Earth. Students will explore how the energy within the earth is release through earthquakes and volcanoes and students will investigate how humans try to mitigate earthquake danger by seismic building codes. Types of rock and modes of erosion to produce surface soils will be investigated and students will identify soil based upon particle size and resistance to water flow.

1. Layers of the Earth
    a. Inner core
    b. Outer core

        c. Mantel
        d. crust
    2. Plate tectonics
        a. Pangea
            i. Activity: piece together the current continents to form the Pangea land mass
        b. Subduction zones
        c. Mountains
        d. Volcanoes
            i. Activity: examine the effects of large volcanic eruptions such as Mt. St. Helen's or Mt. Vesuvio
        e. Earthquakes
            i. Activity: explore building practices in seismic zones. Identify earthquake mitigation practices and how they function.
    3. Rock/Soil
        a. Types of rock
        b. erosion
        c. Soil horizons
        d. Activity: grade a sample of soil based upon the particle size and resistance to water flow

Performance Expectations

Science and Engineering Practices	DCI	Crosscutting Concepts
<u>**Planning and Carrying Out Investigations**</u> • Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (**HS-PS2-5)** <u>**Analyzing and Interpreting Data**</u> • Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an	<u>**SS1.C: The History of Planet Earth**</u> • 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**) <u>**ESS2.B: Plate Tectonics and Large-Scale System Interactions**</u> • 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**) <u>**ESS2.A: Earth Materials and Systems**</u> • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (**HS-ESS2-1),(HS-**	<u>**Patterns**</u> • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (**HS-PS2-4**) <u>**Cause and Effect**</u> • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (**HS-PS2-1),(HS-PS2-5)** • Systems can be designed to cause a desired effect. (**HS-PS2-3**) <u>**Systems and System Models**</u> • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (**HS-PS2-2**)

optimal design solution. (**HS-PS2-1**) **<u>Using Mathematics and Computational Thinking</u>** • Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (**HS-PS2-2),(HS-PS2-4**) **<u>Constructing Explanations and Designing Solutions</u>** • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (**HS-PS2-3**) **<u>Obtaining, Evaluating, and Communicating Information</u>** • Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about 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-PS2-6)**	**ESS2-2**) • Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (**HS-ESS2-3**) • The 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**) **<u>ESS2.B: Plate Tectonics and Large-Scale System Interactions</u>** • The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (**HS-ESS2-3**) • Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (**ESS2.B** Grade 8 GBE)	

	(**HS-ESS2-1**) **<u>ESS2.C: The Roles of Water in Earth's Surface Processes</u>** • 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**)	

Cross-Curricular Connections

English/Language Arts Standards	Mathematics Standards
• Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1) **RST.11-12.7** • 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. (HS-ETS1-3) **RST.11-12.9** • Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.9** • Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) **SL.11-12.5**	• Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) **MP.2** • Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) **MP.4** • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3) **HSN-Q.A.1**

21st Century Career Ready Practices

- **CRP2.** Apply appropriate academic and technical skills.
- **CRP4.** Communicate clearly and effectively and with reason.
- **CRP6.** Demonstrate creativity and innovation.
- **CRP8.** Utilize critical thinking to make sense of problems and persevere in solving them.
- **CRP12.** Work productively in teams while using cultural global competence

Earth, Space & the Environment

Unit 4: Earth Systems

Instructional Time: 4 weeks

This unit will explore the energy and material flows of planet Earth. The sun will be presented as the source of all energy. The effects of solar energy will be studied in the water hydrologic cycle, atmospheric circulation, and oceanic circulation. Theories of the origin of life and the evolution of life with regard to changing conditions on planet Earth will be discussed.

Student Learning Objectives

New Jersey Student Learning Standards for Science/NGSS

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

Enduring Understandings

- The same basic rules govern the motion of all bodies, from planets and stars to birds and billiard balls.
- Mathematics is a tool used to model objects, events, and relationships in the natural and designed world.
- Understanding the development of scientific ideas is essential for building scientific knowledge.
- Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

Essential Questions

- Where does the energy on Earth come from?
- Why don't we run out of water?
- Why are there different organisms in different parts of the world?

Concepts

- All energy on earth comes from the sun
- The sun affects air currents and ocean circulation
- Material on earth flows through a cycle, like the water cycle or carbon cycle
- There are many theories as to the origin of life on earth
- Organisms evolved to adapt to the changing conditions on planet earth

Formative Assessment

Students who understand the concepts are able to:

- Explain the water cycle
- Explain the carbon cycle
- Identify atmospheric wind patterns
- Identify oceanic circulation
- Explain how life evolve as the earth changed

Suggested Learning Activities

Students will examine the effects solar energy has on the atmospheric and oceanic circulation patterns of the planet. The water cycle will be studied and students will build a model aquifer to investigate how water is stored in the earth. The origins of life will be investigated and the process of evolution will be discussed. Students will apply their knowledge of evolution to predicting adaptive changes to an organism in response to environmental changes.

1. Spaceship Earth
    a. Closed system
        i. Activity: compare a closed vs. open system
    b. Solar energy
        i. Atmospheric Circulation
        ii. Ocean circulation
2. Cycles
    a. Water cycle
        i. Surface water
        ii. Aquifers
            1. Activity: build a model aquifer with a soda bottle and gravel. Calculate the porosity

b. Carbon cycle
c. Nitrogen cycle
3. Life
a. Conditions on earth at various times
b. Theories on the beginning of life
c. Evolution and adaptation of life
i. Activity: predict the adaptive changes to an organism in response to environmental changes

Performance Expectations		
Science and Engineering Practices	**DCI**	**Crosscutting Concepts**
Planning and Carrying Out Investigations • Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (**HS-PS2-5)** **Analyzing and Interpreting Data** • Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • ▯ Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (**HS-PS2-1**) **Using Mathematics and Computational Thinking** • Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created	**ESS2.C: The Roles of Water in Earth's Surface Processes** • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (**HS-ESS2-5**) **ESS2.D: Weather and Climate** • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (**HS-ESS2-2),(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) **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**)	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (**HS-PS2-4**) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (**HS-PS2-1),(HS-PS2-5)** • Systems can be designed to cause a desired effect. (**HS-PS2-3**) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (**HS-PS2-2**)

and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (**HS-PS2-2),(HS-PS2-4**) **Constructing Explanations and Designing Solutions** • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (**HS-PS2-3**) **Obtaining, Evaluating, and Communicating Information** • Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about 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-PS2-6)**		

Cross-Curricular Connections	
English/Language Arts Standards	**Mathematics Standards**
• Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1) **RST.11-12.7** • 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. (HS-ETS1-3) **RST.11-12.9** • Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.9** • Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) **SL.11-12.5**	• Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) **MP.2** • Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) **MP.4** • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3) **HSN-Q.A.1**

21st Century Career Ready Practices
• **CRP2.** Apply appropriate academic and technical skills. • **CRP4.** Communicate clearly and effectively and with reason. • **CRP6.** Demonstrate creativity and innovation. • **CRP8.** Utilize critical thinking to make sense of problems and persevere in solving them. • **CRP12.** Work productively in teams while using cultural global competence

Earth, Space & the Environment

Unit 5: Land Use — Instructional Time: 4 Weeks

The uses of land and land management will be discussed. The processes of mineral extraction will be explored as well as methods of timber harvesting. Zoning laws and urban sprawl will be studied. Modern farming techniques will be contrasted with traditional farming.

Student Learning Objectives

New Jersey Student Learning Standards for Science/NGSS

HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate 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 natural systems

Enduring Understandings	Essential Questions
• The same basic rules govern the motion of all bodies, from planets and stars to birds and billiard balls. • Mathematics is a tool used to model objects, events, and relationships in the natural and designed world. • Understanding the development of scientific ideas is essential for building scientific knowledge. • Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.	• How do we get the raw materials to support a modern lifestyle? • Why do newly developed areas have a different look than older areas? • What is the difference between a national park and a monument? • Where does food come from?

Concepts	Formative Assessment
• Many minerals are extracted via mining • Clear cutting and selective cutting are two methods of harvesting timber • Zoning laws are used to plan where different types of development occur • The growth of suburban areas into rural areas is called urban sprawl • There are 6 UN recognized categories of public land • Land management practices vary for rangeland, forest, and parks • The green revolution saw an increase in food production due to modern farming practices • There are many differences between traditional farming and modern farming • Organic is a legally defined term. Natural is not.	Students who understand the concepts are able to: • Explain the benefits and hazards of various mining techniques • Explain the rural - urban connection • Explain zoning laws and the effect on urban sprawl • Explain the difference between rangeland, forest, and parks • Explain the difference between traditional and modern farming

Suggested Learning Activities

Students will explore mining and the concepts of percent yield by extracting all of the chips from a chocolate chip cookie. Urban planning will be practiced by managing a the resources and development of an area on a simulation game. Traditional farming will be contrasted to modern farming, and students will be asked to compare the positive and negative aspects of both.

1. Mining
    a. Surface
    b. Subsurface
    c. Reclamation
    d. Activity: stations with information about each type of mining

        e. Activity: cookie mining. Mine the chips from a cookie and calculate the % yield, etc.
2. Land use
    a. Activity: tragedy of the commons game
    b. Public lands
    c. Timber harvesting
3. Zoning
    a. Urban planning
        i. Activity: Use online game, *Electrocity*, to manage the natural resources and plan the development of a small city
    b. Urban sprawl
4. Farming
    a. Traditional
    b. Modern
    c. Green revolution
    d. Activity: Movie: food Inc.
    e. Activity: write a 5 paragraph persuasive essay, for or against, organic foods

Performance Expectations		
Science and Engineering Practices	**DCI**	**Crosscutting Concepts**
Planning and Carrying Out Investigations • Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (**HS-PS2-5)** **Analyzing and Interpreting Data** • Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (**HS-PS2-1**) **Using Mathematics and Computational Thinking** • Mathematical and computational	**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.	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (**HS-PS2-4**) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **(HS-PS2-1),(HS-PS2-5)** • Systems can be designed to cause a desired effect. (**HS-PS2-3**) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (**HS-PS2-2**)

thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (**HS-PS2-2),(HS-PS2-4**) **<u>Constructing Explanations and Designing Solutions</u>** • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (**HS-PS2-3**) **<u>Obtaining, Evaluating, and Communicating Information</u>** • Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about 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-PS2-6)**	(**HS-ESS3-4**)	

English/Language Arts Standards	Mathematics Standards
• Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1) **RST.11-12.7** • 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. (HS-ETS1-3) **RST.11-12.9** • Draw evidence from informational texts to support	• Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) MP.2 • Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) MP.4 • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3) HSN-Q.A.1

analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.9** • Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) **SL.11-12.5**	

21st Century Career Ready Practices

- **CRP2.** Apply appropriate academic and technical skills.
- **CRP4.** Communicate clearly and effectively and with reason.
- **CRP6.** Demonstrate creativity and innovation.
- **CRP8.** Utilize critical thinking to make sense of problems and persevere in solving them.
- **CRP12.** Work productively in teams while using cultural global competence

Earth, Space & the Environment

Unit 6: Energy — Instructional Time: 4 Weeks

The use of energy to support various levels of development will be discussed. The sources of this energy and the environmental impact of obtaining and using this energy will be explored. Nonrenewable and renewable energy sources will be investigated in the context of environmental impact, sustainability, and economic feasibility.

Student Learning Objectives

New Jersey Student Learning Standards for Science/NGSS

HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate 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 natural systems

Enduring Understandings

- The same basic rules govern the motion of all bodies, from planets and stars to birds and billiard balls.
- Mathematics is a tool used to model objects, events, and relationships in the natural and designed world.
- Understanding the development of scientific ideas is essential for building scientific knowledge.
- Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

Essential Questions

- Where does the energy to power the modern world come from?
- What happens when we run out of oil?
- How does a nuclear submarine go years between refueling?

Concepts

- Primitive societies use wood as fuel
- Fossil fuels power the modern world
- Fossil fuels are non-renewable
- Renewable and alternative energy or sustainable
- Nuclear power is efficient but has risks

Formative Assessment

Students who understand the concepts are able to:

- Explain how a typical power plant works
- Explain the risks of nuclear power
- Explain the benefits of renewable energy

Suggested Learning Activities

Students will be asked to analyze the benefits of energy extraction versus environmental protection. The efficiency of traditional fossil fuels versus nuclear power will be mathematical analyzed. Students will investigate various nuclear disasters and write a persuasive essay in favor of or against nuclear power.

1. Oil
    a. Extraction
    b. Activity: debate drilling for oil in ANWR
2. Coal
    a. Safety risks of mining
    b. Pollution from burning coal
3. Nuclear
    a. Fission
        i. Activity: calculate the energy produced per mass of uranium vs. mass of coal
    b. Risks of nuclear power
        i. Fukushima
        ii. 3 mile island
        iii. Chernobyl
        iv. Activity: research the effects of radiation poisoning; estimate the effected population around a power plant

v. Activity: write a 5 paragraph persuasive essay in favor of, or against nuclear power

4. Activity: Compare and contrast the positives and negatives of various energy sources

Performance Expectations		
Science and Engineering Practices	**DCI**	**Crosscutting Concepts**
Planning and Carrying Out Investigations • Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **(HS-PS2-5)** **Analyzing and Interpreting Data** • Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (**HS-PS2-1**) **Using Mathematics and Computational Thinking** • Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (**HS-PS2-2),(HS-PS2-4**)	**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.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**)	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (**HS-PS2-4**) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (**HS-PS2-1),(HS-PS2-5)** • Systems can be designed to cause a desired effect. (**HS-PS2-3**) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (**HS-PS2-2**)

<u>**Constructing Explanations and Designing Solutions**</u> • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (**HS-PS2-3**) <u>**Obtaining, Evaluating, and Communicating Information**</u> • Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about 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-PS2-6)**		

Cross-Curricular Connections	
English/Language Arts Standards	**Mathematics Standards**
• Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1) **RST.11-12.7** • 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. (HS-ETS1-3) **RST.11-12.9** • Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.9** • Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) **SL.11-12.5**	• Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) **MP.2** • Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) **MP.4** • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3) **HSN-Q.A.1**

21st Century Career Ready Practices
• **CRP2.** Apply appropriate academic and technical skills. • **CRP4.** Communicate clearly and effectively and with reason. • **CRP6.** Demonstrate creativity and innovation. • **CRP8.** Utilize critical thinking to make sense of problems and persevere in solving them. • **CRP12.** Work productively in teams while using cultural global competence

Earth, Space & the Environment

Unit 7: Waste Pollution — Instructional Time: 4 Weeks

This unit will look at waste, pollution, and human health. Various waste streams that result from the modern lifestyle will be traced from the source to the final stage. Treatment, risk mitigation, and waste reduction strategies will be discussed. Pollution and the effects on human health will be explored, as well as pollution cleanup.

Student Learning Objectives

New Jersey Student Learning Standards for Science/NGSS

HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on 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

Enduring Understandings

- The same basic rules govern the motion of all bodies, from planets and stars to birds and billiard balls.
- Mathematics is a tool used to model objects, events, and relationships in the natural and designed world.
- Understanding the development of scientific ideas is essential for building scientific knowledge.
- Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

Essential Questions

- Where does trash go after it is picked up from the curb?
- Why can't oil be dumped down the drain?
- Why can't fish be eaten from some lakes and rivers?
- What is smog?

Concepts

- Landfills are pits where trash is buried
- Recycling is a means to reduce waste
- Toxic materials must be disposed of properly
- Polluted soil and surface water can effect groundwater supplies
- Many pollutants have negative effects on the health of humans and other organisms
- LD50 is a means of testing the acceptable level of a substance
- Indoor and outdoor Air pollution is a major health risk
- Carbon dioxide is considered by many scientists and political bodies to be an air pollutant that contributes to climate change

Formative Assessment

Students who understand the concepts are able to:

- Explain the residential solid and liquid waste stream
- Explain how surface water pollution can contaminate wells
- Identify the health risks from common pollutants
- Explain methods of reducing waste
- Define primary and secondary air pollutants
- Explain the theory of carbon dioxides role in climate change

Suggested Learning Activities

Students will explore solid waste and the amount of waste diverted from landfills by recycling programs. The local municipal water quality report will be scrutinized and the sources of potential contaminants will be researched. Tailpipe emissions of various automobiles will be calculated.

1. Solid waste
   a. Solid waste stream
   b. Activity: compare volume of waste with and without recycling programs
2. Water pollution
   a. Sources of pollution
      i. Point
      ii. Non-point
   b. Waste water treatment

            i. Activity: study the local municipal water report and identify the potential sources and hazards of the pollutants test for

3. Air pollution
    a. Primary
    b. Secondary
    c. Indoor
        i. radon
    d. Activity: calculate tailpipe emissions for different automobiles
4. Health risks
    a. LD50
    b. Activity: research the health effects and cost of air air pollution

Performance Expectations		
Science and Engineering Practices	**DCI**	**Crosscutting Concepts**
Planning and Carrying Out Investigations • Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **(HS-PS2-5)** **Analyzing and Interpreting Data** • Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • □ Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (**HS-PS2-1**) **Using Mathematics and Computational Thinking** • Mathematical and computational thinking at the 9-12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials	**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-ESS3-2**),(secondary **HS-ESS3-4**)	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (**HS-PS2-4**) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (**HS-PS2-1**),(**HS-PS2-5**) • Systems can be designed to cause a desired effect. (**HS-PS2-3**) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (**HS-PS2-2**)

and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (**HS-PS2-2),(HS-PS2-4**) **Constructing Explanations and Designing Solutions** • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (**HS-PS2-3**) **Obtaining, Evaluating, and Communicating Information** • Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about 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-PS2-6)**		

Cross-Curricular Connections	
English/Language Arts Standards	**Mathematics Standards**
• Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1) **RST.11-12.7** • 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. (HS-ETS1-3) **RST.11-12.9** • Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.9** • Make strategic use of digital media (e.g., textual,	• Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) **MP.2** • Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) **MP.4** • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3) **HSN-Q.A.1**

graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) **SL.11-12.5**	

21st Century Career Ready Practices
• **CRP2.** Apply appropriate academic and technical skills. • **CRP4.** Communicate clearly and effectively and with reason. • **CRP6.** Demonstrate creativity and innovation. • **CRP8.** Utilize critical thinking to make sense of problems and persevere in solving them. • **CRP12.** Work productively in teams while using cultural global competence

Earth, Space & the Environment

Unit 8: Sustainability	Instructional Time: 4 Weeks

Sustainability can be considered to be the most important topic in environmental science. This unit will focus on analyzing various situations and strategies for sustainability. Students will examine biodiversity, energy, natural resources, and climate change

Student Learning Objectives

New Jersey Student Learning Standards for Science/NGSS

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 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-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
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

Enduring Understandings

- The same basic rules govern the motion of all bodies, from planets and stars to birds and billiard balls.
- Mathematics is a tool used to model objects, events, and relationships in the natural and designed world.
- Understanding the development of scientific ideas is essential for building scientific knowledge.
- Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

Essential Questions

- Why are some organisms listed as endangered?
- What are carbon credits?
- Why are there limits on how many fish you can catch?

Concepts

- Humans are responsible for most of the current lose in biodiversity
- Carbon credits are a method of attaching an monetary value to carbon emissions to affect economic decisions
- Renewable energy is energy from a limitless source
- Some natural resources are finite, others are renewable
- An exotic species is an organism living outside its natural range
- Overharvesting is a threat to renewable resources
- The earth is mostly a closed system

Formative Assessment

Students who understand the concepts are able to:

- Explain the difference between endangered and threatened species
- Explain the risks of an invasive species
- List sources of renewable energy
- Explain strategies to preserve renewable resources
- Explain methods of combating climate change

Suggested Learning Activities

Students will develop a preservation plan for an endangered species. The energy efficiency of ethanol versus gasoline will be calculated. Students will be presented with scientific studies purported to prove that global warming is anthropogenic and with scientific studies that indicate that global warming is not anthropogenic. Students will calculate the ecological footprint of their lifestyle and will learn about sustainability by playing a sustainable island game.

1. Biodiversity
    a. Endangered species
        i. Activity: Students develop a preservation plan for an endangered species
    b. Invasive species
        i. Activity: research various invasive species in N. America.(i.e.: pythons and monitor lizards in FL, emerald ash borers, etc.)
2. Renewable energy
    a. Solar
        i. Activity: compare solar panel offerings (ie: solar city, etc.)and long term costs
    b. Biomass
        i. Activity: Compare the efficiency of fuel from corn ethanol vs. traditional gasoline
    c. Geothermal
    d. Hydro/wave/tidal
3. Climate change
    a. Greenhouse gasses
        i. Activity: research the source of various greenhouse gasses. Rank them for overall strength in warming.
    b. Potential effects of climate change
        i. Activity: research the change in arable land is temperature changes; the change in coastlines if water rises
    c. Ways to combat climate change
        i. Activity: debate the role of carbon credits in using market forces to control carbon emissions
    d. Arguments and evidence contradicting the theories of climate change
4. Sustainability
    a. Activity: sustainable island simulation
    b. Activity: Ecological footprint calculation

Performance Expectations		
Science and Engineering Practices	**DCI**	**Crosscutting Concepts**
Planning and Carrying Out Investigations • Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (**HS-PS2-5)** **Analyzing and Interpreting Data** • Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	**ESS2.D: Weather and Climate** • 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-ESS3-6**) **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	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (**HS-PS2-4**) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (**HS-PS2-1),(HS-PS2-5)** • Systems can be designed to cause a desired effect. (**HS-PS2-3**) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (**HS-PS2-2**)

• 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-PS2-1**) **Using Mathematics and Computational Thinking** • Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (**HS-PS2-2),(HS-PS2-4**) **Constructing Explanations and Designing Solutions** • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (**HS-PS2-3**) **Obtaining, Evaluating, and Communicating Information** • Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about 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-PS2-6)**	regulations can change the balance of these factors. (**HS-ESS3-2**) **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-ESS3-2**),(secondary **HS-ESS3-4**) **ETS1.A: Defining and 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**) • Humanity faces major global challenges today, such as the need	

	for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (**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**) • 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. (**HS-ETS1-4**) **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**)	

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