PUBLIC SCHOOLS OF EDISON TOWNSHIP

OFFICE OF CURRICULUM AND INSTRUCTION

Environmental Science

Length of Course:	Term
Elective/Required:	Required
Schools:	High Schools
Eligibility:	Grade 9
Credit Value:	5 Credits
Date Approved:	September 24, 2018

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Statement of Purpose

Environmental Science is offered to all ninth graders who are not enrolled in the Honors Biology course as part of a sequence of college preparatory science courses. It is followed by Biology and Chemistry, and Physics. The course presents a comprehensive survey of the interaction between the physical and biological sciences on Earth. The course delivers the content at a level appropriate to its intended audience. The course content is based on the most current Next Generation Science Standards, including science and engineering practices. In addition, it connects the subject matter to everyday experiences, careers in a variety of fields of science including life science, physical science, and environmental concerns. The Career Ready and Educational Technology Standards are embedded in the curriculum.

This curriculum guide was compiled in the year of 2018 and is designed to follow NGSS/NJSLS and utilize existing course materials, Discovery Education Science Tech Book, and online resources.

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Course Objectives

By the end of the Environmental Science course, students will be able to:

- 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(Quarter 1)
- HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements. (Quarter 1)
- HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. (Quarter 1)
- HS-PS2-4.Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. (Quarter 1)
- 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. (Quarter 4)
- HS-ESS3-3. Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity. (Quarter 4)
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. (Quarter 4)
- 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's systems.(Quarter 4)
- 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. (Quarter 4)

Engineering Design

- **(NJSLS/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.
- **(NJSLS/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.
- **(NJSLS/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.
- **NJSLS/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

Timeline

First Quarter Units - Unit 1: The Universe

Big Bang Theory
- Speed of Light
- Theory of Conservation of Matter and Energy
- Theory of Relativity
- Formation of Protons, Neutrons, Electrons
- Nuclear Fusion & Fission

Formation of Planets and Moons

Effects of the Sun's behavior

Gravitational Forces (Newton's Law of Universal Gravitation)

Orbits (Kepler's Laws)

Collisions and Changes to Momentum

Second Quarter Units - Unit 2: Transition of the Dynamic Earth

Settling of Earth and Formation of Oceans and Atmosphere
- Thermodynamics
- Magnetism
- Radioactivity
- Feedback Loops
- Water's Properties

Plate Tectonics
- Thermal Convection Cycles Matter
- Mountain Building
- Formation of Ocean Floor
- Volcanoes

Weather patterns
- Coriolis Effect
- Air Masses
- Predict (forecast) global climate change and its impacts on Earth's systems.

Third Quarter Units- Unit 3: The Dynamic & Living Earth

Formation of Life
- Carbon Cycling

Evolution of Living Things
- Fossil Record

Establishment of Food Chains & Food Webs

Carrying Capacity & Limiting Factors

Fourth Quarter Units - Unit 4: The Relationship Between Humans and Earth

Settlement based on available resources
Changes to human society based on changes in technology
    Hunter Gatherer- Industrial Revolution
Effects of Human Technology on Earth's Systems
    Pollution
    Climate Change
Management of Resources
    Waste Management
    Alternativer Energy
Conservation and Sustainability

Unit 1: Formation of the Universe

Phenomena: The Big Bang Theory is a model of the formation of the Universe and its celestial bodies.

Essential Questions:

- *How do we know how the universe formed?*
- *What events and phenomena occurred and lead to the formation of Earth and its moon?*
- *Why is Pluto no longer considered a planet? (What makes a celestial body a planet?)*
- *How is it possible to keep an artificial satellite (or moon?) in orbit of a celestial body?*
- *Why do the number of moons around planets increase as you move away from the Sun?*

NGSS Performance Expectations: (Students who demonstrate understanding can:)

- 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.
- HS-PS2-4.Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

- Quarterly Exam
- Students will create a model of their understanding of the Universe based on the concepts covered in Unit 1. They must use evidence and strong reasoning skills to justify their claims. Students will have an option of any modality they choose to present their models.

Resources:
Essential Materials, Supplementary Materials, Links to Best Practices

- Discovery Education Science Tech Book
- For phenomena ideas: www.NGSSPhenomena.com
- For simulation labs: Gizmos
- For readings, quizzes, and simulations: www.ck12.org

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-5),(HS-ESS1-6)*
RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS1-5),(HS-ESS1-6)
WHST.9-12.1	Write arguments focused on *discipline-specific content.* (HS-ESS1-6)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2),*(HS-ESS1-3),(HS-ESS1-5)*
SL.11-12.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(HS-ESS1-3)*

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
MP.4	Model with mathematics. (HS-ESS1-1),(HS-ESS1-4)
HSN-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1),*(HS-ESS1-2)*,(HS-ESS1-4),*(HS-ESS1-5),(HS-ESS1-6)*
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
HSA-SSE.A.1	Interpret expressions that represent a quantity in terms of its context. *(HS-ESS1-1),(HS-ESS1-2),*(HS-ESS1-4)
HSA-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*
HSA-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*

HSF-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *(HS-ESS1-6)*
HSS-ID.B.6	Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. *(HS-ESS1-6)*

Technology

8.2.12.E.1. Demonstrate an understanding of the problem-solving capacity of computers in our world.
8.1.12.F.1. Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs
8.1.12.A.5. Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

Career Ready Practices

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Student Learning Objectives: (SLO) 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			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS1.A: The Universe and Its Stars The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.	**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. 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. **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**	**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.	**Discovery Education Tech Book Under Earth and Space Science** Unit- The Universe • Understanding the Universe ○ Big Bang Theory ○ Electromagnetic Spectrum ○ Theory of Relativity ○ Theory of the Conservation of Matter and Energy ○ Redshift Evidence Identifying valid claims, evidence and corresponding reasoning to explain the Big Bang Theory and the creation of all energy and matter Using the speed of light to measure distances Exploration Lab: Understanding the Universe	Tests Quizzes Formative Assessments Labs/Activities Homework

	A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.			

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium)

Assessment Boundary: The assessment does not include specific subatomic particles (ie, positrons, etc)

Student Learning Objectives: (SLO) HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
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. 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.	**Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**Energy and Matter** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	**Discovery Education Tech Book Under Earth and Space Science** Unit- The Universe • Understanding the Universe Formation of heavier elements as stars are creating to explain how heavier elements came to exist through nuclear fusion	Tests Quizzes Formative Assessments Labs/Activities Homework

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime

Assessment Boundary: *Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed*

Student Learning Objectives: (SLO) HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS1.B: Earth and the Solar System Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.	**Using Mathematical and Computational Thinking** Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical or computational representations of phenomena to describe explanations.	**Scale, Proportion, and Quantity** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).	**Discovery Education Tech Book Under Earth and Space Science** Unit- Our Solar System • Planets and Moons Unit- Studying Space • Movements in Space **Discovery Education Tech Book Physics** Unit- Gravity • Newton's Laws Comparing the formation of the planets in regards to size and gravitational pull Formation of moons due to colliding forces	Tests Quizzes Formative Assessments Labs/Activities Homework

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons

Assessment Boundary: *Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus*

Student Learning Objectives: (SLO) HS-PS2-4.Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
PS2.B: Types of Interactions Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. Science Models, Laws, Mechanisms, and	**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	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.	**Discovery Education Tech Book Under Earth and Space Science** Unit- Our Solar System • Planets and Moons Unit- Studying Space • Movements in Space **Discovery Education Tech Book Physics** Unit- Gravity • Newton's Laws Emphasis on supporting why bigger planets have more moons due to the increased gravitational pull based on size and an emphasis on how colliding forces created the planets and other celestial boundaries and how gravity	Tests Quizzes Formative Assessments Labs/Activities Homework

Theories Explain Natural Phenomena Theories and laws provide explanations in science. Laws are statements or descriptions of the relationships among observable phenomena.	used based on mathematical models of basic assumptions. Use mathematical representations of phenomena to describe explanations.		participates in orbital pathways. Also differentiating between the Gravitational Field of a planet (g) versus the Gravitational constant (G)	
Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields Assessment Boundary: *Assessment is limited to systems with two objects*				

Unit 2: Transitioning of the Dynamic Earth

Phenomena: Earth settled into its layers and formed its oceans and atmosphere through a series of extraordinary events.

Essential Questions:

- *What changes occurred in the early Earth due to driving forces (magnetism, gravity, and convection) to lead the planet to layer into the Core, Mantle, and Crust.*
- *What are the internal structures and forces present throughout our galaxy that differentiate the environments present on the different planets and moons?*
- *How do the forces driving plate tectonics lead to changes in geologic features present on Earth? (In comparison to other planets)*
- *How do the forces that drive air and ocean circulation lead to weather patterns?*

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

- Quarterly Exam
- Students will offer alternatives to phenomena that occurred that lead to the creation of Earth and what consequences this would have had for the future of the planet. Students can choose the modality of this presentation.

Resources:
Essential Materials, Supplementary Materials, Links to Best Practices

- Discovery Education Science Tech Book
- For phenomena ideas: www.NGSSPhenomena.com
- For readings, quizzes, and simulations: www.ck12.org

Common Core State Standards Connections:
ELA/Literacy -

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RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS1-5),(HS-ESS1-6)
WHST.9-12.1	Write arguments focused on *discipline-specific content.* (HS-ESS1-6)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2),*(HS-ESS1-3),(HS-ESS1-5)*
SL.11-12.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(HS-ESS1-3)*
Mathematics -	
MP.2	Reason abstractly and quantitatively. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
MP.4	Model with mathematics. (HS-ESS1-1),(HS-ESS1-4)
HSN-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1),*(HS-ESS1-2)*,(HS-ESS1-4),*(HS-ESS1-5),(HS-ESS1-6)*
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
HSA-SSE.A.1	Interpret expressions that represent a quantity in terms of its context. *(HS-ESS1-1),(HS-ESS1-2),*(HS-ESS1-4)
HSA-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*
HSA-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*
HSF-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *(HS-ESS1-6)*
HSS-ID.B.6	Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. *(HS-ESS1-6)*

Technology

8.2.12.E.1. Demonstrate an understanding of the problem-solving capacity of computers in our world.
8.1.12.F.1. Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs
8.1.12.A.5. Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

Career Ready Practices

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Student Learning Objectives: (SLO) 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.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS1.C: The History of Planet Earth • Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth,	**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	**Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable.	**Discovery Education Tech Book Under Earth and Space Science** • Unit 4 - Geologic Time & Earth's History ○ The Development of Earth	Tests Quizzes Formative Assessments Labs/Activities Homework

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. **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)*	scientific ideas, principles, and theories. • Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. • Models, mechanisms, and			

	explanations collectively serve as tools in the development of a scientific theory.			

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.

Assessment Boundary:

Student Learning Objectives: (SLO) HS-ESS2-2: Analyze geoscience date to make the claim that one change to Earth's surface can create feedback that cause changes to other Earth's systems.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS2.A: Earth Materials and Systems • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. **ESS2.D: Weather and Climate** • The foundation for Earth's global climate systems is the electromagnetic	**Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models	**Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. **Influence of Engineering, Technology, and Science on Society and the Natural World** • New technologies can have deep	**Discovery Education Tech Book Under Earth and Space Science** • Unit 5 - Earth's Systems ○ Earth's Spheres • Unit 6 - Plate Tectonics & Earth's Internal Structure ○ Tectonic Plate Interactions	Tests Quizzes Formative Assessments Labs/Activities Homework

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.	(e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	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.		

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.

Assessment Boundary:

Student Learning Objectives: (SLO) HS-ESS2-3: Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection			**Instructional Actions** In this section, magnetism and its effect on the layering of Earth should be covered as a supplement.	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS2.A: Earth Materials and Systems • Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based on empirical evidence.	**Energy and Matter** • Energy drives the cycling of matter within and between systems. **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.	• Unit 6 - Plate Tectonics & Earth's Internal Structure ○ Earth's Interior	Tests Quizzes Formative Assessments Labs/Activities Homework

ESS2.B: Plate Tectonics and Large-Scale System Interactions • The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. **PS4.A: Wave Properties** • Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)	• Science disciplines share common rules of evidence used to evaluate explanations about natural systems. • Science includes the process of coordinating patterns of evidence with current theory.			
Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments Assessment Boundary:				

Student Learning Objectives: (SLO) 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.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS2.A: Earth Materials and Systems • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. 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)*	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**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.	• Unit 6 - Plate Tectonics & Earth's Internal Structure ○ The Continental Drift Hypothesis ○ Evidence for Plate Tectonics ○ Tectonic Plate Interactions	Tests Quizzes Formative Assessments Labs/Activities Homework

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).

Assessment Boundary: *Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.*

Student Learning Objectives: (SLO) 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			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS1.C: The History of Planet Earth • Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • Plate tectonics is the unifying theory that explains the past and current movements of	**Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Evaluate evidence behind currently accepted explanations or solutions to	**Patterns** • Empirical evidence is needed to identify patterns.	**Discovery Education Tech Book Under Earth and Space Science** • Unit 6 - Plate Tectonics & Earth's Internal Structure ○ Evidence for Plate Tectonics	Tests Quizzes Formative Assessments Labs/Activities Homework

the rocks at Earth's surface and provides a framework for understanding its geologic history. *(ESS2.B Grade 8 GBE) (secondary)* **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)*	determine the merits of arguments.			
Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions) Assessment Boundary:				

Student Learning Objectives: (SLO) 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.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
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)* **ESS2.A: Earth Materials and Systems** • The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Use a model to provide mechanistic accounts of phenomena. **Scientific Knowledge is Based on Empirical Evidence** • Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**Discovery Education Tech Book Under Earth and Space Science** • Unit 5 - Earth's Systems ○ Earth's Spheres • Unit 6 - Plate Tectonics & Earth's Internal Structure ○ Tectonic Plate Interactions	Tests Quizzes Formative Assessments Labs/Activities Homework

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. **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.				

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.

Assessment Boundary: *Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.*

Unit 3: The Dynamic & Living Earth

Phenomena: Life was created on Earth approximately 3.8 billion years ago and has continued to develop and evolve into the present day.

Essential Questions:

- *Where did life begin? Why must this have been the case for this?*
- *As life evolved, what characteristics must organisms have had to exhibit to be able to survive with the changing environment?*
- *Why do paleontologists uncover more fossils from less complex organisms than those higher on food chains and webs?*
- *How did each of the five mass extinctions create a new "Living Earth."*

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

- Quarterly Exam
- Students will take on a taxonomic endeavor of a species of their choice, researching its past and its place in one of the complex food webs on Earth. Students will have an option of any modality to present their information

Resources:

Essential Materials, Supplementary Materials, Links to Best Practices

- Discovery Education Science Tech Book
- For phenomena ideas: www.NGSSPhenomena.com
- For simulation labs: Gizmos
- For readings, quizzes, and simulations: www.ck12.org

Common Core State Standards Connections:
ELA/Literacy -

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

RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS1-5),(HS-ESS1-6)
WHST.9-12.1	Write arguments focused on *discipline-specific content.* (HS-ESS1-6)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2),*(HS-ESS1-3),(HS-ESS1-5)*
SL.11-12.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(HS-ESS1-3)*
Mathematics -	
MP.2	Reason abstractly and quantitatively. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
MP.4	Model with mathematics. (HS-ESS1-1),(HS-ESS1-4)
HSN-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1),*(HS-ESS1-2)*,(HS-ESS1-4),*(HS-ESS1-5),(HS-ESS1-6)*
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
HSA-SSE.A.1	Interpret expressions that represent a quantity in terms of its context. *(HS-ESS1-1),(HS-ESS1-2),*(HS-ESS1-4)
HSA-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*
HSA-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*
HSF-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *(HS-ESS1-6)*
HSS-ID.B.6	Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. *(HS-ESS1-6)*

Technology

8.2.12.E.1. Demonstrate an understanding of the problem-solving capacity of computers in our world.
8.1.12.F.1. Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs
8.1.12.A.5. Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

Career Ready Practices

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Student Learning Objectives: (SLO) HS-ESS2-7: Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS2.D: Weather and Climate • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. **ESS2.E Biogeology**	**Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from	**Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable.	**Discovery Education Tech Book Under Earth and Space Science** • Unit 4 - Geologic Time and Earth's History ○ The History of Life on Earth ○ Relative Dating	Tests Quizzes Formative Assessments Labs/Activities Homework

• 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.	current scientific or historical episodes in science. • Construct an oral and written argument or counter-arguments based on data and evidence.		○ Absolute Dating	

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.]

Assessment Boundary: *None*

<table>
<tr><td colspan="3">Student Learning Objectives: (SLO)
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</td><td colspan="2">Instructional Actions</td></tr>
<tr><td>Disciplinary Core Ideas</td><td>Science and Engineering Practices</td><td>Crosscutting Concepts</td><td>Activities/Strategies</td><td>Assessment Checkpoints</td></tr>
<tr>
<td>ESS1.C: The History of Planet Earth
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.
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)</td>
<td>Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
Connections to Nature of Science
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
A scientific theory is a substantiated explanation of some aspect of the natural</td>
<td>Stability and Change
Much of science deals with constructing explanations of how things change and how they remain stable.</td>
<td>Discovery Education Tech Book Under Earth and Space Science
Unit 4 - Geologic Time and Earth’s History
Geologic Time Scale</td>
<td>Tests
Quizzes
Formative Assessments
Labs/Activities
Homework</td>
</tr>
</table>

	world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. • Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.			

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.

Assessment Boundary:

Student Learning Objectives: (SLO) HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
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.	**Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena or design solutions to support claims.	**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.	**Discovery Education Tech Book Under Biology** **Unit 8: Ecology** • Ecosystems	Tests Quizzes Formative Assessments Labs/Activities Homework

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.				

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.

Assessment Boundary: *Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy*

Student Learning Objectives: (SLO) HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
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.	**Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical and/or computational representations of phenomena or design solutions to support explanations.	**Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.	**Discovery Education Tech Book Under Biology** **Unit 8: Ecology** • Describing Populations	Tests Quizzes Formative Assessments Labs/Activities Homework

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets Clarification Statement: Assessment Boundary:

Unit 4: The Relationship Between Humans and Earth

Phenomena: Since their evolution on Earth, human beings as a species have had the largest environmental impact on the planet.

Essential Questions:

- *How have human societies changed over the existence of the species based on natural resource availability?*
- *What human impacts have the largest and most dangerous implications for our current "LIving Earth?"*
- *How can your local community improve their sustainability and conservation efforts?*

NGSS Performance Expectations: (Students who demonstrate understanding can:)

- 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. (Quarter 4)
- HS-ESS3-3. Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity. (Quarter 4)
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. (Quarter 4)
- 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's systems.(Quarter 4)
- 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. (Quarter 4)

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

- Quarterly Exam
- Designing a local plan for sustainability of human population and conservation of local ecosystems. Students can determine what is personally important to them to design a call to action of their choice for their community.

Resources:
Essential Materials, Supplementary Materials, Links to Best Practices

- Discovery Education Science Tech Book
- Holt Environmental Science
- For phenomena ideas: www.NGSSPhenomena.com

- For simulation labs: https://concord.org/stem-resources/subject/biology
- For readings, quizzes, and simulations: www.ck12.org

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-ESS2-2),(HS-ESS2-3)*
RST.11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. *(HS-ESS2-2)*
WHST.9-12.1	Write arguments focused on *discipline-specific content.* (HS-ESS2-7)
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)
SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. *(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4)*

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
MP.4	Model with mathematics. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
HSN.Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
HSN.Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
HSN.Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6)

Technology

8.1.12.C.1 Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community

8.1.12.E.1. Produce a position statement about a real world problem by developing a systematic plan of investigation with peers and experts synthesizing information from multiple sources.

8.2.12.B.2. Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation and maintenance of a chosen product

8.2.12.B.4 Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.
Career Ready Practices

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Student Learning Objectives: (SLO) 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.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS3.A: Natural Resources Resource availability has guided the	**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	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make	**Discovery Education Tech Book Under Earth and Space Science** Unit- Earth Systems	Tests Quizzes Formative Assessments Labs/Activities Homework

development of human society.	supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. 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.	claims about specific causes and effects. Influence of Science, Engineering, and Technology on Society and the Natural World Modern civilization depends on major technological systems.	• Relationships Between Human Activity and Earth's System • Natural Resources Transitioning of Human Society based on available resources (Hunter Gatherers-Industrial Revolution) How the Environment altered how humans settle and the evolution of technology	

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised

Assessment Boundary:

Student Learning Objectives: (SLO) 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.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
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)* **ESS3.D: Global Climate Change** Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are	**Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	modified in response to human activities. **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.	**Discovery Education Tech Book Under Earth and Space Science** Unit- Earth Systems • Relationships Between Human Activity and Earth's System • Natural Resources • Cycling of Matter and Energy Humans effects on each of the spheres	Tests Quizzes Formative Assessments Labs/Activities Homework
Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in				

atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations

Assessment Boundary: *Assessment does not include running computational representations but is limited to using the published results of scientific computational models*

Student Learning Objectives: (SLO) 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's systems.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
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.	**Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using computational models in order to make valid and reliable scientific claims. Scientific Investigations Use a Variety of Methods Science investigations use diverse methods and do not	**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.	Discovery Education Tech Book Under Earth and Space Science Unit- Earth Systems • Relationships Between Human Activity and Earth's System • Natural Resources Humans effects on each of the spheres	Tests Quizzes Formative Assessments Labs/Activities Homework

	always use the same set of procedures to obtain data. New technologies advance scientific knowledge. Scientific Knowledge is Based on Empirical Evidence Science knowledge is based on empirical evidence. Science arguments are strengthened by multiple lines of evidence supporting a single explanation.			
Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition Assessment Boundary: *Assessment is limited to one example of a climate change and its associated impacts*				

Student Learning Objectives: (SLO) HS-ESS3-3. Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS3.C: Human Impacts on Earth Systems The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.	**Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Create a computational model or simulation of a phenomenon, designed device, process, or system.	**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. *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World Modern civilization depends on major technological systems. New technologies can have deep impacts on society and the environment, including some that were not anticipated. *Connections to Nature of Science* Science is a Human Endeavor • Science is a result of human	Discovery Education Tech Book Under Earth and Space Science Unit- Earth Systems • Relationships Between Human Activity and Earth's System • Natural Resources	Tests Quizzes Formative Assessments Labs/Activities Homework

		endeavors, imagination, and creativity.		

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning

Assessment Boundary: *Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations*

Student Learning Objectives: (SLO) HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies**	**Assessment Checkpoints**
ESS3.C: Human Impacts on Earth Systems Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and	**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 knowledge, principles, and theories. Design or refine a solution to a complex real-world problem, based on scientific knowledge,	**Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system. Influence of Science, Engineering, and Technology on Society and the Natural World Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase	Discovery Education Tech Book Under Earth and Space Science Unit- Earth Systems • Relationships Between Human Activity and Earth's System • Natural Resources	Tests Quizzes Formative Assessments Labs/Activities Homework

aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*	student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	benefits while decreasing costs and risks		

Instructional Adjustment: Modifications, student difficulties, possible misunderstandings, Manipulatives, Practice Sets

Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean)

Assessment Boundary: