MANCHESTER REGIONAL HIGH SCHOOL

Environmental Science

Adopted DATE

May 2016

Manchester Regional High School Board of Education
Mrs. Ellen Fischer, President
Mr. Joseph Ferrante, Vice-President
Mr. Michael Boyle
Mr. Albert Demarest
Dr. Edward Domanico
Mr. Jeff Fischer
Mr. Joseph Foti
Mr. Michael Galluccio
Mr. John Vander Molen

Administration
Dr. Miguel Hernandez, Superintendent of Schools
Mr. John Serapiglia, Business Administrator
Dr. Richard Ney, Principal
Mr. Christopher Wacha, Assistant Principal/LAL Supervisor
Ms. Colleen Brogan, Assistant Principal for Curriculum & Student Services

Supervisor
Anthony Emmons

Curriculum Committee
Colleen Brogan
Christopher Wacha

Manchester Regional High School
District Mission Statement

The mission of Manchester Regional High School is to produce respectful, responsible and well-rounded graduates who possess the knowledge and skills to become contributing members of society and life-long learners.

Highly qualified, collaborative and innovative staff address the needs of a diverse school community in a stimulating and nurturing environment.

MANCHESTER REGIONAL HIGH SCHOOL

COURSE DESCRIPTION:Environmental Science

Environmental Science is built upon two core ideas. The first core idea, Earth's Systems, encompasses the processes that drive Earth's conditions and its continual evolution (i.e., change over time). It addresses the planet's large-scale structure and composition, describes its individual systems, and explains how they are interrelated. It also focuses on the mechanisms driving Earth's internal motions and on the vital role that water plays in all of the planet's systems and surface processes.

The second core idea, Earth and Human Activity, addresses society's interactions with the planet. Connecting the ESS to the intimate scale of human life, this idea explains how Earth's processes affect people through natural resources and natural hazards, and it describes as well some of the ways in which humanity in turn affects Earth's processes.

Environmental Science is a lab-based/inquiry science course is structured so that students actively engage in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas. The learning experiences provided for students should engage them with fundamental questions about the world and with how scientists have investigated and found answers to those questions. Students should have the opportunity to carry out scientific investigations and engineering design projects related to the disciplinary core ideas in physical sciences

COURSE DATA:

Length of course:	Full year
Credits:	Five (Six if the lab schedule is implemented)
Periods per week:	Five (Six if the lab schedule is implemented)
Classification:	Grades 10-12
Prerequisite:	None

EVALUATION:

The purposes of evaluation are to provide information about student progress and to determine whether students have learned the subject matter, which has been taught. Teachers will evaluate student progress by utilizing standardized tests, teacher-made quizzes and tests, projects, oral questioning, class participation. Other evaluative criteria will include homework, special projects, special exams and other school records.

NOTE: The following pacing guide was developed during the creation of these curriculum units. The actual implementation of each unit may take more or less time. Time should also be dedicated to preparation for benchmark and State assessments, and analysis of student results on the same. A separate document is included at the end of this curriculum guide with suggestions and resources related to State Assessments (if applicable). The material in this document should be integrated throughout the school year, and with an awareness of the State Testing Schedule. It is highly recommended that teachers meet throughout the school year to coordinate their efforts in implementing the curriculum and preparing students for benchmark and State Assessments in consideration of both the School and District calendars.

Manchester Regional High Schools Curriculum Guide

Content Area: Science

Course Title: Environmental Science	**Grade Levels: 10-12**

Unit 1: Earth's Systems	**9 Weeks**
Unit 2: Human Activity & the Climate System	**9 Weeks**
Unit 3: Human Activity and Sustainability	**9 Weeks**
Unit 4: Human Activity & Energy	**9 Weeks**

Board Approved on:

Unit 1 Overview	
Content Area – Science	
Unit 1 Title – Dynamic Earth	
Target Course/Grade Level – Environmental Science	
Stage 1: Desired Results	
Next Generation Science Standards	
HS-ESS2-2	**Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.** [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.]
HS-ESS2-5	**Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.** [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]
HS-ESS2-6	**Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]
HS-ESS2.7	**Construct an argument based on evidence about the simultaneous co-evolution of Earth's systems and life on Earth.** [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 of 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: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]
Unit Essential Questions	**Unit Enduring Understandings**

• How do changes in the geosphere affect the atmosphere? • How do the properties and movements of water shape Earth's surface and affect its systems? • How does carbon cycle among the hydrosphere, atmosphere, geosphere, and biosphere? • How can one explain and predict interactions between Earth materials and within Earth's system? • How do living organisms alter Earth's processes and structures?	• Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. • 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. • The foundation for Earth's global climate system is the electromagnetic radiation from the sun as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems and this energy's reradiation into space. Climate change can occur when certain parts of Earth's systems are altered. • 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.
Unit Objective:	
In this unit of study, *planning and carrying out investigations*, *analyzing and interpreting data, developing and using models,* and *engaging in arguments from evidence* are key practices to explore the dynamic nature of Earth systems. Students apply these practices to illustrate how Earth's interacting systems cause feedback effects on other Earth systems, to investigate the properties of water and its effects on Earth materials and surface processes, and to model the cycling of carbon through all of the Earth's spheres. Students seek evidence to construct arguments about the simultaneous co-evolution of the Earth's systems and life on Earth. The crosscutting concepts of *energy and matter*, *structure and function,* and *stability and change* are called out as organizing concepts for these disciplinary core ideas. This unit is based on HS-ESS2-2, HS-ESS2-5, HS-ESS2-6, and HS-ESS2-7.	
Content Knowledge:	**Skills and Topics**

ESS2.A:Earth Materials and Systems • Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) **ESS2.C: The Roles of Water in Earth’s Surface Processes** • Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) **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-ESS-2-2) • 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) **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)	**Developing and Using Models** • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6) **Planning and Carrying Out Investigations** • Plan and carry an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design decide on types, how much and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time) and refine the design accordingly. (HS-ESS2-5) **Analyzing and Interpreting Data** • Analyze data using tools, technologies and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2) **Engaging in Argumentation from Evidence** • Construct an oral and written argument or counter-arguments based on data and evidence (HS-ESS2.7) **Energy and Matter** • The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) **Structure and Function** • The functions and properties of natural and designed objects and systems can be inferred from their overall structures, the way their components are shaped and used, and the molecular sub-structures of their various materials. (HS-ESS2-5) **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable (HS-ESS2-7) • Feedback (negative or positive) can stabilize or destabilize a system.(HS-ESS-2-2) **Influence of Engineering Technology and Science on Society and the Natural World**

<table>
<tr><td></td><td>New technologies can have deep impact on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS-2-2)</td></tr>
<tr><th colspan="2">STAGE 2: Assessment Evidence</th></tr>
<tr><th>Formative Assessment</th><th>Summative Assessment</th></tr>
<tr><td>Warm-up activities
Do Now's
Class discussions
Student participation
Teacher observations</td><td>Tests
Quizzes
Projects
Homework
Lab Reports</td></tr>
<tr><th colspan="2">Laboratory and Exploratory Activities</th></tr>
<tr><td rowspan="2">Now you "Sea" Ice, Now You Don't</td><td>Practice Standards
Analyze geoscience data using tools, technologies, and/or models (e.g., computational, mathematical) to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.(HS-ESS2-2)</td></tr>
<tr><td>Resources Required
Specialist fact sheet (one for each student, or one overhead for the entire class)
Data sets for each specialist group:
1.) Ornathologist/Bird Ecologist: Adélie,Chinstrap & Gentoo penguins
2.) Physical Oceanographer: Sea ice
3.) Meteorologist: Winter snow/precipitation
4.) Biologist: Krill,
5.) Climatologist: Temperature
Specialist group report sheets (one for each student)
Sheets of graph paper (one for each student), or computers connected to a printer (one for each specialist group)
Sets of six flowchart cards (one complete set for each base group)
Paper, markers, and tape for constructing flow charts</td></tr>
<tr><td>Ocean Impacts of an El Nino Event</td><td>Practice Standards
Analyze geoscience data using tools, technologies, and/or models (e.g., computational, mathematical) to make the claim that one change to Earth's surface can create feedbacks that cause changes to other</td></tr>
</table>

	Earth systems. (HS-ESS2-2)
	Resources Required • Computers with Internet access • Ability to project images (LCD projector or overhead projector) • Powerpoint or a word processing program that can be used to view multiple images at one time • A globe or world map
Ocean Currents and Sea Surface Temperatures	**Practice Standards** Analyze geoscience data using tools, technologies, and/or models (e.g., computational, mathematical) to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.(HS-ESS2-2)
	Resources Required • Computer with internet and printer access • Red and blue colored pencils • World map with latitude-longitude grid
Hurricanes as Heat Engines	**Practice Standards** Analyze geoscience data using tools, technologies, and/or models (e.g., computational, mathematical) to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.(HS-ESS2-2)
	Resources Required • Computer with Internet access • PowerPoint or other presentation software • Map or Atlas
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards

	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required

Stage 3: Learning Plan

21st Century Themes	**21st Century Skills**
✓ Global Awareness ✓ Civic Literacy ✓ Financial, Economic, Business, and Entrepreneurial Literacy ✓ Health Literacy	✓ Creative and Innovation ✓ Information and Communication Technologies Literacy ✓ Media Literacy ✓ Critical Thinking and Problem Solving ✓ Communication and Collaboration ✓ Life and Career Skills Information Literacy
Integration of Technology	**Suggested Teacher Instructional Resources**
• Internet • Computers • SMART Boards • Multimedia presentations • Video streaming	• MY NASA DATA • Finding the Crater • Images of Change • Climate Reanalyzer

● Globe data uploads and downloads	● USGS Realtime Water data ● Climate data ● Greenhouse Effect ● Earth Systems Activity ● Carbon and Climate ● Carbon Connections ● EarthViewer (IPAd or Android) or for Chrome

Diverse Learners (ELL, Special Ed, Gifted & Talented)- Differentiation strategies may include, but are not limited to, learning centers and cooperative learning activities in either heterogeneous or homogeneous groups, depending on the learning objectives and the number of students that need further support and scaffolding, versus those that need more challenge and enrichment. Modifications may also be made as they relate to the special needs of students in accordance with their Individualized Education Programs (IEPs) or 504 plans, or English Language Learners (ELL). These may include, but are not limited to, extended time, copies of class notes, refocusing strategies, preferred seating, study guides, and/or suggestions from special education or ELL teachers.

Unit 2 Overview	
Content Area – Science	
Unit 2 Title – Human Activity and Climate System	
Target Course/Grade Level – Environmental Science	
Stage 1: Desired Results	
Next Generation Science Standards	
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.** [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.]
HS-PS4-4	*(secondary to HS-ESS2-4)* **Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]
HS-ESS2-2	**(***secondary to HS-ESS2-4)* **Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.** [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.]
HS-ESS2-6	**Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]
HS-ESS1-4	*(Secondary to HS-ESS2-4)* **Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. [**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.]
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**. [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.]

Unit Essential Questions	**Unit Enduring Understandings**
● What happens if we change the chemical composition of our atmosphere? ● How does carbon cycle among the hydrosphere, atmosphere, geosphere, and biosphere? (*repeated from Unit 1*) ● How do changes in the geosphere effect the atmosphere? (*repeated from Unit 1*) ● What happens to solar energy as it moves through the atmosphere and strikes a surface? ● What is the current rate of global or regional climate change and what are the associated future impacts to Earth's 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 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. ● Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the orientation of the planet's axis of rotation, both occurring over tens to hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on Earth. These phenomena cause cycles of ice ages and other gradual climate changes. ● Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect 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 the biosphere. ● When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.
Unit Objective:	
In this unit of study, *planning and carrying out investigations*, *analyzing and interpreting data, developing and using models,* and *engaging in arguments from evidence* are key practices to explore the dynamic nature of Earth systems. Students apply these practices to illustrate how Earth's interacting systems cause feedback effects on other Earth systems, to investigate the properties of water and its effects on Earth materials and surface processes, and to model the cycling of carbon through all of the Earth's spheres. Students seek evidence to construct arguments about the simultaneous co-evolution of the Earth's systems and life on Earth. The crosscutting concepts of *energy and matter*, *structure and function,* and *stability and change* are called out as organizing concepts for these disciplinary core ideas. This unit is based on HS-ESS2-2, HS-ESS2-5, HS-ESS2-6, and HS-ESS2-7.	
Content Knowledge:	**Skills and Topics**
ESS1.B:Earth and the Solar System ● Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes.*(secondary to HS-ESS2-4)* **ESS2.A:Earth Materials and System** ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) ● The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic	**Developing and Using Models** ● Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4), (HS-ESS2-6) **Planning and Carrying Out Investigations** ● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5) **Analyzing and Interpreting Data** ● Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS2-1), (HS-ESS3-5)

activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4) **ESS2.D: Weather and Climate** ● The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space. (HS-PS4-4) **PS4.B: Electromagnetic Radiation** ● When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.(HS-PS4-4)	**Using Mathematical and computational Thinking** ● Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4) **Obtaining, Evaluating, and Communicating Information** ● Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible.(HS-PS4-2) **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). (HS-ESS1-4) **Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) ● Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5) **Energy and Matter** ● The total amount of energy and matter in a closed system is conserved (HS-ESS2-6) **Stability and Change** ● Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2) **Scientific Knowledge is Based on Empirical Evidence** ● Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4) **Influence of Engineering Technology and Science on Society and the Natural World** ● New technologies can have deep impact on society and the environment, including

	some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS-2-2) **Interdependence of Science, Engineering, and Technology** ● Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-4) **Investigations Use a Variety of Methods** ● Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5) ● New technologies advance scientific knowledge. (HS-ESS3-5) **Scientific Knowledge is Based on Empirical Evidence** ● Science knowledge is based on empirical evidence. (HS-ESS3-5) ● Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4),(HS-ESS3-5)

STAGE 2: Assessment Evidence	
Formative Assessment	**Summative Assessment**
● Warm-up activities ● Do Now's ● Class discussions ● Student participation ● Teacher observations	● Tests ● Quizzes ● Projects ● Homework ● Lab Reports

Laboratory and Exploratory Activities	
	Practice Standards
	Resources Required ●
	Practice Standards
	Resources Required ●

	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required

<table>
<tr><th colspan="2">Stage 3: Learning Plan</th></tr>
<tr><th>21st Century Themes</th><th>21st Century Skills</th></tr>
<tr><td>✓ Global Awareness
✓ Civic Literacy
✓ Financial, Economic, Business, and Entrepreneurial Literacy
✓ Health Literacy</td><td>✓ Creative and Innovation
✓ Information and Communication Technologies Literacy
✓ Media Literacy
✓ Critical Thinking and Problem Solving
✓ Communication and Collaboration
✓ Life and Career Skills
Information Literacy</td></tr>
<tr><th>Integration of Technology</th><th>Suggested Teacher Instructional Resources</th></tr>
<tr><td>● Internet
● Computers
● SMART Boards
● Multimedia presentations
● Video streaming
● GLOBE data upload and download</td><td>● Glaciers
● MY NASA DATA
● Solar Variability & Orbital Cycles
● Climate Reanalyzer
● Climate Modeling 101
● Carbon Cycle Lesson Plan
● Paleoclimate Data Access
● Carbon Connections Climate Mode
● NASA - Climate Change Impacts and EP
● Images of Change</td></tr>
<tr><td colspan="2">Diverse Learners (ELL, Special Ed, Gifted & Talented)- Differentiation strategies may include, but are not limited to, learning centers and cooperative learning activities in either heterogeneous or homogeneous groups, depending on the learning objectives and the number of students that need further support and scaffolding, versus those that need more challenge and enrichment. Modifications may also be made as they relate to the special needs of students in accordance with their Individualized Education Programs (IEPs) or 504 plans, or English Language Learners (ELL). These may include, but are not limited to, extended time, copies of class notes, refocusing strategies, preferred seating, study guides, and/or suggestions from special education or ELL teachers.</td></tr>
</table>

<table>
<tr><th colspan="2">Unit 3 Overview</th></tr>
<tr><td colspan="2">Content Area – Science</td></tr>
<tr><td colspan="2">Unit 3 Title – Human Activity and Sustainability</td></tr>
<tr><td colspan="2">Target Course/Grade Level – Environmental Science</td></tr>
<tr><th colspan="2">Stage 1: Desired Results</th></tr>
<tr><th colspan="2">Next Generation Science Standards</th></tr>
<tr><td>HS-ESS3-1</td><td>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. [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</td></tr>
</table>

	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.]
HS-ESS3-3	**Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** [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.]
HS-LS4-6	*(Secondary to HS-ESS3-3)* **Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.** [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]
HS-ESS3-4	**Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.** [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).]
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.** [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.]
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.**

Unit Essential Questions	**Unit Enduring Understandings**
● How are human activities influence the global ecosystem? ● How might we change habits if we replaced the word “environment” with the word “life support system”? ● Is the damage done to the global life support system permanent? ● How can the impacts of human activities on natural systems be reduced?	● Resource availability has guided the development of human society. 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 regulations can change the balance of these factors. ● Natural hazards and other geological events have shaped the course of human history by destroying buildings and cities,

● What are the relationships among earth's systems and how are those relationships being modified due to human activity?	eroding land, changing the course of rivers, and reducing the amount of arable land. These events have significantly altered the sizes of human populations and have driven human migrations. Natural hazards can be local, regional, or global in origin, and their risks increase as populations grow. Human activities can contribute to the frequency and intensity of some natural hazards. ● 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. ● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Scientists and engineers can make major contributions—for example, by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. ● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or too drastic, the opportunity for the species' evolution is lost. ● Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. These problems have the potential to cause a major wave of biological extinctions—as many species or populations of a given species, unable to survive in changed environments, die out—and the effects may be harmful to humans and other living things.

	● 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. But whatever the scale, the first thing that engineers do is define the problem and specify the criteria and constraints for potential solutions. ● 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 the biosphere. Hence the outcomes depend on human behaviors as well as on natural factors that involve complex feedbacks among Earth's systems.

Unit Objective:

How do humans depend on Earth's resources and what are the effects of resource acquisition and use?

"Civilization exists by geological consent, subject to change without notice." Will Durant, American Historian (1885-1981)

In this unit students *construct an explanation based on evidence* for how the availability of natural resources, occurrence of natural hazards are connected to human activity. Additionally, while students are exploring this idea they apply scientific and engineering ideas to *design, evaluate, and refine* a device that can be used to minimize the impacts of natural hazards. They create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity, and create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. They use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity, and evaluate or refine a technological solution that reduces impacts of human activities on natural systems. The crosscutting concepts of *cause and effect, stability and change, systems and system models* are called out as an organizing concept for these disciplinary core ideas.

This unit is based on HS-ESS3-1, HS-ESS3-3, HS-LS4-6, HS-ESS3-4, HS-ESS3-6, and *HS-ETS1-3* (*secondary to HS-ESS3-4*).

[Note: The disciplinary core ideas, science and engineering practices, and crosscutting concepts can be taught in either this course or in a high school chemistry and/or biology/life science course.]

Content Knowledge:	Skills and Topics

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) (HS-ESS3-6) **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) **EESS3.A: Natural Resources** ● Resource availability has guided the development of human society. (HS-ESS3-1) **ESS3.B: Natural Hazards** ● Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) **ESS3.C: Human Impacts on Earth Systems** ● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) **ESS3.D: Global Climate Change** ● 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) **LS4.C: Adaptation**	**Constructing Explanations and Designing Solutions** ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1) (HS-LS4-6) ● Design or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS-3-4) ● Evaluate a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.(HS-ETS1-3) **Analyzing and Interpreting Data** **Using Mathematical and computational Thinking** ● Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) ● Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) **Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1) (HS-LS4-6) **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. **Stability and Change** ● Change and rates of change can be quantified and modeled over very short or

<table>
<tr>
<td>
● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline — and sometimes the extinction — of some species. (HS-ESS4-6)
LS4.D: Biodiversity and Humans
● Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.) (HS-ESS4-6)

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) (HS-ESS4-6) (HS-ESS3-4)
● 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. (secondary) (HS-ESS4-6)
</td>
<td>
very long periods of time. Some system changes are irreversible. (HS-ESS3-3)
● Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

Influence of Engineering Technology and Science on Society and the Natural World
● Modern civilization depends on major technological systems. (HS-ESS3-1) (HS-ESS3-3)
● New technologies can have deep impacts on society and the environment, including some that were not anticipated.(HS-ESS3-3)
● Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-4)
● New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-3)
</td>
</tr>
<tr><th colspan="2">STAGE 2: Assessment Evidence</th></tr>
<tr><th>Formative Assessment</th><th>Summative Assessment</th></tr>
<tr>
<td>● Warm-up activities
● Do Now’s
● Class discussions
● Student participation
● Teacher observations</td>
<td>● Tests
● Quizzes
● Projects
● Homework
● Lab Reports</td>
</tr>
</table>

Laboratory and Exploratory Activities	
	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required

Stage 3: Learning Plan	
21st Century Themes	**21st Century Skills**
✓ Global Awareness ✓ Civic Literacy ✓ Financial, Economic, Business, and Entrepreneurial Literacy ✓ Health Literacy	✓ Creative and Innovation ✓ Information and Communication Technologies Literacy ✓ Media Literacy ✓ Critical Thinking and Problem Solving ✓ Communication and Collaboration ✓ Life and Career Skills Information Literacy
Integration of Technology	**Suggested Teacher Instructional Resources**
• Internet • Computers • SMART Boards • Multimedia presentations • Video streaming • Glencoe Virtual Labs • GLOBE data	• water sanitation • Carbon Stabilization Wedge • One For All: A Natural Resources Game • Building Biodiversity • PREDICTS project • GLOBIO project • Conservation Maps • Schoolyard Biodiversity • I=P*A*T Equation and Its Variants • National Climate Assessment • Stormwater Calculator • Water Erosion Prediction Project • The Bean Game: Exploring Human Interactions with Natural Resources • NSA Challenge: Recycling for a Cleaner World • Land and People: Finding a Balance • Reefs at Risk • NOAA Coral Reefs at Risk • GLOBE Carbon Cycle • Earth: Planet of Altered States
Diverse Learners (ELL, Special Ed, Gifted & Talented)- Differentiation strategies may include, but are not limited to, learning centers and cooperative learning activities in either heterogeneous or homogeneous groups, depending on the learning objectives and the number of students that need further support and scaffolding, versus those that need more challenge and enrichment. Modifications may also be made as they relate to the special needs of students in accordance with their Individualized Education Programs (IEPs) or 504 plans, or English Language Learners (ELL).	

These may include, but are not limited to, extended time, copies of class notes, refocusing strategies, preferred seating, study guides, and/or suggestions from special education or ELL teachers.

Unit 4 Overview
Content Area – Science
Unit 4 Title – Human Activity & Energy:
Target Course/Grade Level – Environmental Science
Stage 1: Desired Results
Next Generation Science Standards

HS-ESS3-2 **Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.** [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

HS-PS3-1 **Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.** [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]

HS-PS3-2 **Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).** [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]

HS-PS3-3 **Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*** [Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency. Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

HS-PS3-5 *(Secondary to HS-PS3-3)* **Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.** [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]

HS-PS4-3	**Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]
HS-PS4-5	**Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*** [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

Unit Essential Questions	**Unit Enduring Understandings**
● What is the best energy source for a home? How would I meet the energy needs of a house of the future? ● How can we use mathematics in decision-making about energy resources? ● I have heard about it since kindergarten but what is energy? ● Superstorm Sandy devastated the New Jersey Shore and demonstrated to the public how ● vulnerable our infrastructure is. Using your understandings of energy, how would you design a low technology system that would insure the availability of energy to residents if catastrophic damage to the grid occurs again? ● How can electromagnetic radiation be both a wave and a particle at the same time?	● 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. But whatever the scale, the first thing that engineers do is define the problem and specify the criteria and constraints for potential solutions. ● Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's *total* energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. ● Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. ● Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their

<table>
<tr><td></td><td>surrounding environment cool down). Any object or system that can degrade with no added energy is unstable. Eventually it will do so, but if the energy releases throughout the transition are small, the process duration can be very long (e.g., long-lived radioactive isotopes).</td></tr>
<tr><td colspan="2">Unit Objective:</td></tr>
<tr><td colspan="2">How is energy generated for human activity?
In this unit of study, students engage in argument from evidence, develop and use models, ask questions and define problems, construct explanations and design solutions, and evaluate information. This unit focuses on the physics core ideas surrounding energy and energy transformations as related to the Earth System core idea of energy needs for human activity. Students create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. They apply engineering design principles to design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. Within this unit students also apply the core ideas of related to the behavior of electromagnetic energy to evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. They develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction (secondary concept). They apply these core ideas to communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. At the basis of our energy needs is the need for resources to create energy, and therefore students evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. The crosscutting concepts of systems and system models, energy and matter, cause and effect, and stability and change are called out as an organizing concept for these disciplinary core ideas. This unit is based on HS-ESS3-2, HS-PS3-1, HS-PS3-2, HS-PS3-3, HS-PS3-5 (secondary to HS-PS3-3), HS-PS4-3, and HS-PS4-5.</td></tr>
<tr><td>Content Knowledge:</td><td>Skills and Topics</td></tr>
<tr><td>ESS3.A: Natural Resources
● 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)

ETS1.A: Defining and Delimiting an Engineering Problem
● Criteria and constraints also include satisfying any requirements set by society,</td><td>Developing and Using Models
● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-1) (HS-PS3-5)

Using Mathematics and Computational Thinking
● Simple computational simulations are created and used based on mathematical models of basic assumptions. Create a computational model or simulation of a</td></tr>
</table>

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. (secondary) (HS-PS3-3) **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)(HS-ESS3-2) **PS3.A: Definitions of Energy** ● Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1) ● Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-2) ● At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) ● These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a	phenomenon, designed device, process, or system. (HS-PS3-1) **Constructing Explanations and Designing Solutions Constructing** ● Design, evaluate, and/or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3) **Engaging in Argument from Evidence** ● Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations). (HS-ESS3-2) **Obtaining, Evaluating, and Communicating Information** ● Communicate technical information or 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). **Cause and Effect** ● Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. (H-PS3-1) ● Systems can be designed to cause a desired effect. (HS-PS4-5) **Systems and System Models** ● Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1) **Energy and Matter** ● Energy cannot be created or destroyed; it only moves between one place and

phenomenon in which energy stored in fields moves across space.(HS-PS3-2) ● At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-3) **PS3.B: Conservation of Energy and Energy Transfer** ● Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1) ● Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) ● The availability of energy limits what can occur in any system. (HS-PS3-1) **PS3.C: Relationship Between Energy and Forces** ● When two objects interacting through a field change relative position, the energy stored in the field is changed.(HS-PS3-5) **PS3.D: Energy in Chemical Processes** ● Although energy cannot be destroyed, it can be converted to less useful forms — for example, to thermal energy in the surrounding environment. (HS-PS3-3) ● Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (secondary) (HS-PS4-5) **PS4.A: Wave Properties** ● [From the 3–5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative	another place, between objects and/or fields, or between systems. (HS-PS3-2) ● Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3) **Connections to Engineering, Technology, and Applications of Science** **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 benefits while decreasing costs and risks. (HS-ESS3-2) ● Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-20 ● Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2) ● Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase ben(HS-PS3-3) **Connections to Nature of Science** **Addresses Questions About the Natural and Material World** ● Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) ● Science knowledge indicates what can happen in natural systems — not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2) ● Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3) ● Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-5) ● **PS4.B: Electromagnetic Radiation** 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) ● Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5) **PS4.C: Information Technologies and Instrumentation** ● Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)	● Modern civilization depends on major technological systems. (HS-PS4-5) **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS-3-1) **Interdependence of Science, Engineering, and Technology** ● Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5)
STAGE 2: Assessment Evidence	
Formative Assessment	**Summative Assessment**
● Warm-up activities ● Do Now's ● Class discussions ● Student participation ● Teacher observations	● Tests ● Quizzes ● Projects ● Homework ● Lab Reports
Laboratory and Exploratory Activities	
	Practice Standards
	Resources Required

	•
	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required •
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
	Practice Standards
	Resources Required
Stage 3: Learning Plan	
21st Century Themes	**21st Century Skills**

✓ Global Awareness ✓ Civic Literacy ✓ Financial, Economic, Business, and Entrepreneurial Literacy ✓ Health Literacy	✓ Creative and Innovation ✓ Information and Communication Technologies Literacy ✓ Media Literacy ✓ Critical Thinking and Problem Solving ✓ Communication and Collaboration ✓ Life and Career Skills Information Literacy
Integration of Technology	**Suggested Teacher Instructional Resources**
• Internet • Computers • SMART Boards • Multimedia presentations • Video streaming •	• Carbon Stabilization Wedge: • One For All: A Natural Resources Game: • National Climate Assessment: • Know Your Energy Costs: • Earth: Planet of Altered States: • Climate Reanalyzer: • Energy Skate Park: Basics: • Work and Energy Workbook Labs: • Build a Solar House: • Work and Energy Workbook Labs: • Introduction to the Electromagnetic Spectrum: • Technology for Imaging the Universe:
Diverse Learners (ELL, Special Ed, Gifted & Talented)- Differentiation strategies may include, but are not limited to, learning centers and cooperative learning activities in either heterogeneous or homogeneous groups, depending on the learning objectives and the number of students that need further support and scaffolding, versus those that need more challenge and enrichment. Modifications may also be made as they relate to the special needs of students in accordance with their Individualized Education Programs (IEPs) or 504 plans, or English Language Learners (ELL). These may include, but are not limited to, extended time, copies of class notes, refocusing strategies, preferred seating, study guides, and/or suggestions from special education or ELL teachers.	