Township of Ocean Schools

Assistant Superintendent
Office of Teaching and Learning

SPARTAN MISSION:
Meeting the needs of all students with a proud tradition of academic excellence.

Curriculum Documents

School: Ocean Township High School

Course: Earth and Our Environment formerly Earth Systems

Department: Science

Supervisor: Patrick Sullivan

Board Approval	Supervisor	Notes
August 2010	Patrick Sullivan	Update Standards
August 2013	Patrick Sullivan	Update Standards and Name Change
December 2017	Patrick Sullivan	Update Standards

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The Earth and Our Environment

Timeline			
Week	**Marking Period 1**	**Week**	**Marking Period 3**
1	Physics of the Earth System	**9**	Human Activity & the Climate System
2	Physics of the Earth System	**10**	Human Activity & Sustainability
3	Physics of the Earth System	**11**	Human Activity & Sustainability
4	Dynamic Earth Systems	**12**	Human Activity & Sustainability
Week	**Marking Period 2**	**Week**	**Marking Period 4**
5	Dynamic Earth Systems	**13**	Human Activity & Energy
6	Dynamic Earth Systems	**14**	Human Activity & Energy
7	Human Activity & the Climate System	**15**	Human Activity & Energy
8	Human Activity & the Climate System	**16**	Sustainable Development Project

Topic: Unit 1 - Physics of the Earth System Instructional days: 15

Unit summary
Students investigate the energy within the Earth as it drives Earth's surface processes. Students evaluate evidence of the past and current movements of continental and oceanic crust for the theory of plate tectonics to explain the ages of crustal rocks. Finally, students develop a model based on evidence of the Earth's interior to describe the cycle of matter by thermal convection. The crosscutting concepts of patterns and stability, cause and effect, stability and change, energy and matter, and systems and systems models are called out as organizing concepts for these disciplinary core ideas. Within this unit, connections to Physical Science are made. Students plan and conduct investigations, and analyze data using math to support claims in order to develop an understanding of ideas related to why some objects keep moving and some objects fall to the ground. Students will also build an understanding of forces and Newton's second law. They will develop an understanding that the total momentum of a system of objects is conserved when there is no net force on the system. Students use mathematical representations to support a claim regarding the relationship among frequency, wavelength, and speed of waves traveling in various media, such as the Earth's layers. Students then apply their understanding of how magnets are created to model the generation of the Earth's magnetic field. The crosscutting concept of cause and effect is called out as an organizing theme. Students are expected to demonstrate proficiency in planning and conducting investigations and developing and using models. These fundamental physics concepts provide a foundation for understanding the dynamics of Earth motions and processes over deep time.
Essential questions
• How long does it take to make a mountain? • How much force is needed to move a continent, and what could provide the energy for that much force? • Are all rocks the same age?
Student learning objectives and NJSLS-S
HS-ESS1-5: Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. HS-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its

acceleration.*

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

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

HS-PS2-5: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.*

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

**secondary objectives*

Learning activities and assessments

EarthViewer: Students explore geological and biological data to develop arguments from evidence for the co-evolution of geology and biology found on Earth.

Le Pichon’s 1968 seafloor age data: Students map and analyze LePichon's field data to identify patterns in the ages of the ocean floor. Extensions: Additional maps and data may be found at NOAA Marine Geology and Geophysics and from their image site.

IRIS - Measuring the Rate of Plate Motion: Students compare GPS data of plate motion to determine the rate at which tectonic plates move. Alternatively, students use real-time plate motion data from UNAVCO to determine the rate at which plates move.

IODP: Deep Earth Academy Core Data investigations: Students investigate seafloor core data to evaluate multiple lines of evidence to support the dynamic plate theory.

GeoMapApp educational activities: Students visualize and explore various lines of evidence for plate dynamics and evaluate the strengths of each line of evidence in supporting the dynamic plate theory.

Lithosphere age research paper: Students read this article which describes how seismic data is used to determine the age of the crust, and the inherent issues associated with the procedure. They use this information in their analysis, evaluation, and synthesis of evidence for the dynamic plate theory.

Google Earth Age of the Lithosphere: Students compare the age of the seafloor and continental crust using the data at this site, or USGS data.

Geologic time and rates of landscape evolution: Students model rates of landscape evolution to gain an understanding of change over deep, historical, and recent time. Alternatively, students compare rates of erosion of a mountain landscape to agricultural lands by completing this activity. Hotspot Lesson: Students analyze the rate of movement of the Hawaiian Island chain to further understand rates of change in geologic processes. How Erosion Builds Mountains: Students read this article and identify feedbacks in the mountain building process. To support their model, they gather supporting evidence using this Isostasy model. Comparing models of the Earth's interior from data: Students compare two models of the Earth's interior and argue from evidence which model more strongly supports the evidence. Seismic Wave: Students receive additional practice in the interpretation of seismic data to model the interior of the Earth.
Interdisciplinary Connections
• Mathematics • English/Language Arts

Topic: Unit 2 – Dynamic Earth Systems Instructional days: 15

Unit summary
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.
Essential questions
• 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 do living organisms alter Earth's processes and structures?
Student learning objectives and NJSLS-S
HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. HS-ESS2-7: Construct an argument based on evidence about the simultaneous co-evolution of Earth's systems and life on Earth.
Learning activities and assessments
MY NASA DATA: Students select satellite datasets to answer questions related to system interactions and feedbacks. Finding the Crater: Students "visit" different K-T boundary sites, evaluate the evidence found in

the cores at each site, find these sites on a map, and predict where the impact crater is located.

Images of Change: Students explore these images of the impacts of climate change over time to develop explanations from evidence of how an impact in one component of the Earth system has effects in other components of the Earth system.

Climate Reanalyzer: Students use the Environmental Change Model of the Climate Reanlyzer to study the feedbacks in the climate system.

USGS Realtime Water data and Climate data: Students create and run an investigation to determine the relationship between streamflow and precipitation data, or another parameter.

Greenhouse Effect: Students explore the atmosphere during the ice age and today. They see what happens when they change parameters including clouds, greenhouse gas concentration, buildings, and light.

Earth Systems Activity: Students model the carbon cycle and its connection with Earth's climate.

Carbon and Climate: Students run a model of carbon sources and sinks and interpret results to develop their own model of the relationship of the carbon cycle to the Earth's climate. Students can also work through the content of the entire module called Carbon Connections which includes numerous models and interactives to gain a deeper understanding of the role of carbon in the climate system.

EarthViewer: Students explore geological and biological data to develop arguments from evidence for the co-evolution of geology and biology found on Earth.

Interdisciplinary Connections

- Mathematics
- English/Language Arts

Topic: Unit 3 – Human Activity and Climate System Instructional days: 15

Unit summary
In this unit of study, students evaluate claims, analyze and interpret data, and develop and use models to explore the core ideas centered on the Earth's climate system. Students evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by the atmosphere and Earth's various surfaces. They apply these core ideas when they use a quantitative model to describe how variations in the flow of energy into an out of the Earth's systems result in changes in climate, and how carbon is cycled through all of the Earth's spheres. They analyze geoscience data to make the claim that one change to Earth's surface can cause changes to other Earth systems, such as the climate system. Finally, students 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. The crosscutting concepts of cause and effect, stability and change, energy and matter, and structure and function are called out as an organizing concept for these disciplinary core ideas.
Essential questions
• 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 2) • How do changes in the geosphere affect the atmosphere? (repeated from unit 2) • 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?
Student learning objectives and NJSLS-S
HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. HS-PS4-4: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.* HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.*

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.

**secondary objectives*

Learning activities and assessments

Glaciers: Students will explain how environmental conditions (temperature and precipitation) impact glacial mass budget; identify where snow accumulates in a glacier and justify why.

MY NASA DATA: Students gather, display, and interpret incoming and outgoing solar radiation data to develop a model of the interactions of Earth's various surface types and incoming solar radiation.

Solar Variability & Orbital Cycles: Students select scientific readings and datasets and identify relationships among solar variability, orbital cycles, and Earth's climate over various time scales. Modification: Ice Cores and Orbital variations: Students apply the output of this visualization to develop a model of orbital changes as related to Earth's temperature over deep time.

Climate Reanalyzer: Students use the data on this website to assess diurnal, monthly, seasonal, and annual changes in the weather and climate parameters. Alternatively, data may be acquired from NASA NEO or NASA Giovanni.

Climate Reanalyzer: Students use the Environmental Change Model of the Climate Reanlyzer to study the feedbacks in the climate system.

Climate Modeling 101: Students use the information in this tutorial to understand how climate models are created and interpreted. They apply what they learn to the climate model outputs they interpret.

Carbon Cycle Lesson Plan: Students develop and apply basic and/or advanced mathematical modeling skills to climate modeling.

Paleoclimate Data Access: Students select from various paleoclimate datasets. After they understand how the data was collected and how it is interpreted, they display and analyze the data. They interpret the data and seek relationships among the datasets in order to understand changes in the Earth's climate over time.

Carbon Connections Climate Model: Students control the inputs of various climate forces to observe the outputs on the climate system. Students can also work through the content of the entire module called Carbon Connections which includes numerous models and interactives to gain a deeper understanding of the role of carbon in the climate system.

NASA - Climate Change Impacts and EPA - Climate Change Impacts: Students construct an explanation and cite evidence for how changes in climate have influenced human activity.

Images of Change: Students explore these images of the impacts of climate change over time to develop explanations from evidence of how an impact in one component of the Earth system has effects in other components of the Earth system.
Interdisciplinary Connections
• Mathematics • English/Language Arts • Social studies

Topic: Unit 4 – Human Activity and Sustainability Instructional days: 15

Unit summary
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.
Essential questions
• How are human activities influencing the global ecosystem? • How might we change habits if we replaced the word "environment" with the phrase "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? • What are the relationships among Earth's systems and how are those relationships being modified due to human activity?
Student learning objectives and NJSLS-S
HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-3: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.* HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-6: Use a computational representation to illustrate the relationships among Earth

systems and how those relationships are being modified due to human activity.

HS-ETS1-3: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

**secondary objectives*

Learning activities and assessments

Cost-Benefit Analysis Primer: Students read this explanation about how cost-benefit analysis is derived and applied in order to apply this model to design solutions related to human sustainability. Students then read the application of CBA to water sanitation.

Carbon Stabilization Wedge: Students play this game in order to evaluate competing design solutions for developing, managing, and utilizing energy resources based on cost-benefit ratios.

One For All: A Natural Resources Game: Identify a strategy that would produce a sustainable use of resources in a simulation game. Draw parallels between the chips used in the game and renewable resources upon which people depend. Draw parallels between the actions of participants in the game and the actions of people or governments in real-world situations.

Building Biodiversity and the PREDICTS project and GLOBIO project: Students explore this website to develop an understanding of how computational models of the impacts on biodiversity are created. Next, they explore Conservation Maps for a global perspective of land use and conservation efforts.

Schoolyard Biodiversity: Students assess the biodiversity in their schoolyards, and apply their model outputs to predict the changes in biodiversity as related to human impacts and the application of sustainable practices.

I=P*A*T Equation and Its Variants: Students read this article to learn how ecological economics models are developed and applied to further understand human impacts on our environment.

National Climate Assessment: Students explore the simulations found at this website in order to create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Stormwater Calculator or the Water Erosion Prediction Project: Students apply the stormwater runoff calculator to determine the impacts of landuse change, precipitation variations, and other parameters on runoff.

The Bean Game: Exploring Human Interactions with Natural Resources: This activity explores the various influences of human consumption of natural resources over time as a primer for making a computational model).

NSA Challenge: Recycling for a Cleaner World: Students will develop a strategy to increase recycling and waste diversion for their school.

Land and People: Finding a Balance: This environmental study project allows a group of students to consider real environmental dilemmas concerning water use and provide solutions to these dilemmas.

Reefs at Risk: and NOAA Coral Reefs at Risk: Students access and explore a series of interactive maps displaying coral reef data from around the globe and develop hypotheses related to the impacts of climate change (i.e. increased levels of carbon dioxide in our atmosphere) on coral reef health.

GLOBE Carbon Cycle: Students collect data about their school field site through existing GLOBE protocols of phenology, land cover and soils as well as through new protocols focused on biomass and carbon stocks in vegetation. Students participate in classroom activities to understand carbon cycling at local and global scales. Students expand their scientific thinking through the use of systems models.

Earth: Planet of Altered States: Watch a segment of a NASA video and discuss how the earth is constantly changing.

Interdisciplinary Connections

- Mathematics
- English/Language Arts
- Social Studies

Topic: Unit 5 – Human Activity & Energy Instructional days: 15

Unit summary
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.
Essential questions
• What is the best energy source for a home? How can we meet the energy needs of a house of the future? • How can we use math in decision-making about energy resources? • What exactly is energy? • As extreme weather becomes more common, can we use our understanding of energy to design a system that would ensure energy availability if catastrophic damage occurs to the grid? • How can electromagnetic radiation be both a wave and a particle at the same time? • How does the International Space Station power its equipment? How do astronauts communicate with people on the ground?

Student learning objectives and NJSLS-S
HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-PS3-1: Create a computational model to calculate the change in energy of one component in a system when the change in energy of the other component(s) and energy flow in and out of the system are known. 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). HS-PS3-3: Design, build, and refine a device that works within given constraints to convert from one form of energy into another form of energy. HS-PS3-5: 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.* 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. **secondary objectives*
Learning activities and assessments
Carbon Stabilization Wedge: Students play this game in order to evaluate competing design solutions for developing, managing, and utilizing energy resources based on cost-benefit ratios. One For All: A Natural Resources Game: Identify a strategy that would produce a sustainable use of resources in a simulation game. Draw parallels between the chips used in the game and renewable resources upon which people depend. Draw parallels between the actions of participants in the game and the actions of people or governments in real-world situations. National Climate Assessment: Students explore the simulations found at this website in order to create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. Know Your Energy Costs: The goal of this activity is to become aware of how much energy you use at school — and the financial and environmental costs. Earth: Planet of Altered States: Watch a segment of a NASA video and discuss how the earth is constantly changing.

Climate Reanalyzer: Students use the Environmental Change Model of the Climate Reanlyzer to study the feedbacks in the climate system.

Energy Skate Park: Basics: Learn about conservation of energy with a skater gal! Explore different tracks and view the kinetic energy, potential energy and friction as she moves. Build your own tracks, ramps, and jumps for the skater.

Work and Energy Workbook Labs: The lab description pages describe the question and purpose of each lab and provide a short description of what should be included in the student lab report.

Build a Solar House: Construct and measure the energy efficiency and solar heat gain of a cardboard model house.

NASA LAUNCHPAD: Making Waves: NASA e-Clips activity on the electromagnetic spectrum

PhET simulations: Radio Waves and Electromagnetic Fields, Refraction, Wave Interference, Photoelectric Effect, Interaction of Molecules with Electromagnetic Radiation, Wave/Particle Dualism.

Open Source Physics simulations: Thin Film Interference, Photoelectric Effect, X-ray Technology.

Interdisciplinary Connections

- Mathematics
- English/Language Arts
- Social Studies