SCHOOL DISTRICT OF THE CHATHAMS

Environmental Science A
Grades 11 & 12
Full Year

Course Overview

Students in high school develop understanding of a wide range of topics in Earth and space science (ESS) that build upon science concepts from middle school through more advanced content, practice, and crosscutting themes. There are five ESS standard topics in high school: Space Systems, History of Earth, Earth's Systems, Weather and Climate, and Human Sustainability. The content of the performance expectations are based on current community-based geoscience literacy efforts such as the Earth Science Literacy Principles (Wysession et al., 2012), and is presented with a greater emphasis on an Earth Systems Science approach. There are strong connections to mathematical practices of analyzing and interpreting data. The performance expectations strongly reflect the many societally relevant aspects of ESS (resources, hazards, environmental impacts) with an emphasis on using engineering and technology concepts to design solutions to challenges facing human society.

New Jersey Student Learning Standards
The New Jersey Student Learning Standards (NJSLS) can be located at www.nj.gov/education/cccs/2020/.

Earth and Space Science
HS-ESS1-1Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
HS-ESS1-2 Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.
HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
HS-ESS1-6 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
HS-ESS2-3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Physical Science:
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.
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 positions of particles (objects).
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
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.

Technology Standards
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.

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9.3.12.AG-NR.1 Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.
9.3.12.AG-NR.2 Analyze the interrelationships between natural resources and humans.
9.3.12.AG-NR.3 Develop plans to ensure sustainable production and processing of natural resources.
9.3.12.AG-NR.4 Demonstrate responsible management procedures and techniques to protect or maintain natural resources.
9.3.12.AG-ENV.3 Develop proposed solutions to environmental issues, problems and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry and ecology.

Career Ready Practices
CRP5. Consider the environmental, social and economic impacts of decisions.
CRP6. Demonstrate creativity and innovation.

Interdisciplinary Connections

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English Language Arts:

Reading

- RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Writing

- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- WHST.9-12.1 Write arguments focused on discipline-specific content.
- WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Speaking and Listening

- SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
- SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Mathematics:

- HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSF-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
- HSS-ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how those variables are related.

Units of Study

Unit 1: Space Systems *(~ 15 days)*

- How can evidence from distant galaxies support the Big Bang theory?

- How is electromagnetic energy produced in stars?
- How can the path of orbiting objects be predicted?

Unit 2: Dynamic Earth *(~ 20 days)*
- How can studying objects in the solar system provide information about Earth's formation and early history?
- How have chemical and physical processes changed the Earth over time?
- How is energy created in the Earth's crust and mantle?
- How is the age of rock determined?

Unit 3: Earth Systems *(~ 15 days)*
- How do the Biogeochemical cycles interact and affect each other?
- How does water affect the Earth's processes?
- How does human activity affect Earth's cycles?
- How can electromagnetic radiation from the sun affect changes in Earth's surface?

Unit 4: Weather and Climate *(~ 20 days)*
- What factors have caused global and regional climates to change?
- How has human activity affected global climate change?
- How can humans develop and use models to predict climate change impacts?
- How does electromagnetic radiation from the sun affect global climate change?
- How reliable are global climate models predicting future temperatures?

Unit 5: Human Impact on Earth *(~ 15 days)*
- How have geological factors shaped human history and guided the development of society?
- How has society's decisions changed the way natural resources are managed?

Unit 6: Energy in the Environment *(~ 15 days)*
- How can energy be utilized and obtained efficiently?
- How can technology help with energy consumption?

Learning Objectives/Discipline Standards of Practice

<u>Learning Objectives</u>
- The age of the Earth's rock both continental and oceanic
- The theory of plate tectonics
- Energy is created in the earth's crust due to the radioactive decay of unstable isotopes continually generating new energy
- Radioactive dating can determine the age of rocks
- Earth's spheres interact in short and long time scales
- Water has the 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 role that plants and animals play in the carbon cycle and other cycles
- The biosphere is affected by the Earth's systems
- Mathematical representations of the energy transfer
- Economic, Social and Environmental limitations of obtaining energy
- The processes by which energy is transferred
- Examples of energy in systems

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- Relationship between the position of particles and production of energy
- Human impact on earth systems both negative and positive
- Sustainable practices that have been developed
- Data from years past can predict future events
- Discoveries are still being made as human impact is lessened
- Energy from the sun is released from nuclear fusion
- Light spectra and brightness of stars can give evidence that will determine the makeup of stars and distances from earth.
- The evidence collected and presented to support the Big Bang Theory
- The Earth's placement in our solar system
- Electromagnetic radiation from the sun can behave in different ways
- Human activity has impacted Global Climate Change
- Humans have the ability to predict and manage impacts on climate change

<u>Discipline Standards of Practice</u>
Science and Engineering Practices
- Plan and Carryout and Investigation
- Ask questions and define problems
- Develop and use models
- Obtain, evaluate and communicate information
- Analyze and interpret data
- Construct explanations and design solutions
- Engage in argument from evidence
- Use mathematics and computational thinking

Crosscutting Concepts
- Cause and Effect
- Scale, Proportion and Quantity
- Structure and Function
- Patterns
- Energy and Matter
- Systems and System Models
- Stability and Change

Instructional Resources and Materials
Whole class resources have been identified with an asterisk.

Resources
The American Geological Institute. (2011) Environmental science: Understanding our changing Earth, 1st ed. Clifton Park, NY: Delmar

Materials

- Kid Wind Turbine materials
- Solar cells
- Multimeters
- Computers
- PhET
- National Energy Education Development Project
- Rutgers Solar Farm
- National Renewable Energy Lab
- Switch Energy Project
- Stream tables
- Rock samples
- Increment borers for tree sampling
- CO2 sensors

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- Soil analysis kits
- Water analysis kits
- Stream tables,
- sand,
- Salt,
- pebbles,
- aluminum pans
- 1 or 2 2-liter bottles
- scissors
- 1 250ml beaker
- filtration materials (examples: soil, gravel, potting soil, cotton balls, scrap material, charcoal, sand, woodchips, Styrofoam packing, charcoal briquettes)
- screening
- rubber bands
- Bunsen burner or heat source for evaporation
- Shake tables
- Earthquake proof building supplies
- Desktops/laptops - seismic waves and seismic eruptions software
- Stream Tables
- CO_2 + O_2 sensors,
- aquarium salt,
- pH sensors,
- Aquaria,
- assortment of seeds,
- pots,
- soil, or other growing medium
- Sand
- Clay
- buckets,
- Tubing
- Astronomy software
- Spectroscopes
- Spectra Tubes
- PhET program for Infrared photon absorption
- Ocean Current Model
- Temperature Sensors
- Humidity Sensors
- Pressure Sensors
- Anemometers
- Globes
- Heat Lamps
- Ring Stands
- Liter and 2 liter bottles
- BAking soda
- Vinegar
- CO2 sensor
- O2 sensor

Assessment Strategies
Assessment is designed to measure a student's mastery of a course standard and learning objective. Assessment can be used for both instructional purposes (formative assessment) and for evaluative purposes (summative assessment).

The following is a general list of the many forms assessment may take in learning.

- Tests
- Quizzes
- Projects
- Unit Assessments
- Labs