TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

GRADE 9 INTEGRATED PHYSICAL SCIENCE

Science Department

2025

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Curriculum Writing Team

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Integrated Physical Science

Grade 9

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The Trumbull Board of Education will continue to take Affirmative Action to ensure that no persons are discriminated against in its employment.

CORE VALUES AND BELIEFS

The Trumbull High School community engages in an environment conducive to learning which believes that all students will **read** and **write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem-solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.
Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

Grade 9 Integrated Physical Science is consistent in the continued development of scientifically literate students. Authentic scientific and engineering experiences build on one another and increase in complexity throughout students' K-12 education. In 2015, the Connecticut State Board of Education adopted the Next-Generation Science Standards (NGSS), which embody the National Research Council's Framework for K-12 Science Education (2012). Both the Framework and the NGSS stress the importance of teaching classroom scientific inquiry as practiced by scientists and engineers. The Framework provides a vision for American science education in the 21st century, while the NGSS provide grade-level student performance expectations, disciplinary core ideas, and crosscutting concepts. The Framework and NGSS indicated a paradigm shift in science education, one in which teachers are to incorporate authentic learning experiences for students that reflect the nature of doing science and engineering.

The Framework and NGSS provide clarity to classroom scientific inquiry by stressing the importance of the eight practices of science and engineering. The practices were designed to help students understand how scientific knowledge develops, and to stimulate students' interest ing and continued study of science. Three-dimensional learning facilitates student engagement with Science and Engineering Practices and Crosscutting Concepts to deepen their understanding of Disciplinary Core Ideas in order to explain phenomena and solve problems. Three-dimensional learning promotes development of student skills in the following areas:

- Knowing, using, and interpreting scientific explanations of the natural world (Disciplinary Core Ideas, and Crosscutting Concepts)
- Generating and evaluating scientific evidence and explanations (Science and Engineering Practices)
- Participating productively in scientific practices and discourse (Science and Engineering Practices)
- Understanding the nature and development of scientific knowledge (Science and Engineering Practices, and Crosscutting Concepts)

The shift of science education reflects the interconnected nature of science as it is practiced in the real world and builds coherently across grades K-12. The NGSS focus on deeper Grade 9 Integrated Physical Science Property of Trumbull Public Schools 3 understanding of content as well as application of content with an alignment to the Connecticut Core Standards. A deeper understanding and application of science and engineering practices prepare students for postsecondary success and citizenship in a world fueled by innovations in science and technology.

Most systems or processes depend at some level on physical and chemical subprocesses that occur within, whether the system in question is a star, Earth's atmosphere, a river, a bicycle, the human brain, or a living cell. Large-scale systems often have emergent properties that cannot be explained on the basis of atomic-scale processes; nevertheless, to understand the physical and chemical basis of a system, one must ultimately consider the structure of matter at the atomic and subatomic scales to discover how it influences the system's larger-scale structures, properties, and functions. Similarly, understanding a process at any scale requires awareness of the interactions occurring – in terms of the forces between objects, the related energy transfers, and their consequences. Earth and space sciences have much in common with the other branches of science, but they also include a unique set of scientific pursuits. Inquiries into the physical sciences (e.g., forces, energy, gravity, magnetism) have been pursued in part as a means of understanding the size, age, structure, composition, and behavior of Earth, the sun, and the moon.

Integrated Physical Science is offered at three separate course levels: Honors, Advanced College Preparatory (ACP), and College Preparatory (CP). All levels will explore each unit of study. The courses are differentiated by pacing of curriculum, rigor of exploration, depth of content knowledge, and the application of quantitative reasoning. The honors course will explore topics with the greatest depth, most rigorous exploration, deepest study of content, and furthest application of quantitative reasoning. More supports will be offered at the ACP course level, with the most support offered at the CP course level.

COURSE GOALS

The course goals derive from the 2013 Next-Generation Science Standards, the 2010 Connecticut Core Standards, and the ISTE (International Society for Technology in Education) Technology Standards. Goals are listed specific to each unit in this curriculum guide, and developed through unit lessons using the 5-E learning model (engage, explore, explain, elaborate, evaluate) in order to encourage student engagement and foster metacognitive learning strategies through a reflective process. An important role of science education is not to teach "all the facts," but rather to prepare students with sufficient core knowledge so that they can later acquire additional information on their own.

COURSE ENDURING UNDERSTANDINGS

Students will understand that . . .

- The planet Earth is a tiny part of a vast universe that has developed over a huge expanse of time. The history of the universe, and of the structures and objects within it, can be deciphered using observations of their present condition together with knowledge of Grade 9 Integrated Physical Science Property of Trumbull Public Schools 4 physics and chemistry. Similarly, the patterns of motion of the objects in the solar system can be described and predicted on the basis of observations and an understanding of gravity.

- Earth's surface is a complex and dynamic set of interconnected systems that interact over a wide range of temporal and spatial scales. All of Earth's processes are the result of energy flowing and matter cycling within and among the systems. For example, the motion of tectonic plates is part of the cycles of convection in Earth's mantle, driven by outflowing heat and the downward pull of gravity, which result in the formation and changes of many features of

Earth's land and undersea surface. Water is essential to the dynamics of most earth systems, and it plays a significant role in shaping Earth's landscape.

- Earth's surface processes affect and are affected by human activities. Humans depend on all of the planet's systems for a variety of resources, some of which are renewable or replaceable and some of which are not. Natural hazards and other geological events can significantly alter human populations and activities.

- Matter can be understood in terms of the types of atoms present and the interactions both between and within them. Nuclear reactions involve changes in the types of atomic nuclei present and are key to the energy release from the sun and the balance of isotopes in matter.

- Interactions between any two objects can cause changes in one or both of them. An understanding of the forces between objects is important for describing how their motions change, as well as for predicting stability or instability in systems at any scale. All forces between objects arise from a few types of interactions: gravity, electromagnetism, and the strong and weak nuclear interactions.

- Interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another. The total energy within a defined system changes only by the transfer of energy into or out of the system.

- Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter. Light and sound are wavelike phenomena.

COURSE ESSENTIAL QUESTIONS

- What methods do scientists employ to explore and model the universe?
- How does energy flow and cycle within and between natural systems?
- What evidence-based models can explain and predict the motions and interactions of objects in a system?
- How do Earth's internal and surface processes, which operate at different spatial and temporal scales, result in the formation of characteristic terrestrial features?
- How do the availability of natural resources influence human activity?
- How can natural resources be used to efficiently generate electrical energy?

COURSE KNOWLEDGE & SKILLS

Students will understand:

- Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

- Cause and effect. Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

- Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

- Systems and system models. Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.

- Energy and matter. Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

- Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Students will be able to . . .

- ask questions (for science) and define problems (for engineering).
- develop and use models.
- plan and carry out investigations.
- analyze and interpret data.
- use mathematics and computational thinking.
- construct explanations (for science) and design solutions (for engineering).
- engage in arguments from evidence.
- obtain, evaluate, and communicate information

COURSE SYLLABUS

Course Name

Grade 9 Integrated Physical Science

Level

College-Preparatory , Advanced College-Preparatory , & Honors

Prerequisites

None

General Description of the Course

This course is aligned to the Next Generation Science Standards (NGSS) Disciplinary Core Ideas for Grade 9. Through the implementation of the Three Dimensions of NGSS (Disciplinary Core Ideas, Science and Engineering Practices and Cross Cutting Concepts), students will explore topics in earth and space science through physical science concepts. Students will engage in the Science and Engineering Practices throughout their studies in order to develop their ability to think critically, engage in analysis, effectively communicate and defend their understandings like a scientist or engineer. At the Honors level, algebraic reasoning and independent discovery are expected; the CP level mirrors the ACP level with additional guided inquiry.

Assured Assessments

Formative Assessments:

Formative assessments can include, but are not limited to:

- Questioning, discussion, and in-class activities

Summative Assessments:

- End-of-unit assessment with multiple-choice questions and interpreting and analyzing data
- Research and presentations
- Midyear examination
- End-of-year examination

Core Texts

- Feather, Jr., Ralph M., Charles William McLaughlin, Marilyn Thompson, & Dinah Zike. Physical Science with Earth Science. Columbus: Glencoe, 2012. Print.

UNIT 1
Cosmic Evolution

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS1-1	**Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.**
NGSS.HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of ~~fission~~, fusion, ~~and radioactive decay~~.
NGSS.HS-PS4-1	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.**
NGSS.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.
NGSS.HS-ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
NGSS.HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
CCS.ELA-Literacy.RST.9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
CCS.ELA-Literacy.RST.9-10.7	**Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.**

CCS.ELA-Literacy.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
CCS.ELA-Literacy.SL.9-10.4	Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
CCS.MP.2	Reason abstractly and quantitatively.
CCS.MP.4	**Model with mathematics**
CCS.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.
CCS.HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
CCS.HSA-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
CCS.HSA-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
CCS.HSA-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
CCS.HSA-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
CCS.HSS-ID.B.6	**Represent data on two quantitative variables on a scatter plot, and describe how those variables are related.**
ISTE Knowledge Constructor (Standard 3c)	Curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.HS-ESS1-1, NGSS.HS-PS1-8) Using Mathematics and Computational Thinking: ● Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (NGSS.HS-PS4-1) Engaging in Argument from Evidence: ● Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (NGSS.HS-PS4-3) Constructing Explanations and Designing Solutions: ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review)	ESS1.A: The Universe and Its Stars: ● The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (NGSS.HS-ESS1-1) ● The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (NGSS.HS-ESS1-2, NGSS.HS-ESS1-3) ● Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (NGSS.HS-ESS1- 2) PS1.C: Nuclear Processes: ● Nuclear processes, including fusion, ~~fission, and radioactive decays of unstable nuclei,~~ involve release ~~or absorption~~ of energy. The total number of neutrons plus protons does not change in any nuclear process. (NGSS.HS-PS1-8)	Energy and Matter: ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (NGSS.HS-PS1-8) ● Energy cannot be created or destroyed – only moved between one place and another place, between objects and/or fields, or between systems. (NGSS.HS-ESS1-2) Systems and System Models: ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows – within and between systems at different scales. (NGSS.HS-PS4-3) Connections to Nature of Science: Scientific Assumes an Order and Consistency in Natural Systems: ● Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (NGSS.HS-ESS1-2)

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. (NGSS.HS-ESS1-2) Obtaining, Evaluating, and Communicating Information: ● Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (NGSS.HS-ESS1-3) **Connections to Nature of Science:** Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena: ● A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	PS3.D: Energy in Chemical Processes and Everyday Life: ● Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary to NGSS.HS-ESS1-1) PS4.A: Wave Processes: ● The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (NGSS.HS-PS4-1) 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. (NGSS.HS-PS4- 3) ● Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic	● Science assumes the universe is a vast single system in which basic laws are consistent. (NGSS.HS-ESS1-2)

(NGSS.HSESS1-2, NGSS.HS-ESS1- 6, NGSS.HS-PS4-3)	quantities. (secondary to NGSS.HS-ESS1-2)	

Unit Essential Questions

- Given the enormous scale of the universe, how is it possible for scientists to study and develop models that explain it?
- Where do the elements that make up the Earth, and all life on it, come from?
- How do stars produce energy?
- How does energy travel from the sun (a star) to the Earth?
- What are the properties of electromagnetic waves, and how are these properties related?
- What is the relationship between the wavelengths of light emitted from a star and its temperature?
- How does interaction with different mediums affect the behavior of waves?
- How do the properties of stars lead us to understand cosmic and stellar evolution?

Unit Essential Vocabulary

proton	neutron	electron	nucleus
atomic number	mass number	isotope	nuclear fusion
energy level	absorption	emission	waves
crest	trough	amplitude	wavelength
resting point	frequency	spectroscopy	emission spectra
luminosity	peak wavelength	absolute magnitude	apparent magnitude
parallax	HR Diagram	protostar	main sequence star
supernova	reflection	refraction	

Unit Scope and Sequence

- Atomic structure
- Nuclear Fusion
- Electromagnetic Energy
  - Production of photons
  - Properties of waves
  - Emission Spectra
  - Behavior of waves
- Stellar Evolution
  - Properties of Stars
  - H-R Diagram
  - Life cycle of stars

Unit Assured Assessments

Formative Assessment:

- Modeling nuclear fusion through conceptual, physical and mathematical models.
- Model the properties of waves applying the relationship between frequency, wavelength and energy.
- Model the behavior of a wave based on the medium it is interacting with.
- Model and interpret the different properties of stars using an H-R diagram

Summative Assessment:

- Students will participate in assessments consisting of multiple-choice questions, and interpreting and analyzing data, related to nuclear fusion, electromagnetic energy and stellar evolution.

Resources

Core

- Feather, Jr., Ralph M., Charles William McLaughlin, Marilyn Thompson, & Dinah Zike. Physical Science with Earth Science. Columbus: Glencoe, 2012. Print.
- "Modeling Nuclear Fusion"
- "Electric Pickle"
- *Wave on a string*. PhET. https://phet.colorado.edu/en/simulations/wave-on-a-string
- "Emission Spectroscopy"
- "Stellar Distance & Parallax Shift"
- "Modeling Properties of Stars"

Supplemental

- *Bending light*. PhET. https://phet.colorado.edu/en/simulations/bending-light
- "New SAT Reading Practice Test 33: Sunspots Passage" http://www.cracksat.net/sat/reading/test-33.htm
- Ruth, Carolyn. "Where Do Chemical Elements Come From?" ChemMatters October 2009: 6-8. Print.
- "Stellar Helium." The Science Teacher 70.4 (April 2003): 10. Print.
- "New SAT Reading Practice Test 40: Bohr Letter" https://www.cracksat.net/sat/reading/test-40.html

Time Allotment

- Approximately 8-10 Weeks

UNIT 2
Motion, Forces, and Energy

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS1-4	**Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.**
NGSS.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.**
NGSS.HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and ~~Coulomb's Law~~ to describe and predict the gravitational ~~and electrostatic~~ force between objects.
NGSS.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).**
CCS.ELA-Literacy.RST.9-10.7	**Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.**
CCS.ELA-Literacy.WHST.9-10.9	Draw evidence from informational texts to support analysis, reflection, and research.
CCS.MP.2	Reason abstractly and quantitatively
CCS.MP.4	**Model with mathematics.**
CCS.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.

CCS.HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
CCS.HSA-SSE.A.1	**Interpret expressions that represent a quantity in terms of its context.**
CCS.HSA-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
CCS.HSA.CED.A.1	**Create equations and inequalities in one variable and use them to solve problems.**
CCS.HSA-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
CCS.HSA-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
CCS.HSF-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
CCS.HSS-IS.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision making.
ISTE Computational Thinker (Standard 5c)	Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem solving.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (NGSS.HS-PS2-1) Using Mathematics and Computational Thinking: ● Use mathematical or computational representations of phenomena to describe explanations. (NGSS.HS-ESS1-4) **Connections to Nature of Science:** Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena: ● Theories and laws provide explanations in science. (NGSS.HS-PS2-1, NGSS.HS-PS2-4) ● Laws are statements or descriptions of the relationships among observable phenomena. (NGSS.HS-PS2-1, NGSS.HS-PS2-4)	ESS1.B: Earth and the Solar System: ● Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (NGSS.HS-ESS1- 4) PS2.A: Forces and Motion: ● Newton's second law accurately predicts changes in the motion of macroscopic objects. (NGSS.HS-PS2-1) PS2.B: Types of Interactions: ● Newton's law of universal gravitation and ~~Coulomb's law~~ provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (NGSS.HS-PS2-4) ● Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or	Patterns: ● Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (NGSS.HS-PS2-4) Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-PS2-1) 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). (NGSS.HS-ESS1-4) Energy and Matter: ● Energy cannot be created or destroyed – only moved between one place and another place, between objects and/or fields, or between systems. (NGSS.HS-PS3-2)

	changing magnetic fields cause electric fields. (NGSS.HS-PS2-4) 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. (NGSS.HS-PS3-2) ● At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (NGSS.HS-PS3-2) ● These relationships are better understood at the macroscopic scale, at which all of the different manifestations of energy can be modeled as a combination of 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 in which energy stored in fields moves	**Connections to Engineering, Technology, and Applications of Science:** Energy and Matter: ● 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. (NGSS.HS-ESS1-4)

	across space. (NGSS.HS-PS3-2) ETS1.A: Defining and Delimiting Engineering Problems: ● Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk migration 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. (NGSS.HS-ETS1-1) ETS1.C: Optimizing the Design Solution: ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (NGSS.HS-ETS1-2)	

Unit Essential Questions

- What evidence-based models can be studied and developed to explain and predict the motion and interaction of objects in a system?
- How do Kepler's Laws provide a basis to understand motions of orbiting objects?
- How can Kepler's Laws of Motion be used to predict changes in the motion of macroscopic objects?
- How can Newton's Law of Universal Gravitation describe and predict the effects of gravitational force between distant objects?
- What is the role of force in the motion of an object?
- How does Newton's Second Law provide a basis to express the relationship between force and the motion of an object?
- How can energy be modeled and applied to the motion of objects in a system?
- How does the principle that energy cannot be created or destroyed, only moved between places, apply in different contexts?

Unit Essential Vocabulary

orbit	orbital period	gravity	ellipse
foci	perihelion	aphelion	velocity
mass	weight	motion	reference point
speed	distance	position - time graph	acceleration
velocity - time graph	force	Newton (N)	net force
balanced forces	unbalanced forces	inertia	work
power	energy	Joule (J)	Watt (W)
kinetic energy	gravitational energy	elastic energy	chemical energy
thermal energy	electrical energy	electromagnetic energy	nuclear energy

Unit Scope and Sequence

- Planetary Formation
- Kepler's Laws of Motion
- Newton's Law of Universal Gravitation
- Describing Motion
    - Modeling constant velocity
    - Modeling change in velocity
- Newton's Laws of Motion
    - First Law
    - Second Law (net force and acceleration)
- Energy
    - Forms & Conversions
    - Law of Conservation

Unit Assured Assessments

Formative Assessment:
- Modeling planetary orbits based on Kepler's Laws
- Model gravitational force between objects
- Using position-time and velocity-time graphs to describe the motion of an object.
- Determining net force with Free Body Force Diagrams
- Modeling the relationship defined by F=ma
- Modeling Conservation of Energy

Summative Assessment:
- Students will participate in assessments consisting of multiple-choice questions, and interpreting and analyzing data, related to motion, forces and energy.

Resources

Core
- Feather, Jr., Ralph M., Charles William McLaughlin, Marilyn Thompson, & Dinah Zike. Physical Science with Earth Science. Columbus: Glencoe, 2012. Print.
- "Modeling Planetary Motion (Kepler's Laws)."
- "Modeling Gravitational Force"
- "Modeling Constant Velocity"
- *The Moving Man*. PhET https://phet.colorado.edu/en/simulation/moving-man
- "Modeling Newton's Second Law of Motion"
- "Comparing Work and Energy"
- *Energy Skate Park*. PhET. https://phet.colorado.edu/en/simulations/energy-skate-park

Supplemental
- *Gravity Force Lab*. PhET. https://phet.colorado.edu/en/simulation/gravity-force-lab
- *Force and Motion: Basics*. PhET. https://phet.colorado.edu/en/simulations/forces-and-motion-basics
- "Exploring Newton's First Law"
- *Energy Forms and Changes- Systems*. PhET. https://phet.colorado.edu/en/simulations/energy-forms-and-changes
- *Gravity and Orbits*. PhET. https://phet.colorado.edu/sims/html/gravity-and-orbits/latest/gravity-and-orbits_en.html
- *Solar System – Planet Movement Animation*. YouTube https://www.youtube.com/watch?v=gvSUPFZp7Yo

Time Allotment

Approximately 8-10 Weeks

UNIT 3
Terrestrial Processes and Cycling of Matter

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the process~~es~~ of ~~fission, fusion, and~~ radioactive decay.
NGSS.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.**
NGSS.HS-ESS2-3	**Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.**
NGSS.HS-PS3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
NGSS.HS-ESS2-5	~~Plan and~~ conduct an investigation of ~~the properties of~~ water and its effects on Earth materials and surface processes.
CCS.ELA-Literacy.RST.9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
CCS.ELA-Literacy.WHST.9-10.1	**Write arguments focused on discipline-specific content.**

CCS.ELA-Literacy.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
CCS.ELA-Literacy.WHST.9-10.9	**Draw evidence from informational texts to support analysis, reflection, and research.**
CCS.ELA-Literacy.SL.9-10.5	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.
CCS.MP.2	Reason abstractly and quantitatively.
CCS.MP.4	**Model with mathematics**
CCS.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.
CCS.HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
CCS.HSF-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
CCS.HSS-ID.B.6	**Represent data on two quantitative variables on a scatter plot, and describe how those variables are related.**
ISTE Computational Thinker (Standard 5c)	Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem solving.
ISTE Creative Communicator (Standard 6c)	Communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models, or simulations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.HS-PS1-8, NGSS.HS-ESS2-1, NGSS.HS-ESS2-3) 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. (NGSS.HS-PS3-4, NGSS.HS-ESS2-5) Constructing Explanations and Designing Solutions: ● Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (NGSS.HS-ESS1-6)	ESS1.C: The History of Planet Earth: ● Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (NGSS.HS-ESS1- 6) ESS2.A: Earth Materials and Systems: ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (NGSS.HS-ESS2-1) ● Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which	Energy and Matter: ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (NGSS.HS-PS1-8) ● Energy drives the cycling of matter within and between systems. (NGSS.HS-ESS2-3) Structure and Function: ● The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (NGSS.HS-ESS2-5) 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. (NGSS.HS-PS3-4) Stability and Change: ● Change and rates of change can be quantified and modeled over very

Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence: ● Science knowledge is based on empirical evidence. (NGSS.HS-ESS2-3) ● Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (NGSS.HS-ESS2-3) ● Science includes the process of coordinating patterns of evidence with current theory. (NGSS.HS-ESS2-3) Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena: ● A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (NGSS.HS-ESS1-6) ● Models, mechanisms, and explanations collectively serve as	involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (NGSS.HS-ESS2- 3) ESS2.B: Plate Tectonics and Large-Scale System Interactions: ● The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (NGSS.HS-ESS2-3) ● Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (NGSS.HS-ESS2-1) ESS2.C: The Roles of Water in Earth's Surface Processes: ● The abundance of liquid water on	short or very long periods of time. Some system changes are irreversible. (NGSS.HS-ESS2-1) ● Much of science deals with constructing explanations of how things change and how they remain stable. (NGSS.HS-ESS1-6) 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. (NGSS.HS-ESS2-3)

tools in the development of a scientific theory. (NGSS.HS-ESS1-6)	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. (NGSS.HS-ESS2-5) PS1.C: Nuclear Processes: ● Nuclear processes, including ~~fusion, fission, and~~ radioactive decay of unstable nuclei, involve release ~~or absorption~~ of energy. The total number of neutrons plus protons does not change in any nuclear process. (NGSS.HS-PS1-8) ● Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to NGSS.HS-ESS1-6) PS3.B: Conservation of Energy and Energy Transfer: ● Energy cannot be created or destroyed, but it can be transported from one place to another and	

	transferred between systems. (NGSS.HS-PS3-4) ● Uncontrolled systems always evolve toward more stable states – that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (NGSS.HS-PS3-4) 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. (NGSS.HS-PS3-4) PS4.A: Wave Properties: ● Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to NGSS.HS-ESS2-3)	

Unit Essential Questions

- What is the relationship between geographic features of the Earth's crust and its internal processes?
- What is the Plate Tectonic Theory, and what evidence supports it?
- What are the characteristics of different plate boundaries?
- How is seismic activity related to tectonism?
- What is "Deep Time"?
- What is radiometric dating, and how can it be utilized to determine absolute age of crustal materials?
- How is volcanic activity related to tectonism?
- What are the different characteristics of the three main types of rocks, and how do they form?
- What is the Hydrologic Cycle?
- How is the role of water in shaping the Earth's surface?

Unit Essential Vocabulary

thermal energy	temperature	heat	convection current
lithosphere	asthenosphere	continental crust	oceanic crust
tectonic plate	divergent boundary	convergent boundary	mid - ocean ridge
rift valley	subduction	volcanic arc	island arc
trench	mountain range	hotspot	seamount
evaporation	condensation	precipitation	transpiration
igneous rock	magma	sedimentary rock	weathering
sediment	metamorphic rock	relative dating	absolute dating
parent isotope	daughter isotope	half-life	

Unit Scope and Sequence

- Thermal energy
- Heat transfer in the Earth (*convection*)
- Theory of Plate Tectonics
    - Plate boundaries
    - Crustal features
    - Global seismic activity & distribution
- Earth Processes & Cycling of Matter
    - Processes (*earthquakes, volcanoes, weather, erosion, deposition*)
    - Water Cycle
    - Rock Cycle
- Deep Time
    - Relative & Absolute Dating

Unit Assured Assessments

Formative Assessment:
- Model thermal energy
- Application of the Theory of Plate Tectonics
- Interpret seismic data
- Modeling the earth processes relating to the cycling of matter
- Application of relative and absolute dating methods

Summative Assessment:
- Students will participate in assessments consisting of multiple-choice questions, and interpreting and analyzing data, related to tectonism and the cycling of matter.

Resources

Core
- Feather, Jr., Ralph M., Charles William McLaughlin, Marilyn Thompson, & Dinah Zike. Physical Science with Earth Science. Columbus: Glencoe, 2012. Print
- NOAA National Centers for Environmental Information. "Marine Geology and Geophysics Surface of the Earth (ETOPO2v2)." https://www.ngdc.noaa.gov/mgg/image/2minrelief.html
- Terry, Travis. "Going DEEP with Plate Tectonics: Study Guide and Practice," 2003. https://www.teacherspayteachers.com/Product/Worksheet-Plate-Tectonics-Study-Guideand-Practice-1204872
- "Incorporated Institutes of Seismology (IRIS) Earthquake Browser." https://ds.iris.edu/ieb/index.html?format=text&nodata=404&starttime=1970-01-01&endtime=2025-01-01&minmag=0&maxmag=10&mindepth=0&maxdepth=900&orderby=time-desc&src=usgs&limit=1000&maxlat=81.60&minlat=-81.60&maxlon=129.38&minlon=-129.38&zm=2&mt=ter
- "Penny Lab" *(Absolute Dating)*

Supplemental
- "Kinetic Molecular Theory." SAT practice article adapted from "Kinetic Molecular Theory." World of Physics. Farmington Hills, MI: Gale, 2014.
- "New SAT Reading Practice Test 7: Plate Tectonics." http://www.cracksat.net/sat/reading/test-7.html
- *Energy Forms and Changes- Intro*. PhET. https://phet.colorado.edu/en/simulations/energy-forms-and-changes

Time Allotment

Approximately 8-10 Weeks

UNIT 4

Natural Resources & Electrical Energy

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS3-1	**Construct an explanation based on evidence for how the availability of natural resources, ~~occurrence of natural hazards, and changes in climate have~~ has influenced human activity.**
NGSS.HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
NGSS.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
NGSS.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.**
NGSS.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.**
NGSS.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.
CCS.ELA-Literacy.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
CCS.ELA-Literacy.WHST.9-10.7	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.
CCS.ELA-Literacy.WHST.9-10.9	**Draw evidence from informational texts to support analysis, reflection, and research.**

CCS.MP.2	Reason abstractly and quantitatively.
CCS.MP.4	**Model with mathematics.**
CCS.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.
CCS.HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
ISTE Innovative Designer (Standard 4a)	Know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems.
ISTE Computational Thinker (Standard 5c)	**Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem solving.**
ISTE Creative Communicator (Standard 6c)	Communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models, or simulations.
ISTE Global Collaborator (Standard 7c)	Contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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). (NGSS.HS-ESS3-2) 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 according. (NGSS.HS-PS2-5) Constructing Explanations and Designing Solutions: ● Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized	ESS3.A: Natural Resources: ● Resource availability has guided the development of human society. (NGSS.HS-ESS3-1) ● All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (NGSS.HS-ESS3-2) ESS3.B: Natural Hazards: ● Natural hazards and other geologic events have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations. (NGSS.HS-ESS3-1) ● ESS3.C: Human Impacts on Earth Systems: ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (NGSS.HS-ESS3-4)	Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-PS2-5, NGSS.HS-ESS3-1) ● 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. (NGSS.HS-PS3-5) Stability and Change: ● Feedback (negative or positive) can stabilize or destabilize a system. (NGSS.HS-ESS3-4) Energy and Matter: ● 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. (NGSS.HS-PS3-3)

criteria, and trade off considerations. (NGSS.HS-PS3-3, NGSS.HS-ESS3-4) ● 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. (NGSS.HS-ESS3-1) Developing and Using Models: ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.HS-PS3-5) 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. (NGSS.HS-ESS3-2)	PS2.B: Types of Interactions: ● Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (NGSS.HS-PS2-4) ● Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (NGSS.HS-PS2-5) PS3.A: Definitions of Energy: ● At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (NGSS.HS-PS3-3) ● "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (secondary to NGSS.HS-PS2-5) 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. (NGSS.HS-PS3-5)	Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World: ● Modern civilization depends on major technological systems. (NGSS.HS-ESS3-1, NGSS.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. (NGSS.HS-PS3-3, NGSS.HS-ESS3-2, NGSS.HS-ESS3-4)

	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. (NGSS.HS-PS3-3) ETS1.A: Defining and Delimiting Engineering Problems: ● Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to NGSS.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 to NGSS.HS-ESS3-2, secondary to NGSS.HS-ESS3-4)	

Unit Essential Questions

- How is the distribution of energy resources related to natural systems?
- What methods are utilized to obtain energy resources?
- What are the best ways to use resources effectively while reducing harm to the environment?
- How can natural resources be used to generate electrical energy?
- What is electrical energy, and how is it utilized within a system?
- What is the relationship between electricity and magnetism?

Unit Essential Vocabulary

natural resource	non-renewable	fossil fuel	coal
natural gas	petroleum	nuclear	renewable
geothermal	hydroelectric	solar	tidal
biomass	wind	generator	turbine
voltage	volt	ohm's law	electrical power
current	amp	series circuit	electrical energy
resistance	ohm	parallel circuit	

Unit Scope and Sequence

- Energy resources
  - Types of resources (*non-renewable, renewable*)
  - Distribution and cost-benefit
  - Conversions
- Electrical Energy
  - Attraction and repulsion
  - Ohm's Law
  - Circuits (*series, parallel*)
  - Consumption (*power*)
  - Relationship to magnetism

Unit Assured Assessments

Formative Assessment:

- Cookie Mining Lab (cost-benefit analysis of non-renewable resources)
- Comparative analysis of energy resources
- Modeling energy conversions
- Model electrical systems

Summative Assessment:

- Students will participate in assessments consisting of multiple-choice questions, and interpreting and analyzing data, related to natural resources and electricity.

Resources

Core

- Feather, Jr., Ralph M., Charles William McLaughlin, Marilyn Thompson, & Dinah Zike. Physical Science with Earth Science. Columbus: Glencoe, 2012. Print.
- “Critical Minerals Scavenger Hunt” https://mrdata.usgs.gov/
- “Cookie Mining”
- “Ohm’s Law Lab”
- “Modeling Electrical Circuits”
- “Electromagnets”

Supplemental

- “New SAT Reading Practice Test 42: Paired Passages – Solar Farming.” http://www.cracksat.net/sat/reading/test-42.html
- “New SAT Reading Practice Test 43: Carbon Dioxide Passage.” http://www.cracksat.net/sat/reading/test-43.html
- “New SAT Reading Practice Test 53: Hydrogen Passage.” http://www.cracksat.net/sat/reading/test-53.html ”
- “Engineering Design Challenge: Wind Turbines”
- “Mining for you Cell Phone”
- “Consuming Energy Resources”
- “Interpreting an Electricity Bill”
- “Evaluating Personal Energy Consumption”

Time Allotment

Approximately 8-10 Weeks

CREDIT

One THS credit in Science

Three (3) class periods every four (4) day rotation for a full year

PREREQUISITES

None

CURRENT REFERENCES

- *Next Generation Science Standards*. https://www.nextgenscience.org/

ASSURED STUDENT PERFORMANCE RUBRICS

- VOG Skill Rubric: Communication 9-12 (***currently under revision***)
- VOG Skill Rubric: Collaboration 9-12 (***currently under revision***)
- VOG Skill Rubric: Critical Thinking/Problem Solving 9-12 (***currently under revision***)
- Trumbull High School School-Wide Writing Rubric
- Trumbull High School School-Wide Problem-Solving Rubric
- Trumbull High School School-Wide Independent Learning and Thinking Rubric

Skill Rubric: Communication 9-12 (currently under revision)

Indicator of Attainment	Beginning 1	Meets 2	Exceeds 3	Score
PURPOSE Expresses ideas in alignment with the intended purpose.	Limited demonstration of understanding. Purpose is not identified and/or not fully articulated. Does not or partially expresses ideas in alignment with purpose.	Purpose is identified and articulated but may be occasionally unclear. Expresses ideas with purpose.	Purpose is identified and clearly articulated and enhanced. Clearly expresses ideas in alignment with the intended purpose. Makes connections beyond the intended purpose.	
AUDIENCE Demonstrates an awareness of the intended audience.	Demonstrates little to no awareness of the audience. Language and content is inappropriate and/or ineffective for the audience.	Demonstrates an awareness of the audience. Language and content is appropriate and helps the audience understand the topic/position.	Clearly and consistently demonstrates a complete awareness of the intended audience by connecting to the audience and adjusting as needed. Engages with and responds to the intended audience in a developmentally appropriate manner. Language and content is appropriate and precise which helps the intended audience further understand the topic/position.	
ORGANIZATION Organizes and supports ideas in alignment with the intended purpose.	The organizational structure is not and/or minimally effective for the purpose. The topic/position is not focused and/or minimally supported by details.	Effective organizational structure supports the purpose. The topic/position is focused, well thought out, and supported by accurate and effective details.	Clearly expresses ideas in alignment with the intended purpose. Purpose is clearly identified and connections are made beyond the intended purpose. Substantive and accurate details support and extend the topic/position with exceptional development, specificity, and depth.	
LISTENING Receives and responds to ideas in alignment with the intended purpose.	Limited to no ability to listen to others. Unable to ask relevant questions. Can not paraphrase/restate the message.	Listens to, evaluates, and responds to others. Asks relevant questions. Demonstrates understanding by accurately paraphrasing/restating the message.	Actively listens to, evaluates and responds to others. Asks relevant questions that indicate an interest to learn more and understand further. Demonstrates understanding by accurately paraphrasing/ restating the message and expanding upon the ideas presented.	
SCORING	Beginning: 4 - 6	**Meets: 7 - 8 GOAL**	Exceeds: 10 - 12	__ / 12

Skill Rubric: Collaboration 9-12 (currently under revision)

Indicator of Attainment	Beginning 1	Meets 2	Exceeds 3	Score
PLANNING Works effectively with and is receptive to the ideas/contributions of group members.	Does not or lacks a discussion on the strengths of each group member. Does not define group roles.	Assigns roles and defines contributions of those in the group. Suggests ways the group can approach the task.	Assigns roles and defines contributions based upon the unique knowledge, abilities, or interests of those in the group. Plans the approach to the task and anticipates challenges and resolutions.	
COMMUNICATION Thinks with the group and acknowledges multiple perspectives.	Does not or rarely listens to the thinking of the group. Provides little to no feedback.	Utilizes the thinking of the group in order to work toward the completion of the task. Provides feedback.	Synthesizes and expresses the multiple perspectives of the group in order to complete the task. Provides feedback that improves the quality of the task.	
CONTRIBUTION Works with others to complete a task and shares the credit.	Little or no contribution to the task.	Shares work, reviews others' contributions and offers general feedback.	Shares work beyond the individual task, constructively critiques others' contributions, and offers feedback to improve the overall quality of the task.	
REFLECTION Monitors individual and collective contributions of each group member throughout the completion of the task.	Little or no reflection on ways to adjust the group's collaboration process throughout the task/product. Focuses only on individual contributions to the task.	Reflects and suggests individual and/or collective contributions to adjust the group's collaboration process to improve the quality of the task.	Applies relevant and diverse individual and collective contributions to monitor and adjust the quality of the task.	
SCORING	Beginning: 4 - 6	**Meets: 7 - 8 GOAL**	Exceeds: 10 - 12	__ / 12

SKill Rubric: Critical Thinking/Problem Solving 9-12 (currently under revision)

Indicator of Attainment	Beginning 1	Meets 2	Exceeds 3	Score
UNDERSTANDING Identifies the problem, question or issue being addressed.	Exhibits limited and/or no understanding of key concepts.	Exhibits an understanding of key concepts.	Exhibits a thorough and accurate understanding of key concepts and can access those concepts from multiple perspectives.	
PLANNING Applies systematic thinking and selects strategies to address the problem, question or issue.	Shows limited to no evidence of a plan, model or strategy to solve a problem.	Shows a plan, model or strategy to solve a problem.	Shows innovative and creative thinking to solve a problem.	
QUESTIONING Analyzes relevant information related to the problem, question or issue.	Unable to or has difficulty questioning and analyzing numerical, written, or visual data and identifying related evidence.	Questions and analyzes numerical, written, or visual data and selects the relevant evidence.	Questions and analyzes numerical, written, or visual data and selects the most relevant and impactful evidence. Describes why different approaches to a problem or situation could yield the same or similar results.	
REFLECTION Makes evidence-based conclusions/solutions and makes adjustments as needed to address the problem, question or issue.	Solution is inadequately supported or supported with minimal evidence, limited analysis of data and relevant information.	Solution is accurately supported by evidence and the student makes conclusions based on appropriate evidence.	Solution is thorough, accurate, and evidence-based. Shows extensive, thoughtful and reflective thinking on how a problem is solved and makes adjustments as needed.	
SCORING	Beginning: 4 - 6	**Meets: 7 - 8 GOAL**	Exceeds: 10 - 12	__ / 12

Trumbull High School School-Wide Writing Rubric

Category/Weight	Exemplary 4 **Student work:**	Goal 3 **Student work:**	Working Toward Goal 2 **Student work:**	Needs Support 1-0 **Student work:**
Purpose X_______	• Establishes and maintains a clear purpose • Demonstrates an insightful understanding of audience and task	• Establishes and maintains a purpose • Demonstrates an accurate awareness of audience and task	• Establishes a purpose • Demonstrates an awareness of audience and task	• Does not establish a clear purpose • Demonstrates limited/no awareness of audience and task
Organization X_______	• Reflects sophisticated organization throughout • Demonstrates logical progression of ideas • Maintains a clear focus • Utilizes effective transitions	• Reflects organization throughout • Demonstrates logical progression of ideas • Maintains a focus • Utilizes transitions	• Reflects some organization throughout • Demonstrates logical progression of ideas at times • Maintains a vague focus • May utilize some ineffective transitions	• Reflects little/no organization • Lacks logical progression of ideas • Maintains little/no focus • Utilizes ineffective or no transitions
Content X_______	• Is accurate, explicit, and vivid • Exhibits ideas that are highly developed and enhanced by specific details and examples	• Is accurate and relevant • Exhibits ideas that are developed and supported by details and examples	• May contain some inaccuracies • Exhibits ideas that are partially supported by details and examples	• Is inaccurate and unclear • Exhibits limited/no ideas supported by specific details and examples
Use of Language X_______	• Demonstrates excellent use of language • Demonstrates a highly effective use of standard writing that enhances communication • Contains few or no errors. Errors do not detract from meaning	• Demonstrates competent use of language • Demonstrates effective use of standard writing conventions • Contains few errors. Most errors do not detract from meaning	• Demonstrates use of language • Demonstrates use of standard writing conventions • Contains errors that detract from meaning	• Demonstrates limited competency in use of language • Demonstrates limited use of standard writing conventions • Contains errors that make it difficult to determine meaning

Trumbull High School School-Wide Problem-Solving Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Understanding X___	• Student demonstrates clear understanding of the problem and the complexities of the task	• Student demonstrates sufficient understanding of the problem and most of the complexities of the task	• Student demonstrates some understanding of the problem but requires assistance to complete the task	• Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X___	• Student gathers compelling information from multiple sources including digital, print, and interpersonal	• Student gathers sufficient information from multiple sources including digital, print, and interpersonal	• Student gathers some information from few sources including digital, print, and interpersonal	• Student gathers limited or no information
Reasoning and Strategies X_______	• Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	• Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	• Student demonstrates some critical thinking skills to develop a plan integrating some strategies	• Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X__	• Solution shows deep understanding of the problem and its components • Solution shows extensive use of 21st-century technology skills	• Solution shows sufficient understanding of the problem and its components • Solution shows sufficient use of 21st-century technology skills	• Solution shows some understanding of the problem and its components • Solution shows some use of 21st-century technology skills	• Solution shows limited or no understanding of the problem and its components • Solution shows limited or no use of 21st-century technology skills

Trumbull High School School-Wide Independent Learning and Thinking Rubric

Category/Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Proposal x_______	Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work.	Student demonstrates initiative by generating appropriate questions, creating original projects/work.	Student demonstrates some initiative by generating questions, creating appropriate projects/work.	Student demonstrates limited or no initiative by generating few questions and creating projects/work.
Independent Research & Development x_______	Student is analytical, insightful, and works independently to reach a solution.	Student is analytical, and works productively to reach a solution.	Student reaches a solution with direction.	Student is unable to reach a solution without consistent assistance.
Presentation of Finished Product x_______	Presentation shows compelling evidence of an independent learner and thinker. Solution shows deep understanding of the problem and its components. Solution shows extensive and appropriate application of 21st Century Skills.	Presentation shows clear evidence of an independent learner and thinker. Solution shows adequate understanding of the problem and its components. Solution shows adequate application of 21st Century Skills.	Presentation shows some evidence of an independent learner and thinker. Solution shows some understanding of the problem and its components. Solution shows some application of 21st Century Skills.	Presentation shows limited or no evidence of an independent learner and thinker. Solution shows limited or no understanding of the problem. Solution shows limited or no application of 21st Century Skills.