Physical Science: Energy

Stage 1 Desired Results

ESTABLISHED GOALS:

<u>*Competencies:*</u>

- ***Energy & Matter in Systems: Students will demonstrate the ability to analyze evidence from a variety of sources (investigations, models) to predict, connect and/or evaluate the cycling of matter and flow of energy within and between systems in order to understand, describe, or predict possibilities and limitations of systems.***
- ***Nature of Science: Student will demonstrate the ability to work collaboratively and individually to generate testable questions or define problems, plan and conduct investigations using a variety of research methods in a various settings, analyze and interpret data, reason with evidence to construct explanations in light of existing theory and previous research, and effectively communicate the research processes and conclusions.***
- ***Students will demonstrate the ability to analyze and summarize text and integrate knowledge to make meaning of discipline-specific materials.***
- ***Students will demonstrate the ability to produce coherent and supported writing in order to communicate effectively for a range of discipline-specific tasks, purposes, and audiences.***
- ***Students will demonstrate the ability to speak purposefully and effectively by strategically making decisions about content, language use, and discourse style.***

<u>*Content Standards:*</u>

- 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-PS3-4. 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).

Transfer

Students will be able to independently use their learning to ***make informed decisions based upon their understanding of change in energy.***

Meaning

ENDURING UNDERSTANDINGS

Students will understand that…

- 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.
- 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.
- energy cannot be created or destroyed-it only moves between one place and another place, between objects and/ or fields, or between systems.
- science assumes the universe is a vast single system in which basic laws are consistent.
- energy drives the cycling of matter within and between systems.
- 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.

ESSENTIAL QUESTIONS

- *If energy is neither created nor destroyed, where does it go?*

Acquisition

Students will know…

- that 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

Students will be skilled at…

- creating computational models to calculate change.
- developing and using models.
- designing, building, and refining a device that works within given constraints.
- planning and conducting investigations.

• HS-PS-3-5. 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-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.	continually transferred from one object to another and between its various possible forms. • that at the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. • that these relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. • that conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. • that energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • that mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. • that the availability of energy limits what can occur in any system. • that 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). • that, when two objects interacting through a field change relative position, the energy stored in the field is changed. • that, although energy cannot be destroyed, it can be converted to less useful forms—for example, to	• analyzing data and results. • using mathematical representations to support claims. • evaluating claims, evidence, and reasoning.

	thermal energy in the surrounding environment. • that 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. • that 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. • that cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. • that the geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. • that the foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. • that changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. • that, though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.	

	• that solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. • that 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. • that information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. • that waves can add or cancel one another as they cross, depending on their relative phase (i.e. relative position of peaks and troughs of the waves), but they emerge unaffected by each other. • that 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. • that when light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. • that photoelectric materials emit electrons when they absorb light of a high-enough frequency. • that multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.	

	vocabulary: kinetic theory of matter, thermal expansion, laws of thermodynamics, calories, absolute zero, energy (motion, light, sound, thermal), radiation, convection, conduction, potential, kinetic, entropy, enthalpy, waves, transverse, compressional, crest, trough, amplitude, rarefaction, Doppler effect, red shift, blue shift, interference (constructive and destructive), Electromagnetic Spectrum, photon,opaque, translucent, transparent, wavelength, frequency, intensity, loudness, pitch, acoustical resonance, reflection, refraction, diffraction, photovoltaic, wave pulses	

Content Area Literacy Standards	***21st Century Skills***
• 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. • RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. • RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. • RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. • RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*). • 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. • RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. • RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. • WHST.9-10.1 Write arguments focused on *discipline-specific content*. • WHST.9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • WHST.9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. • 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. • WHST.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. • WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.	• *make judgments and decisions* • *solve problems* • *communicate clearly* • *use systems thinking*

Stage 2 - Evidence	
Evaluative Criteria	***Assessment Evidence***
	PERFORMANCE TASK(S):
	OTHER EVIDENCE:

Stage 3 – Learning Plan	
Summary of Key Learning Events and Instruction	
Language Arts Integration	***Mathematics Integration***
• 1.OA.1 Use	• **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.** • **MP.2 - Reason abstractly and quantitatively.** • **MP.4 - Model with mathematics.**
Technology Integration	***District Materials***
• 1.OA.1 Use	

Science and Engineering Practices	
S&EP 1. Asking questions and defining problems S&EP 2. Developing and using models S&EP 3. Planning and carrying out investigations S&EP 4. Analyzing and interpreting data S&EP 5. Using mathematics and computational thinking S&EP 6. Constructing explanations (for science) and designing solutions (for engineering) S&EP 7. Engaging in argument from evidence S&EP 8. Obtaining, evaluating, and communicating information	