Physics: Energy

Stage 1 Desired Results

ESTABLISHED GOALS:

Competencies:

- ***Cause & Effect: Students will demonstrate the ability to investigate, explain, and evaluate potential causal relationships by using evidence to support claims and predictions about the mechanisms that drive those relationships.***
- ***Scale, Proportion, & Quantity: Students will demonstrate the ability to describe and represent the significance of changes in observable and non-observable phenomena in terms of relative scale, proportion, and quantity.***
- ***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.***
- ***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.***

Content Standards:

- HS-PS3-1. Create a mathematical 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-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.

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.
- 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.
- models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.
- 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.

ESSENTIAL QUESTIONS

- *What is the fundamental cause of changes in systems?*
- *Must energy be conserved?*

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

Students will be skilled at…

- creating a mathematical model to calculate change.
- developing and using models.
- designing, building, and refining a device

	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. • that at the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. • 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 changes form through work which is force applied through that change in a 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 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	that works within given constraints.

	one can tell if a given design meets them. <u>*vocabulary*</u>: P=F/A, $\Delta P=pg\Delta h$, $\sum E=PE+KE+\ldots+H$, kinetic, potential, chemical, electric, atomic, electromagnetic (light), work, system, entropy, enthalpy	
Content Area Literacy Standards		***21st Century Skills***
• 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.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. • RST.11-12.4 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 11-12 texts and topics*. • RST.11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. • RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. • 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. • RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. • WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. • WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • WHST.11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. • WHST.11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. • WHST.11-12.7 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.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.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.	• *reason effectively* • *use systems thinking* • *solve problems* • *use and manage information*

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 Science and Engineering Practices	***District Materials***
● 1.OA.1 Use ***Science and Engineering Practices***	
● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	

• 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. • Create a computational model or simulation of a phenomenon, designed device, process, or system. • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • 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 8. Obtaining, evaluating, and communicating information	