Space Science: Energy

Stage 1 Desired Results

ESTABLISHED GOALS:

<u>*Competencies:*</u>

- ***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.***
- ***Structure & Function Students will demonstrate the ability to use evidence to support claims about the relationship among structure and function of natural and human designed objects.***
- ***Stability & Change in Systems Students will demonstrate the ability to investigate and analyze static and dynamic conditions of natural and human designed systems in order to explain and predict changes over time.***
- ***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-PS3-4. 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

Transfer

*Students will be able to independently use their learning to **make models and predictions about the unknown based upon their understanding of what is known.***

Meaning

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
Students will understand that… ● cause and effect relationships can be suggested and predicted for complex natural systems by examining what is known about smaller scale mechanisms within the system. ● 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. ● new technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	● *Should society care about space?*

Acquisition

Students will know…	*Students will be skilled at…*
● 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	● creating a computational model to calculate the change. ● developing and using models. ● planning and conducting investigations.

components in the system (second law of thermodynamics). • 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-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. • HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. • HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost benefit ratios. • HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.	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. ● 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.,	● analyzing data to make a claim. ● evaluating competing design solutions.

	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, 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 Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. ● that 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 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. ● 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. *vocabulary*: solar flux, astronomical Unit (AU), Albedo, clast, gravity surface, escape velocity, average molecular velocity, differentiation, collision theory, walker cycle	

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	*reason effectively*

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.11-12.7 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.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, 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.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.	*adapt to change* *use systems thinking* *access and evaluate 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.**
Science and Engineering Practices	***District Materials***
S&EP 2. Developing and using models 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	