Physical Science Frameworks Pacing Guide
Energy and Matter
Crosscutting Concepts: Energy and Matter; Systems and systems models
Topics: Thermal energy; Electricity and magnetism; Fusion and Fission; Radioactive decay; Nuclear energy; Energy transformations
8-week Instructional Segment

Anchoring Phenomenon	GSE	Sample Lessons	Disciplinary Core Ideas	Science and Engineering Practices	Instructional Notes
Overall: How cars or rockets are powered. Lesson Level: Long after a nuclear accident, certain areas remain dangerous due to radioactive isotopes. Turning on a light switch as an example of the energy transformation changes from chemical to electrical to light. Electric cars require a	SPS4a, b, c; SPS7a, b, c, d; SPS10a, b, c	**Changes in Nuclear Structure** **Transformers** **Limit the Resistance to Learn about Electricity**	Frameworks of K-12 Science Education: ***By the end of grade 12*** **PS1.C: Nuclear Processes** ● Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve changes in nuclear binding energies. ● The total number of neutrons plus protons does not change in any nuclear process. ● Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials from the isotope ratios present. ● Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. ● All forms of electricity generation and transportation fuels have associated economic, social, and environmental costs and benefits, both short and long term. **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	Developing and using models Using mathematics and computational thinking Engaging in argument from evidence Constructing explanations Analyzing and interpreting data Planning and carrying out investigations	Additional topic, focus, and phenomena notes can be found within instructional segments. Safety: Classroom activities or demonstrations involving all forms of energy (chemical, electrical, heat, etc.) should have carefully designed safety practices in place. By the end of this unit, students are using the following language in their speaking and

relationship between electricity and magnetism.			is continually transferred from one object to another and between its various possible forms. ● At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. **PS2.B: Types of Interactions** ● Forces at a distance are explained by fields permeating space that can transfer energy through space. ● Magnets or changing electric fields cause magnetic fields; electric charges or changing magnetic fields cause electric fields. ● Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. ● The strong and weak nuclear interactions are important inside atomic nuclei—for example, they determine the patterns of which nuclear isotopes are stable and what kind of decays occur for unstable ones. **PS2.C: Stability and Instability in Physical Systems** ● Systems often change in predictable ways; understanding the forces that drive the transformations and cycles within a system, as well as the forces imposed on the system from outside, helps predict its behavior under the variety of conditions. **PS3.B: Conservation of Energy and Energy Transfer** ● 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		writing during EXPLAIN or ELABORATE. ● Conservation of energy ● Energy transformation ● Energy transfer ● Fission ● Fusion ● Radioactive decay ● Heat (Thermal energy) ● Temperature ● Flow of energy ● Electricity ● Magnetism

			system. • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. **PS3.C: Relationship Between Energy and Forces** ● Force fields (gravitational, electric, and magnetic) contain energy and can transmit energy across space from one object to another. **PS3.D: Energy in Chemical Processes and Everyday Life** ● Although energy cannot be destroyed, it can be converted to less useful forms--for example, to thermal energy in the surrounding environment. ● Energy is also stored in the electric fields between charged particles and the magnetic fields between magnets, and it changes when these objects are moved relative to one another. ● The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and energy transfers by convection, conduction, and radiation (particularly infrared and light). ● In science, heat is used only for this second meaning; it refers to energy transferred when two objects or systems are at different temperatures. ● Temperature is a measure of the average kinetic energy of particles of matter. ● The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.		

			● The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. ● Energy is transferred out of hotter regions or objects and into colder ones by the processes of conduction, convection, and radiation.		

This instructional segment will connect to all other units for the transformation of energy, the overarching theme of the physical science curriculum. Assumed prerequisites for this unit would be an understanding of atomic structure, isotopes, and chemical reactions. Additionally, a thorough understanding of energy is essential to explain force and motion, reduced work requirements for simple machines and the energy contained in certain types of waves and electromagnetic fields. As with all other instructional segments, these concepts should relate back to the overarching theme of the function of a rocket and/or car. Many energy transformations are required to power not only the motion of these vehicles, but also the operations.