**High School Domains Model Course II - Physics**

**Narrative and Rationale:** This Physics model course map is the second in a three-year course sequence that uses a customized version of the Modified High School Domains Model from NGSS Appendix K as the instructional year end goals. This course model assumes that students are grounded in the basics of chemistry and have previously spent one year in high school developing their proficiency in the NGSS Science and Engineering Practices and crosscutting concepts.

The first bundle in this course continues the study of structure and properties of matter that began in chemistry the previous year, and extends to a focus on how forces arise from the interactions between fields. The second bundle continues a focus on forces, but shifts to a study of collisions at the macroscopic scale. The third bundle focuses on forces and energy transfer when objects interact, and the fourth bundle ends the course by focusing on harnessing energy transfer for communication purposes. Throughout the course, relevant Earth and Space Sciences and Engineering Design PEs are integrated.

The bundles in this domains model guide students through the use of the SEPs, CCCs, and DCIs to answer the essential questions for each unit listed in the bundles below. It is important to note that the practices and crosscutting concepts described are intended as end-of-instructional unit expectations and not curricular designations. Additional practices and crosscutting concepts should be used throughout instruction toward each bundle.

<table>
<thead>
<tr>
<th>Bundle 1: Why Don’t We Fall Through the Floor? “6 weeks”</th>
<th>Bundle 2: How Do We Protect Ourselves From Collisions? “6 weeks”</th>
<th>Bundle 3: What Happens When Energy Moves From One Place to Another? “8 weeks”</th>
<th>Bundle 4: How Do We Use Energy to Communicate With Each Other? “4 weeks”</th>
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<tbody>
<tr>
<td>HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.</td>
<td>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.</td>
<td>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.</td>
<td>HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.</td>
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<td>HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.</td>
<td>HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.</td>
<td>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. *</td>
<td>HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.</td>
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<td>HS-PS2-4. Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.</td>
<td>HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*</td>
<td>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).</td>
<td>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.</td>
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<td>HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*</td>
<td>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.</td>
<td>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.</td>
<td>HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.</td>
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<td>HS-PS2-5. Develop and use a model of two objects interacting through electric or magnetic forces.</td>
<td>HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.</td>
<td>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.</td>
<td>HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*</td>
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<td>HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</td>
<td>HS-ETS1-2. Analyze a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, and predict the gravitational and electrostatic forces between objects.</td>
<td>HS-ETS2-3. Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection.</td>
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<td>magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</td>
<td>including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.</td>
<td>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-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</td>
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1. The bundle only includes part of this PE; the PE is not fully assessable in a unit of instruction leading to this bundle.
• 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 various possible sources.

• 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.

• Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.

• 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.

• The availability of energy limits what can occur in any system.

PS3.B as found in HS-PS3-4

• Although energy cannot be destroyed, it can be transformed from one useful form to another.

• Energy cannot be produced, transmitted, and captured in the environment.

• The geologic record shows that climates have changed over long time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term climatic cycles.

• 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.

• 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, volcanic activity, 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 climatic cycles.

PS3.D as found in HS-PS4-5

• Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy.

• The wavelength and frequency of a wave are related to another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

• Information can be digitized (e.g., a picture stored as the values of an array of pixels); this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.

• 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.

• Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.

• Photovoltaic materials emit electrons when they absorb light of a high-enough frequency.

• 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.
ETS1.C as found in HS-ETS1-3

- 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.

ESS2.B as found in 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.

ESS2.B as found in HS-ESS2-3

- 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.

ESS2.C as found in 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.

ESS2.D as found in HS-ESS2-3 and HS-ESS2-4

- 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.

ETS1.A as found in HS-ETS1-3

- 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.

ETS1.C as found in HS-ETS1-2

- 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.