**NACA Physics Year Long UbD**

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| **Stage 1 - Desired Results** |
| Directions: Choose multiple CCSS (or other standards), copy and paste them here, and unpack them for big ideas and assessment verbs by highlighting.  |
| **NGSS - Disciplinary Core Ideas** |
| PS2.A: Forces and Motion* Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)
* Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2)
* If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3)

PS2.B: Types of Interactions* Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
* Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5)

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 is continually transferred from one object to another and between its various possible forms. (HS-PS3-1),(HS-PS3-2)
* At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3)
* “Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5)

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 system. (HS-PS3-1)
* Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)
* 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. (HS-PS3-1)
* The availability of energy limits what can occur in any system. (HS-PS3-1)
* 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). (HS-PS3-4)

PS3.C: Relationship Between Energy and Forces* When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)

PS3.D: Energy in Chemical Processes* Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4)
* Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy. (secondary to HS-PS4-5)

PS4.A: Wave Properties* 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. (HS-PS4-1)
* 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. (HS-PS4-2),(HS-PS4-5)
* [From the 3–5 grade band endpoints] 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. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)

PS4.B: Electromagnetic Radiation* 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. (HS-PS4-3)
* 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. (HS-PS4-4)
* Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)

PS4.C: Information Technologies and Instrumentation* 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. (HS-PS4-5)

ESS1.B: Earth and the Solar System * Kepler’s laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4)

ESS1.C: The History of Planet Earth* Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)

ESS2.A: Earth Materials and Systems * Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),(HS-ESS2-2)
* 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. (HS-ESS2-3)

ESS2.B: Plate Tectonics and Large-Scale System Interactions * 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. (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 Grade 8 GBE) (HS-ESS2-1)

ETS1.A: Defining and Delimiting Engineering Problems* 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. (HS-ETS1-1)
* Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

ETS1.B: Developing Possible Solutions* When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)
* Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

ETS1.C: Optimizing the Design Solution* 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. (HS-ETS1-2)
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| **NGSS - Performance Expectations** |
| * 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. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]
* 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. [Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.
* 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.\* [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.
* 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.[Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.]
* HS-PS2-5.Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.]
* 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. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]
* 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.\*
* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.
* HS-PS3-5. 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. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]
* HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]
* HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.
* 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. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]
* 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. [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]
* 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.\* [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]
* HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.] [Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler’s Laws of orbital motions should not deal with more than two bodies, nor involve calculus.]
* HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core (a result of past plate interactions).]
* 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. [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] [Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth’s surface.]
* HS-ESS2-3. Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth’s three-dimensional structure obtained from seismic waves, records of the rate of change of Earth’s magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth’s layers from high-pressure laboratory experiments.]
* 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.
* 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.
* HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
* HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
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| **NGSS - Crosscutting Concepts** |
| Patterns* Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4)
* Empirical evidence is needed to identify patterns. (HS-ESS1-5)

Cause and Effect* Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1),(HS-PS2-5),(HS-PS4-1)
* Systems can be designed to cause a desired effect. (HS-PS2-3, HS-PS4-5)
* Cause and effect relationships can be suggested [and](http://www.nap.edu/openbook.php?record_id=13165&page=87) predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5), (HS-PS4-4)

Systems and System Models* When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)
* 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. (HS-PS3-1)
* 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. (HS-PS4-3)

Energy and Matter* 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. (HS-PS3-3)
* Energy drives the cycling of matter within and between systems. (HS-ESS2-3)

Stability and Change* Systems can be designed for greater or lesser stability. (HS-PS4-2)
* Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)

Scale, Proportion, and Quantity* Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4)
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| **NGSS - Science and Engineering Practices** |
| [Asking Questions and Defining Problems](http://www.nap.edu/openbook.php?record_id=13165&page=54)Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.* Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS-PS4-2)

Developing and Using ModelsModeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.* Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2),(HS-PS3-5), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-6)

Planning and Carrying Out InvestigationsPlanning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models.* 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. (HS-PS2-5)

Analyzing and Interpreting DataAnalyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.* Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS2-1)

Using Mathematics and Computational ThinkingMathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.* Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)
* Use mathematical or computational representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS2-2),(HS-PS2-4),(HS-PS4-1),(HS-ESS1-4)

Constructing Explanations and Designing SolutionsConstructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3)
* 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. (HS-PS3-3)

Engaging in Argument from EvidenceEngaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.* Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3), (HS-ESS1-5)

Obtaining, Evaluating, and Communicating InformationObtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.* Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)
* Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS4-5)
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| **NGSS - Nature of Science** |
| Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena* Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4)
* Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4)

A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-PS4-3)Scientific Knowledge Assumes an Order and Consistency in Natural Systems* Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)

Scientific Knowledge is Based on Empirical Evidence* Science knowledge is based on empirical evidence. (HS-ESS2-3)
* Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (HS-ESS2-3)
* Science includes the process of coordinating patterns of evidence with current theory. (HS-ESS2-3)
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| **NGSS - Engineering,Technology, and Applications of Science** |
| Influence of Science, Engineering and Technology on Society and the Natural World* Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3), (HS-PS4-2),(HS-PS4-5), (HS-PS4-2)
* 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. (HS-ESS2-2)

Interdependence of Science, Engineering, and Technology* Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-PS4-5), [(HS-ESS1-2),(HS-ESS1-4), (HS-ESS2-3)](http://www.nap.edu/openbook.php?record_id=13165&page=210)
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| **CCSS - ELA/Literacy** |
| 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. (HS-PS2-1),(HS-PS2-6),(HS-PS4-2),(HS-PS4-3),(HS-PS4-4),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-2),(HS-ESS2-3)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. (HS-PS2-1),(HS-PS4-1),(HS-PS4-4)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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4), (HS-ESS1-5),(HS-ESS1-6)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. (HS-PS2-3),(HS-PS2-5), (HS-PS3-3),(HS-PS3-4),(HS-PS3-5)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. (HS-PS2-5),(HS-PS3-4),(HS-PS3-5),(HS-PS4-4)WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5),(HS-PS3-4),(HS-PS3-5)WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-5)SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-1),(HS-PS3-2),(HS-PS3-5),(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4) |
| **CCSS - Mathematics** |
| MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5), (HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6), MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5),(HS-PS4-1),(HS-ESS1-1),(HS-ESS1-4), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)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. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5), (HS-PS2-6),(HS-PS3-1),(HS-PS3-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6)HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)HSA.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)HSA.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-PS2-1),(HS-PS2-2)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)(HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)HSS-ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. (HS-ESS1-6)HSF-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. (HS-ESS1-6)HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by in hand in simple cases and using technology for more complicated cases. (HS-PS2-1)HSS-IS.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-PS2-1) |
| **Indigenous Standards** |
| **Community/Service:** * Recognize, serve and sustain for future generations, a community that includes people, the environment and all living things.

**Reflection:*** Make connections between diverse culture by identifying themes and archetypes while remaining specific to a time and place.
* Evaluate diverse perspectives, claims and evidence by corroborating or challenging them with other information.
* Develop a creative learning process that uses reflection to transform and improve personal and community well-being.
* Demonstrate self-knowledge by showing meta-cognitive awareness, using productive habits of mind, and reflecting on the meaning of the learning and experience.

**Culture:*** Actively cultivate and express one’s own identity/story and find connections with other’s identity/story in order to create ongoing resilient change.
* Demonstrate empowerment through language, stories, spirituality, song, art, dance, and food.

**Respect:*** Cultivate harmonious relationships that value self, all individuals and their environment through active listening, mindfulness and thoughtful consideration in order to create places of belonging and community.

**Responsibility:*** Plan daily responsibility to our people, past-present-future, as well as our environment through words, actions and conduct that embodies trustworthiness and accountability in all that we do.

**Perseverance:*** Use self-determination, commitment and traditional cultural teachings to develop resiliency in the face of adversity.
 |
| **Other - *Other than the big ideas explicitly in the standards you chose, what big ideas might frame a unit?*** |
| * environmentalism, conservation, sustainability,
 |
| CHOSEN BIG IDEA(S):**Energy****Science and Engineering Cycles** | **Transfer** |
| **Students will be able to independently use their learning to…**I want my students to \_\_\_\_\_\_\_\_\_\_, so that in the long-run, on their own, they will be able to \_\_\_\_\_\_\_\_\_\_\_\_\_. * evaluate the reliability of scientific claims, so that they can make wise choices that affect themselves and their communities
* model natural systems and processes, so that they can analyze the effects of changes to those systems and processes
* develop and analyze solutions to engineering problems and opportunities, so that they address the challenges that affect themselves and their communities
* communicate effectively about technical issues, so that they can actively participate in decision making processes that affect themselves and their communities
 |
|
| **Meaning** |
| UNDERSTANDINGS*Students will understand that...** Energy drives all systems
* Scientific thinking helps us understand our world and make educated decisions to improve the lives of future generations.
 | ESSENTIAL QUESTIONS* How does scientific understand help us understand our world?
* How do we use science to improve the lives of future generations?
* How do we determine what is true?
 |
| **Acquisition** |
| *Students will know…** Unit 1 - Forces
	+ Master
		- Newton’s second law
		- motion
		- acceleration
		- force
		- net force
		- velocity
		- time
		- systems can be designed to cause a desired effect
		- tool
		- technology
		- model
		- validity
		- reliability
		- unanticipated effects
		- function
		- number line
		- data
	+ Spiral
		- system
		- balance
		- engineering criteria and constraints (quantification)
		- risk mitigation
		- empirical evidence
		- cause vs. correlation
		- cause and effect
		- laws
		- textual evidence
		- inconsistency
		- distinction
		- question
		- problem
		- information sources
		- units
		- formulas
		- scale
		- origin
		- graphs
		- quantity
		- accuracy
		- measurement
		- expressions
		- equivalent form of expression
		- equation
		- inequality
		- variable
		- coordinate
		- axis
		- label
		- formula
		- criteria
		- constraint
		- risk mitigation
		- design
 | *Students will be skilled at…** Unit 1 - Forces
	+ Master
		- Analyze data to make scientific claims
		- Analyze data to determine optimal design solutions
		- solving design problems
		- graph functions by hand
		- graph functions using technology
		- plot data on number lines
		- determine net force
		- measure mass
		- calculate acceleration
		- measure force
	+ Spiral
		- quantifying criteria and constraints
		- breaking down criteria
		- prioritizing criteria
		- systematically approaching criteria
		- differentiating between cause and correlation
		- making claims about specific causes and effects
		- cite specific textual evidence
		- analyze science and technical texts
		- attend to distinctions in text
		- attend to gaps and inconsistencies
		- integrate information sources
		- evaluate information sources
		- conduct research
		- synthesize multiple information sources
		- draw evidence from informational texts
		- reason quantitatively
		- reason abstractly
		- create mathematical models
		- use units to understand problems
		- use units to guide solutions
		- choose appropriate units
		- interpret units in formulas
		- interpret scale and origin on graphs and data displays
		- define quantities for modeling
		- choose appropriate accuracy levels
		- interpret expressions in context
		- choose equivalent forms of expressions
		- produce equivalent forms of an expression
		- create equations in one variable
		- create inequalities in one variable
		- use equations and inequalities to solve problems
		- create equations in two or more variables
		- graph equations on coordinate axes
		- rearrange formulas
 |
|  | * Unit 2 - Energy
	+ Master
		- energy
		- energy availability
		- system
		- model
		- assumption
		- approximation
		- precision
		- reliability
		- prediction
		- matter flows
		- energy flows
		- computational model
		- computational simulation
		- process
		- device
		- prioritization
		- trade-off
		- universe
		- laws
	+ Spiral
		- criteria
		- constraints
		- risk mitigation
 | * Unit 2 - Energy
	+ Master
		- Use models to predict system behavior
		- Identify precision and reliability limitations of predictions
		- Describe energy and matter changes in a system
		- Describe energy and matter flows into and out of a system
		- create computational models
		- create computational simulations
		- designing solutions
		- evaluating solutions
		- refining solutions
	+ Spiral
		- quantify criteria and constraints
		- research to answer questions
		- research to solve problems
		- narrow or broaden inquiry
		- synthesize multiple sources
		- present findings using digital media
		- reason abstractly
		- reason quantitatively
		- model mathematically
		- use units to understand problems
		- use units to guide solutions
		- choose appropriate units
		- interpret units in formulas
		- interpret scale and origin on graphs and data displays
		- define quantities in modeling
		- choose accuracy levels when reporting
 |
|  | Unit 3 - Momentum* Master
	+ Momentum
	+ frame of reference
	+ mass
	+ velocity
	+ system
	+ conservation of momentum (open and closed systems)
	+ boundaries
	+ initial conditions
	+ equation
	+ inequality
	+ conservation
* Spiral
	+ mathematical representations
	+ units
	+ scale
	+ origin
	+ descriptive modeling
	+ accuracy
	+ measurement limitations
	+ relationships between quantities
	+ label
	+ formula
 | Unit 3 - Momentum* Master
	+ Calculate the momentum of an object
	+ Determine the frame of reference for an object in motion
	+ describe the boundaries and initial conditions of a system
	+ investigate the momentum in a system
	+ create equations and inequalities (1 variable)
	+ use equations and inequalities to solve problems (1 var)
* Spiral
	+ create mathematical representations of phenomena
	+ reason abstractly
	+ reason quantitatively
	+ model mathematically
	+ use units to understand problems
	+ use units to guide the solution
	+ choose units for formulas
	+ interpret units in formulas
	+ choose scale and origin in graphs
	+ interpret scale and origin in graphs
	+ define quantities for descriptive modeling
	+ choose appropriate accuracy for reporting
	+ create equations w/ 2+ variables
	+ graph equations
	+ rearrange formulas
 |
|  | Unit 4 - Gravity* Master
	+ Newton’s Law of Universal Gravitation
	+ Gravitational forces
	+ orbiting objects
	+ solar system
	+ Kepler’s laws
	+ orbiting objects
	+ ellipse
	+ sun
	+ collision
	+ solar system
	+ algebraic thinking
	+ scientific data
	+ linear growth
	+ exponential growth
* Spiral
	+ mathematical representations
	+ mathematical models
	+ Forces at a distance
	+ energy transfer
	+ space
	+ phenomena
	+ Computational representations
	+ Theories
	+ laws
	+ relationships
	+ observable phenomena
	+ science
	+ engineering
	+ research & development
	+ area of expertise
	+ descriptive modeling
	+ quantitative modeling
	+ accuracy
	+ measurement limitations
	+ context
	+ equivalent form
	+ property
	+ formula
 | Unit 4 - Gravity* Master
	+ Predict gravitational forces
	+ Use Newton’s Law of Gravitation
	+ Predict the motion of orbiting objects
	+ predict the effect of a change in one variable on another
	+ describe and predict the gravitational forces between objects
* Spiral
	+ Use computational representations
	+ Use mathematical representations
	+ describe explanations
	+ reason abstractly
	+ reason quantitatively
	+ model mathematically
	+ use units to understand problems
	+ use units to guide solutions (multi-step)
	+ choose units in formulas
	+ interpet units in formulas
	+ choose scale and origin
	+ interpret scale and origin
	+ model descriptively
	+ define quantities
	+ choose appropriate level of accuracy
	+ interpret expressions in context
	+ choose equivalent forms
	+ produce equivalent forms
	+ reveal properties of quantity in expression
	+ explain properties of quantity in expressions
	+ create equations (2+ variables)
	+ graph on coordinate axes
	+ rearrange formulas
 |
|  | Unit 5 - Electricity & Magnetism* Master
	+ Coulomb’s law
	+ mathematical models
	+ electrostatic forces
	+ electric fields
	+ magnetic fields
	+ energy transfer through space
	+ electromagnetic induction
	+ electric currents
	+ electrical energy
	+ battery
	+ stored energy
	+ energy changes due to position changes
	+ patterns
	+ causality
	+ phenomena
	+ evidence
	+ scales
	+ investigation
	+ data
	+ data types
	+ accuracy
	+ reliable measurements
	+ precision limitations
	+ trials
	+ cost
	+ risk
	+ theories
	+ laws
	+ observable phenomena
	+ model
	+ forces
* Spiral
	+ mathematical representations
	+ phenomena
	+ empirical evidence
	+ cause vs correlation
	+ cause and effects
	+ claims
	+ systems
	+ natural systems
	+ human designed systems
	+ models
	+ components of systems
	+ research projects
	+ inquiry
	+ sources
	+ investigation
	+ relevant information
	+ authoritative sources
	+ strengths and limitations of sources
	+ plagiarism
	+ overreliance
	+ citation formats
	+ informational texts
	+ analysis
	+ reflection
	+ digital media
	+ findings
	+ reasoning
	+ interest
	+ units
	+ quantities
	+ descriptive modeling
	+ accuracy levels
	+ measurement limitations
	+ expressions in context
	+ equivalent forms
 | Unit 5 - Electricity & Magnetism* Master
	+ predicting electrostatic forces
	+ plan investigations
	+ conduct investigations
	+ working collaboratively
	+ making decisions about types, quantity and accuracy of data
	+ considering precision limitations
	+ predict the electrostatic forces between objects
	+ predict the electrostatic forces between objects
	+ develop a model
	+ illustrate the forces between objects in fields and the changes due to interaction
* Spiral
	+ using mathematical representations of phenomena
	+ predicting cause and effect for complex systems
	+ developing models of relationships
	+ using models of relationships
	+ conducting research projects
	+ generating research questions
	+ deciding when to narrow or broaden inquiry
	+ broadening or narrowing inquiry
	+ synthesizing sources
	+ gathering information
	+ using advanced searches
	+ assessing strengths and limitations of sources
	+ integrating information into text
	+ avoiding plagiarism
	+ following standard citation format
	+ avoiding overreliance on any one source
	+ drawing evidence from informational texts
	+ strategically use digital media
	+ reason abstractly
	+ reason quantitatively
	+ modeling mathematically
	+ using units to understand problems
	+ using units to guide solutions
	+ choosing units in formulas
	+ interpreting units in formulas
	+ choosing scale and origin
	+ interpreting scale and origin
	+ defining quantities
	+ reporting quantities
	+ choosing accuracy levels
	+ interpreting expressions in context
	+ choosing equivalent forms
	+ producing equivalent forms
	+ revealing properties of quantities in expressions
	+ explaining properties of quantities in expressions
 |
|  | Unit 6 - Waves* Mastery
	+ Mathematical representation
	+ claims
	+ support for claims
	+ relationship
	+ frequency
	+ wavelength
	+ speed
	+ waves
	+ media
	+ relationship between wavelength and frequency
	+ wave types
	+ empirical evidence
	+ Cause vs. correlation
	+ cause and effect
	+ mathematical representations
	+ claims
* Spiral
	+ sources
	+ qualitative data
	+ video
	+ multimedia
	+ abstract reasoning
	+ quantitative reasoning
	+ model
	+ expressions
	+ equivalent form
	+ formulas
 | Unit 6 - Waves* Mastery
	+ Use mathematical representations
	+ Support claims
	+ differentiate between cause and correlation
	+ make claims about cause and effect
	+ use mathematical representations
	+ design solutions
	+ describe claims and explanations
	+ support claims and explanations
* Spiral
	+ integrate sources
	+ evaluate sources
	+ using information to address a question or solve a problem
	+ reason abstractly
	+ reason quantitatively
	+ model mathematically
	+ interpret expressions in context
	+ choose equivalent forms
	+ produce equivalent forms
	+ rearrange formulas
 |
|  | Unit 7 - Electromagnetic Radiation* Mastery
	+ Waves
	+ Wave interference
	+ Peaks
	+ Troughs
	+ Electromagnetic radiation
	+ radio waves
	+ microwaves
	+ light waves
	+ model
	+ electric fields
	+ magnetic fields
	+ particles
	+ photons
	+ wave model
	+ particle model
	+ wavelength
	+ absorption
	+ energy conversion
	+ thermal energy
	+ heat
	+ ionization
	+ cause and effect
	+ natural systems
	+ human designed systems
	+ physical models
	+ mathematical models
	+ computer models
	+ energy flows
	+ information flows
	+ matter flows
	+ scale
	+ claims
	+ evidence
	+ reasoning
	+ merits of arguments
	+ validity
	+ reliability
	+ scientific and technical texts or media reports
	+ scientific theory
	+ facts
	+ confirmation
	+ observation
	+ experiment
	+ science community
	+ modification of theories
	+ information sources
	+ relevance
	+ authoritative sources
	+ strengths and limitations
	+ task
	+ purpose
	+ audience
	+ idea flow
	+ plagiarism
	+ overreliance on a source
	+ standard citation format
	+ expressions
	+ context
	+ equivalent forms
	+ formulas
	+ claims
	+ evidence
	+ reasoning
	+ frequency
* Spiral
	+
 | Unit 7 - Electromagnetic Radiation* Mastery
	+ predict cause and effect relationships from smaller scale mechanisms within systems
	+ simulate systems and interactions using models
	+ Evaluate currently accepted explanations or solutions
	+ determine the merits of arguments
	+ evaluate the validity and reliability of claims
	+ verify data when possible
	+ integrate multiple sources of information
	+ evaluate multiple sources of information
	+ address a question
	+ solve a problem
	+ gather relevant information
	+ uses advanced searches
	+ assess the strengths and limitations of sources
	+ integrate information into text
	+ avoid plagiarism
	+ avoid over reliance on a single source
	+ follow a standard format for citation
	+ interpret expressions
	+ choose equivalent forms
	+ produce equivalent forms
	+ explain properties of quantity represented by expression
	+ rearrange formulas
	+ evaluate idea of wave-particle duality
	+ evaluate validity and reliability of claims regarding effects of different frequencies of EM radiation
* Spiral
	+
 |
|  | Unit 8 - Technology* Mastery
	+ solar cell
	+ human-made devices
	+ sun’s energy
	+ electrical energy
	+ information
	+ digitize
	+ array
	+ pixels
	+ computer memory
	+ series
	+ wave pulse
	+ photoelectric material
	+ electron
	+ emission
	+ absorption
	+ ligh
	+ frequency
	+ technology
	+ waves
	+ signals
	+ systems
	+ stability
	+ questions
	+ premise
	+ argument
	+ data set
	+ suitability
	+ technical ideas or information
	+ phenomena
	+ process of development
	+ design
	+ performance
	+ process
	+ formats
	+ modify
	+ scientific knowledge
	+ engineering design practices
	+ benefits
	+ costs
	+ risks
	+ reasoning
	+ evidence
	+ author’s claim
	+ question
	+ advantage
	+ digital transmission
	+ digital information storage
	+ technical information
	+ technological devices
	+ principles of wave behavior
	+ wave interactions with matter
	+ transmitting energy
	+ capturing energy
	+ capture information
* Spiral
	+
 | Unit 8 - Technology* Mastery
	+ design systems for greater or lesser stability
	+ evaluate questions
	+ communicate technical information or ideas
	+ modify technological systems
	+ apply scientific knowledge
	+ apply engineering design practices
	+ assess reasoning and evidence in a text
	+ evaluate questions about digital transmission and storage of information
	+ communicate technical information
* Spiral
	+
 |
|  | Unit 9 - Geology* Mastery
	+ continental rocks
	+ oceanic rocks
	+ dynamic systems
	+ feedback
	+ deep probes
	+ seismic waves
	+ changes to Earth’s surface
	+ Earth’s magnetic field
	+ Earth’s layers
	+ motion in tectonic plates
	+ thermal convection
	+ energy
	+ density
	+ radioactive decay
	+ unstable isotopes
	+ energy generation in Earth
	+ inner core
	+ outer core
	+ mantle
	+ crust
	+ plate tectonics
	+ mantle convection
	+ geologic history
	+ plate movement
	+ rock & mineral distribution
	+ empirical evidence
	+ patterns
	+ Energy
	+ cycling of matter
	+ systems
	+ change
	+ rate of change
	+ irreversible change
	+ components
	+ science knowledge
	+ science disciplines
	+ rules of evidence
	+ theory
	+ patterns of evidence
	+ research and development cycle
	+ scientists
	+ engineers
	+ textual evidence
	+ hypothesis
	+ data
	+ analysis
	+ conclusion
	+ corroborate
	+ data verification
	+ informative/explanatory text
	+ technical processes
	+ scientific procedures/experiments
	+ digital media
	+ units
	+ data display
	+ origin
	+ scale
	+ quantities
	+ descriptive modeling
	+ accuracy
	+ measurement limitations
* Spiral
	+
 | Unit 9 - Geology* Mastery
	+ Identify patterns
	+ quantify change
	+ quantify rates of change
	+ model change
	+ model rates of change
	+ develop models based on evidence
	+ use models to illustrate relationships
	+ evaluate evidence
	+ evaluate explanations about natural systems
	+ coordinate patterns of evidence with current theory
	+ cite textual evidence
	+ analyze science and technical texts
	+ attend to important distinctions made by authors
	+ attend to gaps or inconsistencies in texts
	+ evaluate hypotheses, data, analysis, conclusion in science or technical text
	+ Verify data
	+ corroborate or challenge conclusions with other sources
	+ write informative/explanatory texts (scientific procedures/experiments & technical processes)
	+ make strategic use of digital media
	+ reason abstractly
	+ reason quantitatively
	+ model mathematically
	+ use units to understand problems
	+ use units to guide the solution of multi-step problems
	+ choose units in formulas
	+ interpret units in formulas
	+ choose and interpret scale and origin in graphs & data displays
	+ define quantities for descriptive modeling
	+ choose accuracy levels
	+ evaluate evidence
	+ evaluate the theory of plate tectonics
	+ develop model of Earth’s internal and surface processes
	+ Develop a model of earth’s interior
* Spiral
 |

|  |
| --- |
| **Stage 2 - Evidence** |
| **Evaluative Criteria** | **Assessment Evidence** |
| **Standards-based A+ Rubric in Student-friendly Language**

|  |
| --- |
| Asking questions and defining problems* questions and design problems are empirically testable
* questions and design problems challenge either:
	+ premise of an argument,
	+ interpretation of a data set, or
	+ suitability of a design
* evaluates question or design problem
 |
| Developing and Using Models* Develops a model
* Model is based on evidence
* Uses model to illustrate relationships
* Relationships are between either:
	+ systems, or
	+ between components of a system
 |
| Planning and Carrying Out Investigations* Plans an investigation
* conducts the investigation as planned
* Investigation designed to produce data
* Data produced serves a basis for evidence
* Design includes:
	+ decisions on types, quantity and accuracy of data needed
	+ Data decisions based on what is needed for reliable measurement
	+ considerations of limitations on data precision
	+ refinements based on considerations of limitations
 |
| Analyzing and Interpreting Data* Analyzes data
* Uses tools, technologies, and/or models
* makes valid and reliable scientific claims, OR
* determines optimal design solutions
 |
| Using mathematics and Computational thinking* Creates a computational model or simulation
* Uses mathematical or computational representation to:
	+ describe claims/explanations
	+ support claims/explanations
 |
| Constructing Explanations and Designing Solutions* Creates, evaluates, and/or refines a design solution
* Solution is based on:
	+ scientific ideas & knowledge
	+ multiple student generated sources of evidence
	+ prioritized criteria
	+ tradeoff considerations
* Takes into account possible unanticipated effects
* solution addresses complex real-world problem
 |
| Engaging in Argument from Evidence* Evaluates claims, evidence, and reasoning behind currently accepted explanations or solutions
* Determines the merits of arguments
 |
| Obtaining, Evaluating, and Communicating Information* Evaluates validity and reliability of multiple claims
* Claims come from scientific and technical texts/media reports
* Data verified when possible
* Communicates technical information idea
* Uses multiple formats to communicate
 |

 | **PERFORMANCE TASK(S):** * Analysis of a physics related community issue, including recommendations for addressing the issue
	+ Evaluation of reliability of relevant scientific claims
	+ Modeling of the systems and processes involved in the issue
	+ Using the model to analyze potential changes to the systems and processes
	+ developing and analyzing solution(s) to the issue
	+ communicating findings and recommendations in technical and comprehensible manner.

 **What (cognitive verb + big idea):**Investigate scientific questions and engineering problemsEvaluate scientific explanations and engineering solutionsDevelop scientific explanations and engineering solutions**Why (copied and pasted EUs from Stage 1):**Scientific thinking helps us understand our world and improve the lives of future generations.**How (GRASPS, written to and for students):*** **Goal:** Investigate concept/problem relevant to physics, community, and identity
* **Role:** Community Member
* **Audience:** Community
* **Situation:** Research symposium & community presentation
* **Product, Performance, and Purpose:** Presentation of findings and/or solutions
* **Standards and Criteria for Success:** Proficiency on key sections of the NACA Science & Engineering Practices Rubric
 |
|  | **Other Evidence:**Final Exam - Assesses content knowledge (EOC) |

|  |
| --- |
| **Stage 3 - Learning Plan** *What lessons will you teach, and what skills will students master, as a result of this unit?* |
| 2015-16 Curriculum Map |
| Unit Big Idea (Title) | Unit Essential Question(s) | Unit Standard(s) | Assessment(s) | Time Frame |
| What big idea anchors this unit? | What EQ will anchor conceptual, critical thinking related to the big idea? | What core standard(s) anchors this unit, and therefore what observable skills will you evaluate ? | What summative assessment will provide you evidence of skills and understanding? | What is the approximate time frame for the teaching and learning in this unit? |
| 1 - Force | How are force, mass, and acceleration mathematically related?How can we create a device that minimizes the force on an object during a collision? | * Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)
* If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3)
* 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. (HS-ETS1-1)
* 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. (HS-ETS1-2)
* Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1),(HS-PS2-5),(HS-PS4-1)
* Systems can be designed to cause a desired effect. (HS-PS2-3)
* Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS2-1)
* Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3)
* Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4)
* 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.11-12.7 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.
* 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.
* MP.2 Reason abstractly and quantitatively.
* MP.4 Model with mathematics.
* 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.
* HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context.
* HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
* HSA.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.
* HSA.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
* HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
* HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by in hand in simple cases and using technology for more complicated cases. (HS-PS2-1)
* HSS-IS.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-PS2-1)
 | 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.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.\* | Weeks 2-5 |
| 2 - Energy | How can I describe the energy changes within and between systems?How can we use energy conversion to support our communities? | * The availability of energy limits what can occur in any system. (HS-PS3-1)
* 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. (HS-ETS1-1)
* 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. (HS-PS3-1)
* 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. (HS-PS3-3)
* Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)
* 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. (HS-PS3-3)
* Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)
* Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.
* 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.
* SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
* MP.2 Reason abstractly and quantitatively.
* MP.4 Model with mathematics.
* 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.
 | 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-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.\* | Weeks 6-9 |
| 3 - Momentum | How is momentum changed/conserved in a system? | * Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2)
* If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3)
* When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)
* Use mathematical representations of phenomena to describe explanations. (HS-PS2-2),(HS-PS2-4)
* MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5), (HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6),
* MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5),(HS-PS4-1),(HS-ESS1-1),(HS-ESS1-4), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* 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. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5), (HS-PS2-6),(HS-PS3-1),(HS-PS3-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6)
* HSA.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)
* HSA.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-PS2-1),(HS-PS2-2)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
* HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)(HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
 | 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. | Weeks 10-11 |
| 4 - Gravity | What causes objects in the solar system to move the way they do? | * Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
* Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5)
* Kepler’s laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4)
* Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4)
* Use mathematical representations of phenomena to describe explanations. (HS-PS2-2),(HS-PS2-4)
* Use mathematical or computational representations of phenomena to describe explanations. (HS-PS2-2),(HS-PS2-4) (HS-PS4-1), (HS-ESS1-4)
* Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4)
* Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4)
* Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-PS4-5), (HS-ESS1-2),(HS-ESS1-4), (HS-ESS2-3)
* MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5), (HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6),
* MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5),(HS-PS4-1),(HS-ESS1-1),(HS-ESS1-4), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* 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. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5), (HS-PS2-6),(HS-PS3-1),(HS-PS3-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6)
* HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)
* HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
* HSA.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-PS2-1),(HS-PS2-2)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
* HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)(HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
 | 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.HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. | Weeks 12-14 |
| 5/6 - Electricity & Magnetism | How do the electrostatic forces between objects work?How is electrical energy converted into mechanical energy and vice versa? | * Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
* Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5)
* “Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5)
* When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)
* Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4)
* Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1),(HS-PS2-5),(HS-PS4-1)
* 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. (HS-PS3-5), (HS-PS4-4)
* Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2),(HS-PS3-5), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-6)
* 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. (HS-PS2-5)
* Use mathematical representations of phenomena to describe explanations. (HS-PS2-2),(HS-PS2-4), (HS-PS4-1)
* Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4)
* Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4)
* 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. (HS-PS2-3),(HS-PS2-5), (HS-PS3-3),(HS-PS3-4),(HS-PS3-5)
* 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. (HS-PS2-5),(HS-PS3-4),(HS-PS3-5),(HS-PS4-4)
* WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5),(HS-PS3-4),(HS-PS3-5)
* SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-1),(HS-PS3-2),(HS-PS3-5),(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4)
* MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5), (HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6),
* MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5),(HS-PS4-1),(HS-ESS1-1),(HS-ESS1-4), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* 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. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5), (HS-PS2-6),(HS-PS3-1),(HS-PS3-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6)
* HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)
* HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
 | 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.HS-PS2-5.Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.HS-PS3-5.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. | Weeks 19-22 |
| 7 - Waves | How do waves move? | * 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. (HS-PS4-1)
* Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1),(HS-PS2-5),(HS-PS4-1)
* Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations (HS-PS2-2),(HS-PS2-4), (HS-PS4-1).
* 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. (HS-PS2-1),(HS-PS4-1),(HS-PS4-4)
* MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5), (HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6),
* MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5),(HS-PS4-1),(HS-ESS1-1),(HS-ESS1-4), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)
* HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
* HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)(HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
 | HS-PS4-1.Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. | Weeks 23-24 |
| 8 - Electromagnetic Radiation | Is light a wave or a particle?How do different types of light affect matter? | * [From the 3–5 grade band endpoints] 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. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)
* 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. (HS-PS4-3)
* 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. (HS-PS4-4)
* 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. (HS-PS3-5), (HS-PS4-4)
* 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. (HS-PS4-3)
* Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3)
* Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)
* A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-PS4-3)
* 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. (HS-PS2-1),(HS-PS2-6),(HS-PS4-2),(HS-PS4-3),(HS-PS4-4),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-2),(HS-ESS2-3)
* 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. (HS-PS2-1),(HS-PS4-1),(HS-PS4-4)
* 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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)
* 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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4), (HS-ESS1-5),(HS-ESS1-6)
* 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. (HS-PS2-5),(HS-PS3-4),(HS-PS3-5),(HS-PS4-4)
* MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5), (HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6),
* HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)
* HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
* HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)(HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
 | 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.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.  | Weeks 25-27 |
| 9 - Technology | How does digital technology affect our world?How can we use the principles of wave behavior to help our communities?This seems broad, help the communities with what specifically? | * Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy. (secondary to HS-PS4-5)
* 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. (HS-PS4-2),(HS-PS4-5)
* Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)
* 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. (HS-PS4-5)
* Systems can be designed for greater or lesser stability. (HS-PS4-2)
* Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS-PS4-2)
* Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS4-5)
* Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3), (HS-PS4-2),(HS-PS4-5), (HS-PS4-2)
* 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. (HS-PS2-1),(HS-PS2-6),(HS-PS4-2),(HS-PS4-3),(HS-PS4-4),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-2),(HS-ESS2-3)
* 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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)
* 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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4), (HS-ESS1-5),(HS-ESS1-6)
* WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-5)
 | HS-PS4-2.Evaluate questions about the advantages of using a digital transmission and storage of information.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.\*  | Weeks 28-29 |
| 10 - Geology | How do the Earth’s internal structure and processes affect our lives? | * Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)
* Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),(HS-ESS2-2)
* 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. (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. (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 Grade 8 GBE) (HS-ESS2-1)
* Empirical evidence is needed to identify patterns. (HS-ESS1-5)
* Energy drives the cycling of matter within and between systems. (HS-ESS2-3)
* Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)
* Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2),(HS-PS3-5), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-6)
* Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5)
* Science knowledge is based on empirical evidence. (HS-ESS2-3)
* Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (HS-ESS2-3)
* Science includes the process of coordinating patterns of evidence with current theory. (HS-ESS2-3)
* Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-PS4-5), (HS-ESS1-2),(HS-ESS1-4), (HS-ESS2-3)
* 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. (HS-PS2-1),(HS-PS2-6),(HS-PS4-2),(HS-PS4-3),(HS-PS4-4),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-2),(HS-ESS2-3)
* 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. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4), (HS-ESS1-5),(HS-ESS1-6)
* WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-5)
* SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-1),(HS-PS3-2),(HS-PS3-5),(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4)
* MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5), (HS-PS4-1),(HS-PS4-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6),
* MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5),(HS-PS4-1),(HS-ESS1-1),(HS-ESS1-4), (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* 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. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6),(HS-PS3-1),(HS-PS3-3), (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)
* HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5), (HS-PS2-6),(HS-PS3-1),(HS-PS3-3),(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6)
 | HS-ESS1-5.Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.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.HS-ESS2-3.Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection. | Weeks 31-35 |