TOWNSHIP OF UNION PUBLIC SCHOOLS

Physics
Curriculum Guide
2016

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TOWNSHIP OF UNION PUBLIC SCHOOLS

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Curriculum Committee
Physics

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Mission Statement

The mission of the Township of Union Public Schools is to build on the foundations of honesty, excellence, integrity, strong family, and community partnerships. We promote a supportive learning environment where every student is challenged, inspired, empowered, and respected as diverse learners. Through cultivation of students' intellectual curiosity, skills and knowledge, our students can achieve academically and socially, and contribute as responsible and productive citizens of our global community.

District Philosophy

The Township of Union Public School District, as a societal agency, reflects democratic ideals and concepts through its educational practices. It is the belief of the Board of Education that a primary function of the Township of Union Public School System is the formulation of a learning climate conducive to the needs of all students in general, providing therein for individual differences. The school operates as a partner with the home and community.

Conceptual Physics is an approach to physics that will stimulate students' higher level cognitive skills and encourage them to see science everywhere. The three step learning cycle developed for Conceptual

Course Description

Physics builds students understand through exploration, develops comprehension through demonstrations and thought provoking questioning, culminating with students applying what they have learned through a variety of inquiry-based activities.

Conceptual Physics at UHS will focus on hands on activities designed to replicate the team based experience students should expect to find in a college level science course. This course is to be taught at the college prep level and will include a broad survey of physics and engineering topics. Students are expected to use both mathematical and language arts skills to document their understanding and growth while learning about the world around them through a new perspective.

Recommended Textbooks

Hewitt, Paul G. "Conceptual Physics." Third Edition, 2009, Pearson Education, Upper Saddle River, NJ

Course Proficiencies

Students will be able to…

1. Read, interpret and display graphical information.

2. Demonstrate understanding of linear, exponential, and circular motion.

3. Use their knowledge of the transformation of energy to interpret the world around them.

4. Use skills and equations to understand the fundamental forces that drive the universe.

4. Explain mathematically and conceptually the physical concepts of heat.

5. Explain mathematically and conceptually the different types of waves and how waves propagate.

6. Understand the intricate relationship between electricity and magnetism and their consequences on the universe.

7. How sub atomic forces dictate the properties of the macroscopic world and the probabilistic nature of particles.

9. Use mathematical and logical reasoning.

10. Design experiments, execute them and interpret the results.

Curriculum Units and Pacing

Unit 1: Force and Motion 25 Instructional Days
In this unit of study, students are expected to plan and conduct investigations, analyze data and using math to support claims, and apply scientific ideas to solve design problems students in order to develop an understanding of ideas related to why some objects keep moving and some objects fall to the ground. Students will also build an understanding of forces and Newton's second law. Finally, they will develop an understanding that the total momentum of a system of objects is conserved when there is no net force on the system. Students are also able to apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. The crosscutting concepts of patterns, cause and effect, and systems and systems models are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in planning and conducting investigations, analyzing data and using math to support claims, and applying scientific ideas to solve design problems and to use these practices to demonstrate understanding of the core ideas. This unit is based on HS-PS2-1, HS-PS2-2, HS-PS2-3, HS-ETS1-2, and HS-ETS1-3
Unit 2: Fundamental Forces 20 Instructional Days
In this unit of study, students plan and conduct investigations and apply scientific ideas to make sense of Newton's law of gravitation and Coulomb's Law. They apply these laws to describe and predict the gravitational and electrostatic forces between objects. The crosscutting concept of patterns is called out as an organizing concept for this disciplinary core idea. Students are expected to demonstrate proficiency in planning and conducting investigations and applying scientific ideas to demonstrate an understanding of core ideas. This unit is based on HS-PS2-4.
Unit 3: Kepler's Laws 15 Instructional Days
In this unit of study, students use mathematical and computational thinking to examine the processes governing the workings of the solar system and universe. The crosscutting concepts of scale, proportion, and quantity are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in using mathematical and computational thinking and to use this practice to demonstrate understanding of core ideas. This unit is based on HS-ESS1-4.
Unit 4: Energy 25 Instructional Days
In this unit of study, students develop and use models, plan and carry out investigations, use computational thinking and design solutions as they

make sense of the disciplinary core idea. The disciplinary core idea of Energy is broken down into subcore ideas: definitions of energy, conservation of energy and energy transfer, and the relationship between energy and forces. Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter, and the total change of energy in any system is equal to the total energy transferred into and out of the system. Students also demonstrate their understanding of engineering principles when they design, build, and refine devices associated with the conversion of energy. The crosscutting concepts of cause and effect, systems and systems models, energy and matter, and the influence of science, engineering, and technology on society and the natural world are further developed in the performance expectations. Students are expected to demonstrate proficiency in developing and using models, planning and carry out investigations, using computational thinking and designing solutions, and they are expected to use these practices to demonstrate understanding of core ideas.

This unit is based on HS-PS3-2, HS-PS3-1, HS-PS3-3, HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, and HS-ETS1-4.

Unit 5: Physics of the Geosphere
15 Instructional Days

In this unit of study, students construct explanations for the scales of time over which Earth processes operate. An important aspect of Earth and space sciences involves making inferences about events in Earth's history based on a data record that is increasingly incomplete the farther one goes back in time. A mathematical analysis of radiometric dating is used to comprehend how absolute ages are obtained for the geologic record. Students develop models and explanations for the ways that feedback among different Earth systems controls the appearance of the Earth's surface. Central to this is the tension between internal systems, which are largely responsible for creating land at Earth's surface (e.g., volcanism and mountain building), and the sun-driven surface systems that tear down land through weathering and erosion. Students demonstrate proficiency in developing and using models, constructing explanations, and engaging in argument from evidence. The crosscutting concepts of stability and change, energy and matter, and patterns are called out as organizing elements of this unit.

This unit is based on HS-ESS2-1, HS-ESS2-3, HS-ESS1-5, and HS-ESS2-2

Unit 6: Wave Properties
20 Instructional Days

In this unit of study, students apply their understanding of how wave properties can be used to transfer information across long distances, store information, and investigate nature on many scales. The crosscutting concept of cause and effect is highlighted as an organizing concept for these disciplinary core ideas. Students are expected to demonstrate proficiency in using mathematical thinking, and to use this practice to demonstrate understanding of the core idea.

This unit is based on HS-PS4-1.

Unit 7: Electromagnetic Radiation
30 Instructional Days

In this unit of study, students are able to apply their understanding of wave properties to make sense of how electromagnetic radiation can be used to transfer information across long distances, store information, and be used to investigate nature on many scales. Models of electromagnetic radiation as both a wave of changing electrical and magnetic fields or as particles are developed and used. Students also demonstrate their understanding of engineering ideas by presenting information about how technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. The crosscutting concepts of systems and system models; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are highlighted as organizing concepts. Students are expected to demonstrate proficiency in asking questions, engaging in argument from evidence, and obtaining, evaluating, and communicating information, and they are expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on HS-PS4-3, HS-PS4-4, HS-PS4-5, HS-ETS1-1, HS-ETS1-3, and HS-PS4-2.

Unit 8: Electricity and Magnetism
15 Instructional Days

In this unit of study, students' understanding of how forces at a distance can be explained by fields, why some materials are attracted to each other while other are not, how magnets or electric currents cause magnetic fields, and how charges or changing magnetic fields cause electric fields. The crosscutting concept of cause and effect is called out as an organizing concept. Students are expected to demonstrate proficiency in planning and conducting investigations and developing and using models.

This unit is based on HS-PS2-5 and HS-PS3-5.

Unit 1: Forces and Motion
Unit Summary
How can one explain and predict interactions between objects and within systems of objects? In this unit of study, students are expected to *plan and conduct investigations*, *analyze data and using math to support claims*, and *apply scientific ideas to solve design problems* students in order to develop an understanding of ideas related to why some objects keep moving and some objects fall to the ground. Students will also build an understanding of forces and Newton's second law. Finally, they will develop an understanding that the total momentum of a system of objects is conserved when there is no net force on the system. Students are also able to apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. The crosscutting concepts of *patterns*, *cause and effect*, and *systems and systems models* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in *planning and conducting investigations*, *analyzing data and using math to support claims*, and *applying scientific ideas to solve design problems* and to use these practices to demonstrate understanding of the core ideas.
Student Learning Objectives
Given a graph of position or velocity as a function of time, recognize in what time intervals the position, velocity and acceleration of an object are positive, negative, or zero and sketch a graph of each quantity as a function of time. **(PS2.A)**
Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. **(PS2.A)**
Understand and apply the relationship between the net force exerted on an object, its inertial mass, and its acceleration to a variety of situations. **(PS2.A)**
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-PS2-1)**
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. **(HS-PS2-2)**
Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. **(HS-PS2-3)**
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-ETS1-2)**
Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. **(HS-ETS1-3)**

Concepts	Formative Assessment *Students who understand the concepts are able to:*
• Theories and laws provide explanations in science. • Laws are statements or descriptions of the relationships among observable phenomena. • Empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. • Newton's second law accurately predicts changes in the motion of macroscopic objects.	• Analyze data using tools, technologies, and/or models 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. • Analyze data using one-dimensional motion at nonrelativistic speeds 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.
• Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. • 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. • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.	• 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. • Use mathematical representations of the quantitative conservation of momentum and the qualitative meaning of this principle in systems of two macroscopic bodies moving in one dimension. • Describe the boundaries and initial conditions of a system of two macroscopic bodies moving in one dimension.
• 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. • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and the criteria and constraints should be quantified to the extent possible and stated in such a way that one can determine whether a given design meets them. • Criteria may need to be broken down into simpler ones that can be	• Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. • Apply scientific ideas to solve a design problem for a device that minimizes the force on a macroscopic object during a collision, taking into account possible unanticipated effects. • Use qualitative evaluations and /or algebraic manipulations to design and refine a device that minimizes the force on a macroscopic object during a collision.

approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. • 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. • 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. • Systems can be designed to cause a desired effect.	

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting 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 Thinking** • Use mathematical representations of phenomena to describe explanations. (HS-PS2-2) **Constructing Explanations and Designing Solutions** • Apply scientific ideas to solve a design problem, taking into account possible	**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) **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS21) • Systems can be designed to cause a desired effect. (HS-PS2-3) **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) --- **Connections to Engineering, Technology,**

unanticipated effects. (HSPS2-3) • Design a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	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. (secondary to HS-PS23) **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 (tradeoffs) may be needed. (secondary to (HS-PS2-3) **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)	**and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World** • 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-ETS1-3) **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-1) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1)

English Language Arts	Mathematics
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) **RST.11-12.1** 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) **RST.11-12.7** 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-ETS1-3) **RST.11-12.8** Synthesize information from a range of sources (e.g., texts, experiments,	Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) **MP.2** Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) **MP.4** 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) **HSN.Q.A.1** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2) **HSN.Q.A.2**

simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-3) **RST.11-12.9** 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-ETS1-3) **WHST.11-12.7** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1) **WHST.11-12.9**	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2) **HSN.Q.A.3** Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1) **HSA.SSE.A.1** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. **HSA.SSE.B.3** (HS-PS2-1) Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2) **HSA.CED.A.1** 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) **HSA.CED.A.2** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) **HSA.CED.A.4** 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) **HSF-IF.C.7** Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-PS2-1) **HSS-IS.A.1**

Activities
Phet Simulation (phet.colorado.edu) "Forces in One Dimension": Explore the forces at work when you try to push a filing cabinet. Create an applied force and see the resulting friction force and total force acting on the cabinet. Charts show the forces, position, velocity, and acceleration vs. time. View a Free Body Diagram of all the forces (including gravitational and normal forces). "Forces and Motion": Explore the forces at work when you try to push a filing cabinet. Create an applied force and see the resulting friction force and total force acting on the cabinet. Charts show the forces, position, velocity, and acceleration vs. time. View a Free Body Diagram of all the forces (including gravitational and normal forces).

"Parachute and Terminal Velocity": How does an object's speed change as it falls through the atmosphere? When first learning about how objects fall, usually just one force—gravity—is considered. Such a simplification only accurately describes falling motion in a vacuum. This model of a parachute carrying a load incorporates a second force—air resistance—and allows experimentation with two variables that affect its speed: the size of the parachute and the mass of its load. This model graphs both the parachute's height above the Earth's surface and its speed after it is released. Motion continues until a constant speed is achieved, the *terminal velocity*.

Have the students

- design hypothetical vehicles to take advantage of their knowledge of motion and mechanics
- Create a seatbelt safety video using the concepts of Newton's laws of motion.
- Design their own experiments based on mechanics.
- Create an updateable poster of all physics quantities and their units.
- Create and record a lesson for a middle school class.
- Research and present a topic that goes beyond what the book explains.
- participate in in-class demonstrations
- work in groups to solve problems on chalk boards
- use the computers to research topics before they are formally taught

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Cite specific textual evidence 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.
- Integrate and evaluate multiple sources of information presented in diverse formats and media in order 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.
- Draw evidence from informational texts 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.
- Conduct short as well as more sustained research projects to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
- Integrate and evaluate multiple sources of information presented in diverse formats and media in order to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
- Evaluate the hypotheses, data, analysis, and conclusions in a scientific or technical text in order to refine a device that minimizes the force on a macroscopic object during a collision.
- Analyze multiple sources to inform design decisions.

Mathematics

- Represent 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 symbolically and manipulate the representative symbols. Make sense of quantities and relationships among net force on a macroscopic object, its mass, and its acceleration.
- Use a mathematical model to describe how Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. Identify important quantities representing the net force on a macroscopic object, its mass, and its acceleration and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.
- Use units as a way to understand how Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. Choose and interpret units consistently in Newton's second law of motion, and choose and interpret the scale and origin in graphs and data displays representing the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- Define appropriate quantities for the purpose of descriptive modeling of Newton's second law of motion.

Unit 2: Fundamental Forces
Unit Summary
How can one explain and predict interactions between objects and within systems of objects? In this unit of study, students plan and conduct investigations and apply scientific ideas to make sense of Newton's law of gravitation and Coulomb's Law. They apply these laws to describe and predict the gravitational and electrostatic forces between objects. The crosscutting concept of *patterns* is called out as an organizing concept for this disciplinary core idea. Students are expected to demonstrate proficiency in *planning and conducting investigations* and *applying scientific ideas* to demonstrate an understanding of core ideas.
Student Learning Objectives
Make predictions about the sign and relative quantity of net charge of objects or systems after various charging processes. (PS2.B)
Construct an explanation of a model of electric charge, and make a qualitative prediction about the distribution of positive and negative electric charges within neutral systems as they undergo various processes. (PS2.B)
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-PS2-4)

Concepts	Formative Assessment *Students who understand the concepts are able to:*
• Newton's Law of Universal Gravitation provides the mathematical models to describe and predict the effects of gravitational forces between distant objects. • Forces at a distance are explained by fields (gravitational) permeating space that can transfer energy through space. • 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 the gravitational force between objects.	• Use mathematical representations of phenomena to describe or explain how gravitational force is proportional to mass and inversely proportional to distance squared. • Demonstrate how Newton's Law of Universal Gravitation provides explanations for observed scientific phenomena. • Observe patterns at different scales to provide evidence for gravitational forces between two objects in a system with two objects.
• Coulomb's Law provides the mathematical models to describe and	• Use mathematical representations of phenomena to describe or

predict the effects of electrostatic forces between distant objects. • Forces at a distance are explained by fields (electric and magnetic) that permeate space and can transfer energy through space. • Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. • 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 electrostatic attraction and repulsion.	explain how electrostatic force is proportional to charge and inversely proportional to distance squared. • Use mathematical representations of Coulomb's Law to predict the electrostatic forces between two objects in systems with two objects. • Observe patterns at different scales to provide evidence for electrostatic forces between two objects in systems with two objects.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking • Use mathematical representations of phenomena to describe explanations. (HS-PS2-4)	**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)	**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) - - - - - - - - - - - - - - - - ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-4) Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)

English Language Arts	Mathematics
	Mathematics Choose a level of accuracy appropriate to limitations on measurement

	when reporting quantities. (HS-PS2-4) **HSN.Q.A.3** Interpret expressions that represent a quantity in terms of its context. (HS-PS2-4) **HSA.SSE.A.1** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-4) **HSA.SSE.B.3** Reason abstractly and quantitatively. (HS-PS2-4) **MP.2** Model with mathematics. (HS-PS2-4) **MP.4** 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-PS2-4) **HSN.Q.A.1** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-4) **HSN.Q.A.2**

Activities
Phet Simulation (phet.colorado.edu) "Gravity Force Lab": Visualize the gravitational force that two objects exert on each other. Adjust properties of the objects to see how changing the properties affect the gravitational attraction. "Graphical Relationships in Electric Fields": Activity uses the simulations to generate data to be analyzed. Allows for graphical analysis and equations related to voltage and Coulombs Law. "Electrostatics": Use a series of interactive models and games to explore electrostatics. Learn about the effects positive and negative charges have on one another, and investigate these effects further through games. Learn about Coulomb's law and the concept that both the distance between the charges and the difference in the charges affect the strength of the force. Explore polarization at an atomic level, and learn how a material that does not hold any net charge can be attracted to a charged object. Have the students - Design their own experiments. - Create an updateable poster of all physics quantities and their units.

- Create and record a lesson for a middle school class.
- Research and present a topic that goes beyond what the book explains.
- participate in in-class demonstrations
- work in groups to solve problems on chalk boards
- use the computers to research topics before they are formally taught

Connecting with Other Courses

Physical science

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That a single quantity called energy exists 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.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position) of the particles. In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

Earth and space science

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- The Big Bang theory is supported by observations of distant galaxies receding from our own, by the measured composition of stars and nonstellar gases, and by the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova

stage and explode.

- 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.
- Continental rocks, which can be more than 4 billion years old, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.
- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. Water's physical and chemical properties include its exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.
- Resource availability has guided the development of human society.
- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Unit 3: Kepler's Laws
Unit Summary
How was it possible for NASA to intentionally fly into Comet Tempel 1? In this unit of study, students *use mathematical and computational thinking* to examine the processes governing the workings of the solar system and universe. The crosscutting concepts of *scale, proportion, and quantity* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in *using mathematical and computational thinking* and to use this practice to demonstrate understanding of core ideas.
Student Learning Objectives
Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. (HS-ESS1-4)

Concepts	Formative Assessment *Students who understand the concepts are able to:*
• 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. • 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).	• Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. • Use mathematical and computational representations of Newtonian gravitational laws governing orbital motion that apply to moons and human-made satellites. • Use algebraic thinking to examine scientific data and predict the motion of orbiting objects in the solar system.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematical and Computational Thinking • Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)	**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)	**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) --- **Connection to Engineering, Technology, and Applications of Science** **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-ESS1-4)

English Language Arts	Mathematics
	Reason abstractly and quantitatively. (HS-ESS1-4) **MP.2** Model with mathematics. (HS-ESS1-4) **MP.4** 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-ESS1-4) **HSN-Q.A.1** Define appropriate quantities for the purpose of descriptive modeling.

	(HS-ESS1-4) **HSN-Q.A.2** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-4) **HSN-Q.A.3** Interpret expressions that represent a quantity in terms of its context. (HS-ESS1-4) **HSA-SSE.A.1** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-ESS1-4) **HSA-CED.A.2** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-ESS1-4) **HSA-CED.A.4**

Activities

Phet Simulation (phet.colorado.edu)

"Gravity Force Lab" - Students will use the Gravity Force Lab PhET Simulation to investigate what the gravitational force between two objects depends on and experimentally determine the Universal Gravitational constant, G.

Have the students

- design hypothetical vehicles to take advantage of their knowledge of motion and mechanics
- Create a seatbelt safety video using the concepts of Newton's laws of motion.
- Design their own experiments based on mechanics.
- Create an updateable poster of all physics quantities and their units.
- Create and record a lesson for a middle school class.
- Research and present a topic that goes beyond what the book explains.
- participate in in-class demonstrations
- work in groups to solve problems on chalk boards
- use the computers to research topics before they are formally taught
- calculate and model planetary orbits

Connecting to Other Courses

Physical Science

- 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.
- 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.

  Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Unit 4: Energy
Unit Summary
How is energy transferred and conserved? In this unit of study, students *develop and use models, plan and carry out investigations, use computational thinking and design solutions* as they make sense of the disciplinary core idea. The disciplinary core idea of *Energy* is broken down into subcore ideas: *definitions of energy, conservation of energy* and *energy transfer*, and *the relationship between energy and forces*. Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter, and the total change of energy in any system is equal to the total energy transferred into and out of the system. Students also demonstrate their understanding of engineering principles when they design, build, and refine devices associated with the conversion of energy. The crosscutting concepts of *cause and effect, systems and systems models, energy and matter, and the influence of science, engineering, and technology on society and the natural world* are further developed in the performance expectations. Students are expected to demonstrate proficiency in *developing and using models, planning and carry out investigations, using computational thinking and designing solutions*, and they are expected to use these practices to demonstrate understanding of core ideas.
Student Learning Objectives
Identify and quantify the various types of energies within a system of objects in a well-defined state, such as elastic potential energy, gravitational potential energy, kinetic energy, and thermal energy and represent how these energies may change over time. **(PS3.A and PS3.B)**
Calculate changes in kinetic energy and gravitational potential energy of a system using representations of that system. **(PS3.A)**
Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). **(HS-PS3-2)**
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-PS3-1)**
Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy **(HS-PS3-3)**
Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **(HS-ETS1-1)**
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-ETS1-2)**
Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost,

safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. **(HS-ETS1-3)**
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. **(HS-ETS1-4)**

Concepts	Formative Assessment *Students who understand the concepts are able to:*
• Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. • These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). • In some cases, the relative position energy can be thought of as stored in fields (which mediate interactions between particles). • Radiation is a phenomenon in which energy stored in fields moves across spaces. • Energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems.	• Develop and use models based on evidence to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with motions of particles (objects) and energy associated with the relative position of particles (objects). • Develop and use models based on evidence to illustrate that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. • Use mathematical expressions to quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compressions of a spring) and how kinetic energy depends on mass and speed. • Use mathematical expressions and the concept of conservation of energy to predict and describe system behavior.
• 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. • Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or	• Use basic algebraic expressions or computations to create a computational model to calculate the change in the energy of one component in a system (limited to two or three components) when the change in energy of the other component(s) and energy flows in and out of the system are known. • Explain the meaning of mathematical expressions used to model the

out of the system. • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • The availability of energy limits what can occur in any system. • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximation inherent in models. • Science assumes that the universe is a vast single system in which basic laws are consistent.	change in the energy of one component in a system (limited to two or three components) when the change in energy of the other component(s) and out of the system are known.
• At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. • 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. • 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. • News 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. • 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.	• Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • Analyze a device to convert one form of energy into another form of energy by specifying criteria and constraints for successful solutions. • Use mathematical models and/or computer simulations to predict the effects of a device that converts one form of energy into another form of energy.

• Humanity faces major global challenges today, such as the need for supplies of clean water or for energy sources that minimize pollution that can be addressed through engineering. These global challenges also may have manifestations in local communities.	

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2) **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1) • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** • 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	**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-PS3-2) • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) • These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be	**Systems and System Models** • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (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-ETS1-4) **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 cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or

tradeoff considerations. (HS-PS3-3) **Asking Questions and Defining Problems** • Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Constructing Explanations and Designing Solutions** • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) **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) • 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) **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)	between systems. (HS-PS3-2) - - - - - - - - - - - - - - - - ***Connections to 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) • 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-ETS1-1) (HS-ETS1-3) - - - - - - - - - - - - - - - - *Connections to Nature of Science* **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)

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ETS1.A: Defining and Delimiting an Engineering Problem

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. (secondary to HS-PS3-3)

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)

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	• 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)	

English Language Arts	Mathematics
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-PS1-3) **RST.11-12.1** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2) **WHST.9-12.2** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2),(HS-ETS1-3) **WHST.9-12.5** 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	Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) **MP.2** Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) **MP.4** 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-PS1-2),(HS-PS1-3) **HSN-Q.A.1**

investigation. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.7** 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-PS1-3),(HS-ETS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.11-12.8** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-1),(HS-ETS1-3) **WHST.9-12.9** 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-PS1-4) **SL.11-12.5**	

Activities
Phet Simulation (phet.colorado.edu) "Energy Skate Park: Basics": Learn about conservation of energy with a skater gal! Explore different tracks and view the kinetic energy, potential energy and friction as she moves. Build your own tracks, ramps, and jumps for the skater. Have the students - design hypothetical vehicles to take advantage of their knowledge of motion and mechanics - Create a seatbelt safety video using the concepts of Newton's laws of motion. - Design their own experiments based on mechanics. - Create an updateable poster of all physics quantities and their units. - Create and record a lesson for a middle school class. - Research and present a topic that goes beyond what the book explains. - participate in in-class demonstrations - work in groups to solve problems on chalk boards - use the computers to research topics before they are formally taught - have students design a roller coaster

- build mousetrap cars
- build egg drop challenge
- have students research alternative energy methods and create a report

Connecting to Other Courses

English Language Art/Literacy

- Make strategic use of digital media in presentations to enhance understanding of the notion that energy is a quantitative property of a system and that the change in the energy of one component in a system can be calculated when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Make strategic use of digital media in presentations to support the claim that energy at the macroscopic scale can be accounted for as a combination of energy associated with motions of particles (objects) and energy associated with the relative position of particles (objects).
- Conduct short as well as more sustained research projects to describe energy conversions as energy flows into, out of, and within systems.
- Integrate and evaluate multiple sources of information presented in diverse formats and media to describe energy conversions as energy flows into, out of, and within systems.
- Evaluate scientific text regarding energy conversions to determine the validity of the claim that although energy cannot be destroyed, it can be converted into less useful forms.
- Compare different sources of information describing energy conversions to create a coherent understanding of energy flows into, out of, within, and between systems.

Mathematics

- Represent symbolically an explanation about the notion that energy is a quantitative property of a system and that the change in the energy of one component in a system can be calculated when the change in energy of the other component(s) and energy flows in and out of the system are known, and manipulate the representing symbols. Make sense of quantities and relationships about 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 symbolically, and manipulate the representing symbols.
- Use a mathematical model to explain the notion that energy is a quantitative property of a system and that the change in the energy of one component in a system can be calculated when the change in energy of the other component(s) and energy flows in and out of the system are known. Identify important quantities in energy of components in systems and map their relationships using tools. Analyze those relationships

mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.

- Use units as a way to understand how the change in the energy of one component in a system can be calculated when the change in energy of the other component(s) and energy flows in and out of the system are known; choose and interpret units consistently in formulas representing how the change in the energy of one component in a system can be calculated when the change in energy of the other component(s) and energy flows in and out of the system are known; choose and interpret the scale and the origin in graphs and data displays representing that the energy of one component in a system can be calculated when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Define appropriate quantities for the purpose of descriptive modeling of how the quantitative change in energy of one component in a system can be calculated when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities representing how the energy of one component in a system can be calculated when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Represent symbolically that energy at the macroscopic scale can be accounted for as a combination of energy associated with motions of particles (objects) and energy associated with the relative position of particles (objects), and manipulate the representing symbols. Make sense of quantities and relationships between the energy associated with motions of particles (objects) and energy associated with the relative position of particles (objects).
- Represent the conversion of one form of energy into another symbolically, considering criteria and constraints, and manipulate the representing symbols. Make sense of quantities and relationships in the conversion of one form of energy into another.
- Use a mathematical model of how energy at the macroscopic scale can be accounted for as a combination of energy associated with motions of particles (objects) and energy associated with the relative position of particles (objects). Identify important quantities representing how the energy at the macroscopic scale can be accounted for as a combination of energy associated with motions of particles (objects) and energy associated with the relative position of particles (objects), and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.
- Use a mathematical model to describe the conversion of one form of energy into another and to predict the effects of the design on systems and/or interactions between systems. Identify important quantities in the conversion of one form of energy into another and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.
- Use units as a way to understand the conversion of one form of energy into another; choose and interpret units consistently in formulas representing energy conversions as energy flows into, out of, and within systems; choose and interpret the scale and the origin in graphs and data displays representing energy conversions as energy flows into, out of, and within systems.

- Define appropriate quantities for the purpose of descriptive modeling of a device to convert one form of energy into another form of energy.

  Choose a level of accuracy appropriate to limitations on measurement when reporting quantities of energy conversions as energy flows into, out of, and within systems.

Physical science

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.
- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places elements with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- A stable molecule has less energy than the same set of atoms separated; at least this much energy must be provided in order to take the molecule apart.
- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the number of all types of molecules present.

  The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

Unit 5: Physics of the Geosphere
Unit Summary
How much force and energy is needed to move a continent? In this unit of study, students construct explanations for the scales of time over which Earth processes operate. An important aspect of Earth and space sciences involves making inferences about events in Earth's history based on a data record that is increasingly incomplete the farther one goes back in time. A mathematical analysis of radiometric dating is used to comprehend how absolute ages are obtained for the geologic record. Students develop *models and explanations* for the ways that feedback among different Earth systems controls the appearance of the Earth's surface. Central to this is the tension between internal systems, which are largely responsible for creating land at Earth's surface (e.g., volcanism and mountain building), and the sun-driven surface systems that tear down land through weathering and erosion. Students demonstrate proficiency in *developing and using models, constructing explanations, and engaging in argument from evidence*. The crosscutting concepts of *stability and change, energy and matter, and patterns* are called out as organizing elements of this unit.
Student Learning Objectives
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-ESS2-1)
Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. (HS-ESS2-3)
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-ESS1-5)
Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. (HS-ESS2-2)
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-ESS2-1)
Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. (HS-ESS2-3)
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-ESS1-5)
Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. (HS-ESS2-2)

Concepts	Formative Assessment

	Students who understand the concepts are able to:

• Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
• 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.
• Change and rates of change can be quantified and modeled over very short or very long periods of time.
  • Some system changes are irreversible.
	• Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
	• 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.
	• Change and rates of change can be quantified and modeled over very short or very long periods of time.
	  • Some system changes are irreversible.

• 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, and a solid mantle and crust. • Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. • The 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. • Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.	• Develop an evidence-based model of Earth's interior to describe the cycling of matter by thermal convection. • Develop a one-dimensional model, based on evidence, of Earth with radial layers determined by density to describe the cycling of matter by thermal convection. • Develop a three-dimensional model of Earth's interior, based on evidence, to show mantle convection and the resulting plate tectonics. • Develop a model of Earth's interior, based on evidence, to show that energy drives the cycling of matter by thermal convection.

• Energy drives the cycling of matter within and between Earth's systems. • 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. • Science knowledge is based on empirical evidence. • Science disciplines share common rules of evidence used to evaluate explanations about natural systems. • Science includes the process of coordinating patterns of evidence with current theory..	
• 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. • 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. • Spontaneous radioactive decay follows a characteristic exponential decay law. • Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. • Empirical evidence is needed to identify patterns in crustal rocks.	• 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. Evaluate evidence of plate interactions to explain the ages of crustal rocks.
• Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	• Analyze geoscience data using tools, technologies, and/or models (e.g., computational, mathematical) to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

• Feedback (negative or positive) can stabilize or destabilize a system. • 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.	

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1),(HS-ESS2-3) **Analyzing and Interpreting 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-ESS2-2) **Engaging in Argument from Evidence** • Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (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	**Energy and Matter** • 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) • Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2) **Patterns** • Empirical evidence is needed to identify patterns. (HS-ESS1-5) - ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each

	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. (HS-ESS2-1) **ESS2.D: Weather and Climate** • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2) **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)	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-ESS2-3) **Influence of Engineering, Technology, and Science on Society and the Natural World** • 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) **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)

English Language Arts	Mathematics
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any	Reason abstractly and quantitatively. (HS-ESS1-5), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3) **MP.2**

gaps or inconsistencies in the account. (HS-ESS1-5), (HS-ESS2-2),(HS-ESS2-3) **RST.11-12.1** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2) **RST.11-12.2** 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-ESS1-5) **RST.11-12.8** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-5) **WHST.9-12.2** 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-ESS2-5) **WHST.9-12.7** 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-ESS2-1),(HS-ESS2-3) **SL.11-12.5**	Model with mathematics. (HS-ESS2-1),(HS-ESS2-3) **MP.4** 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-ESS1-5), (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3) **HSN-Q.A.1** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-5), (HS-ESS2-1),(HS-ESS2-3) **HSN-Q.A.2** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-5) ,(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3) **HSN-Q.A.3**

Activities
Phet Simulation (phet.colorado.edu) "Greenhouse Effect": Students explore the atmosphere during the ice age and today. What happens when you add clouds? Change the greenhouse gas concentration and see how the temperature changes. Then compare to the effect of glass panes. Zoom in and see how light interacts with molecules. Do all atmospheric gases contribute to the greenhouse effect? Have the students

- Design their own experiments.
- Create an updateable poster of all physics quantities and their units.
- Create and record a lesson for a middle school class.
- Research and present a topic that goes beyond what the book explains.
- participate in in-class demonstrations
- work in groups to solve problems on chalk boards
- use the computers to research topics before they are formally taught

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of Earth's internal and surface processes and the different spatial and temporal scales at which they operate and to add interest.
- Cite specific textual evidence to support analysis of the Earth's interior, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to model the Earth's interior and the cycling of matter by thermal convection to enhance understanding of findings, reasoning, and evidence and to add interest.
- Cite specific textual evidence to support analysis of the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Determine the central ideas or conclusions of a text about changes to Earth's surface changes and their effects on Earth systems; summarize complex concepts, processes, or information presented in a text describing Earth's surface changes and their effects on Earth systems by paraphrasing them in simpler but still accurate terms.
- Cite specific textual evidence of past and current movements of continental and oceanic crust to support analysis of the ages of crustal rocks, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Evaluate the hypotheses, data, analysis, and conclusions regarding the ages of crustal rocks based on evidence of past and current movements of continental and oceanic crust, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- Write informative texts about the ages of crustal rocks based on evidence of past and current movements of continental and oceanic crust,

including the narration of historical events, scientific procedures/experiments, or technical processes.

Mathematics

- Represent symbolically an explanation for Earth's internal and surface processes and the different spatial and temporal scales at which they operate, and manipulate the representing symbols. Make sense of quantities and relationships about Earth's internal and surface processes and the different spatial and temporal scales at which they operate symbolically, and manipulate the representing symbols.
- Use a mathematical model to explain Earth's internal and surface processes and the different spatial and temporal scales at which they operate. Identify important quantities in Earth's internal and surface processes and the different spatial and temporal scales at which they operate and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.
- Use units as a way to understand problems and to guide the solution to multistep problems representing Earth's internal and surface processes and the different spatial and temporal scales at which they operate. Choose and interpret units consistently in formulas representing Earth's internal and surface processes and the different spatial and temporal scales at which they operate; choose and interpret the scale and the origin in graphs and data displays representing Earth's internal and surface processes and the different spatial and temporal scales at which they operate.
- Define appropriate quantities for the purpose of descriptive modeling of Earth's internal and surface processes and the different spatial and temporal scales at which they operate.
- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities representing Earth's internal and surface processes and the different spatial and temporal scales at which they operate.
- Represent an explanation for the Earth's interior and the cycling of matter by thermal convection symbolically and manipulate the representing symbols. Make sense of quantities and relationships about the Earth's interior and the cycling of matter by thermal convection symbolically and manipulate the representing symbols.
- Use a mathematical model to explain the Earth's interior and the cycling of matter by thermal convection. Identify important quantities in the Earth's interior and the cycling of matter by thermal convection and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.
- Use units as a way to understand problems and to guide the solution of multistep problems about the Earth's interior and the cycling of matter by thermal convection; choose and interpret units consistently in formulas representing the Earth's interior and the cycling of matter by thermal convection; choose and interpret the scale and the origin in graphs and data displays of the Earth's interior and the cycling of matter by thermal convection.
- Use units as a way to understand problems and to guide the solution of multistep problems about the ages of crustal rocks and past and current

movements of continental oceanic crust; choose and interpret units consistently in formulas representing the ages of crustal rocks and past and current movements of continental and oceanic crust; choose and interpret the scale and the origin in graphs and data displays of the ages of crustal rocks and past and current movements of continental and oceanic crust.

- Define appropriate quantities for the purpose of descriptive modeling of the ages of crustal rocks based on evidence of past and current movements of continental and oceanic crust.
- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities related to the ages of crustal rocks based on evidence of past and current movements of continental and oceanic crust.
- Represent an explanation for Earth's surface changes and their effects on Earth systems symbolically, and manipulate the representing symbols. Make sense of quantities and relationships about Earth's surface changes and their effects on Earth systems symbolically and manipulate the representing symbols.
- Use units as a way to understand problems and to guide the solution of multistep problems about Earth's surface changes and their effects on Earth systems; choose and interpret units consistently in formulas representing Earth's surface changes and their effects on Earth systems; choose and interpret the scale and the origin in graphs and data displays representing Earth's surface changes and their effects on Earth systems.
- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities representing Earth's surface changes and their effects on Earth systems.
- Represent symbolically an explanation for the ages of crustal rocks based on evidence of past and current movements of continental and oceanic crust, and manipulate the representing symbols. Make sense of quantities and relationships about the ages of crustal rocks based on evidence of past and current movements of continental and oceanic crust symbolically and manipulate the representing symbols.

Unit 6: Wave Properties
Unit Summary
How are waves used to transfer energy and send and store information? In this unit of study, students apply their understanding of how wave properties can be used to transfer information across long distances, store information, and investigate nature on many scales. The crosscutting concept of *cause and effect* is highlighted as an organizing concept for these disciplinary core ideas. Students are expected to demonstrate proficiency in *using mathematical thinking*, and to use this practice to demonstrate understanding of the core idea.
Student Learning Objectives
Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. (HS-PS4-1)

Concepts	Formative Assessment *Students who understand the concepts are able to:*
• The wavelength and frequency of a wave 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. • Empirical evidence is required to differentiate between cause and correlation and to make a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	*Students who understand the concepts are able to:* • Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. • Use algebraic relationships to quantitatively describe relationships among the frequency, wavelength, and speed of waves traveling in various media.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking • Use mathematical representations of	PS4.A: Wave Properties • The wavelength and frequency of a wave are related to one another by the speed of travel	Cause and Effect • Empirical evidence is required to differentiate between cause and correlation

phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1)	of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)	and make claims about specific causes and effects. (HS-PS4-1)

English Language Arts	Mathematics
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-PS4-1) **RST.11-12.7**	Reason abstractly and quantitatively. (HS-PS4-1) **MP.2** Model with mathematics. (HS-PS4-1) **MP.4** Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1) **HSA-SSE.A.1** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1) **HSA-SSE.B.3** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1) **HSA.CED.A.4**

Activities
Phet Simulation (phet.colorado.edu) "**Wave on a string**": Students will watch a wave on a string. Adjusting the amplitude, frequency, damping and tension will demonstrate wave properties. "**Slinky Lab**": Students will observe patterns of waves and their interactions using a slinky. "**Ripple Tank**": Students will investigate wave properties (speed in a medium, reflection, diffraction, interference) using the PhET virtual ripple tank, or use an actual ripple tank. "Resonance": Students will identify, through experimentation, cause and effect relationships that affect natural resonance of these systems. "**Sound Waves**": Students will adjust the frequency to both see and hear how the wave changes to explain how different sounds are modeled, described, and produced. Have the students - Design their own experiments. - Create an updateable poster of all physics quantities and their units. - Create and record a lesson for a middle school class.

- Research and present a topic that goes beyond what the book explains.
- participate in in-class demonstrations
- work in groups to solve problems on chalk boards
- use the computers to research topics before they are formally taught

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

Mathematics

- Represent symbolically relationships among the frequency, wavelength, and speed of waves traveling in various media, and manipulate the representing symbols. Make sense of quantities and relationships among the frequency, wavelength, and speed of waves traveling in various media.
- Use a mathematical model to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. Identify important quantities representing the frequency, wavelength, and speed of waves traveling in various media and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.
- Interpret expressions that represent the frequency, wavelength, and speed of waves traveling in various media in terms of their context.
- Choose and produce an equivalent form of an expression to reveal and explain properties of the frequency, wavelength, and speed of waves traveling in various media.
  - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations when representing the frequency, wavelength, and speed of waves traveling in various media.

Unit 7: Electromagnetic Radiation
Unit Summary
Why has digital technology replaced analog technology?   In this unit of study, students are able to apply their understanding of wave properties to make sense of how electromagnetic radiation can be used to transfer information across long distances, store information, and be used to investigate nature on many scales. Models of electromagnetic radiation as both a wave of changing electrical and magnetic fields or as particles are developed and used. Students also demonstrate their understanding of engineering ideas by presenting information about how technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. The crosscutting concepts of *systems and system models*; *stability and change*; *interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world* are highlighted as organizing concepts. Students are expected to demonstrate proficiency in *asking questions, engaging in argument from evidence, and obtaining, evaluating, and communicating information*, and they are expected to use these practices to demonstrate understanding of the core ideas.
Student Learning Objectives
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-PS4-3)
Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. (HS-PS4-4)
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. (HS-PS4-5)
Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. (HS-ETS1-1)
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-ETS1-3)
Evaluate questions about the advantages of using a digital transmission and storage of information. (HS-PS4-2)

Concepts	Formative Assessment *Students who understand the concepts are able to:*

• 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. • 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. • A wave model or a particle model (e.g., physical, mathematical, computer models) can be used to describe electromagnetic radiation—including energy, matter, and information flows—within and between systems at different scales. • A wave model and a particle model of electromagnetic radiation are 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.	• 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. • Evaluate experimental evidence 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. • Use models (e.g., physical, mathematical, computer models) to simulate electromagnetic radiation systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
• 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. • Cause-and-effect relationships can be suggested and predicted for electromagnetic radiation systems when matter absorbs different frequencies of light by examining what is known about smaller scale mechanisms within the system.	• Evaluate the validity and reliability of multiple claims in published materials about the effects that different frequencies of electromagnetic radiation have when absorbed by matter. • Evaluate the validity and reliability of claims that photons associated with different frequencies of light have different energies and that the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. • Give qualitative descriptions of how photons associated with different frequencies of light have different energies and how the damage to living tissue from electromagnetic radiation depends on the energy of the radiation.

	• Suggest and predict cause-and-effect relationships for electromagnetic radiation systems when matter absorbs different frequencies of light by examining what is known about smaller scale mechanisms within the system.
• Solar cells are human-made devices that capture the sun's energy and produce electrical energy. • 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. • Photoelectric materials emit electrons when they absorb light of a high enough frequency. • Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. • 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. • Humanity faces major global challenges today, such as the need for supplies of clean water and food and for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. • 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	• Communicate qualitative 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. • Communicate technical information or ideas about technological devices that use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy in multiple formats (including orally, graphically, textually, and mathematically). • Analyze technological devices that use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy by specifying criteria and constraints for successful solutions. • Evaluate a solution offered by technological devices that use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

impacts. • Wave interaction with matter systems can be designed to transmit and capture information and energy. • Science and engineering complement each other in the cycle known as research and development (R&D). • Modern civilization depends on major technological systems. • 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.	
• 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. • Systems for transmission and storage of information can be designed for greater or lesser stability. • Modern civilization depends on systems for transmission and storage of information. • Engineers continuously modify these technological systems for transmission and storage of information by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	• Evaluate questions about the advantages of using digital transmission and storage of information by challenging the premise of the advantages of digital transmission and storage of information, interpreting data, and considering the suitability of digital transmission and storage of information. • Consider advantages and disadvantages in the use of digital transmission and storage of information. •

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or	**PS4.A: Wave Properties** • Waves can add or cancel one another as they cross, depending on their relative	**Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate

solutions to determine the merits of arguments. (HS-PS4-3) **Obtaining, Evaluating, and Communicating Information** • 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) **Asking Questions and Defining Problems** • Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) • 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) **Constructing Explanations and Designing Solutions** • Evaluate a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	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) • 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-PS4-5) • 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) **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	systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-3) **Cause and Effect** • 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-PS4-4) • Systems can be designed to cause a desired effect. (HS-PS4-5) **Stability and Change** • Systems can be designed for greater or lesser stability. (HS-PS4-2) **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5) **Influence of Engineering, Technology, and Science on Society and the Natural World** • Modern civilization depends on major technological systems. (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-ETS1-3)

	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-PS45) **PS3.D: Energy in Chemical Processes** • Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (secondary to 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) **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	• Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HSPS4-2) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • 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. 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)

	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)	

English Language Arts	Mathematics
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-PS4-3), (HS-PS4-4),(HS-PS4-2) **RST.9-10.8** 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-PS4-3), (HS-PS4-4),(HS-PS4-2) **RST.11-12.1** 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-PS4-4),(HS-ETS1-1),(HS-ETS1-3) **RST.11-12.7** 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-PS4-3), (HS-ETS1-1), (HS-ETS1-3),(HS-PS4-2) **RST.11-12.8**	Reason abstractly and quantitatively. (HS-PS4-3), (HS-ETS1-1), (HS-ETS1-3) **MP.2** Model with mathematics. (HS-ETS1-1),(HS-ETS1-3) **MP.4** Interpret expressions that represent a quantity in terms of its context. (HS-PS4-3) **HSA-SSE.A.1** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-3) **HSA-SSE.B.3** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-3) **HAS.CED.A.4**

Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3) **RST.11-12.9** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-PS4-5) **WHST.11-12.2** 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-PS4-4) **WHST.11-12.8**	

Activities
Phet Simulation (phet.colorado.edu) "Radio Waves and Electromagnetic Fields": Phet simulation demonstrating wave generation, propagation and detection with antennas. "Refraction": PHeT simulation addressing refraction of light at an interface. "Wave Interference": Phet simulation of both mechanical and optical wave phenomena "Photoelectric Effect Phet":_ Phet simulation addressing evidence for particle nature of electromagnetic radiation "Interaction of Molecules with Electromagnetic Radiation": Phet simulation exploring the effect of microwave, infrared, visible and ultraviolet radiation on various molecules. "Wave/Particle Dualism": Phet simulation of wave and particle views of interference phenomena. - Design their own experiments. - Create an updateable poster of all physics quantities and their units. - Create and record a lesson for a middle school class. - Research and present a topic that goes beyond what the book explains.

- participate in in-class demonstrations
- work in groups to solve problems on chalk boards
- use the computers to research topics before they are formally taught
- create a battery from fruit and vegetables.
- test batteries with a voltmeter.
- construct series and parallel circuits.
- build a simple electric motor
- build a simple electric generator.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Assess the extent to which the reasoning and evidence in a text supports the author's claim 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.
- Cite specific textual evidence to support the wave model or particle model in describing electromagnetic radiation, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text relating 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, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- Assess the extent to which the reasoning and evidence in a text describing the effects that different frequencies of electromagnetic radiation have when absorbed by matter support the author's claim or recommendation.
- Cite textual evidence to support analysis of science and technical texts describing the effects that different frequencies of electromagnetic radiation have when absorbed by matter, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., qualitative data, video multimedia) in order to address the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text describing the effects that different frequencies of electromagnetic radiation have when absorbed by matter, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- Gather relevant information from multiple authoritative print and digital sources describing the effects that different frequencies of electromagnetic radiation have when absorbed by matter, 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.

- Write informative/explanatory texts about technological devices that use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy, including the narration of scientific procedures, experiments, or technical processes.
- Integrate and evaluate multiple sources of information about technological devices that use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy, presented in diverse formats and media (e.g., quantitative data, video, multimedia), in order to address a question or solve a problem.
- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text describing technological devices that use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- Synthesize information about technological devices that use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy from a range of sources. (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- Assess the extent to which the reasoning and evidence in a text support the advantages of using digital transmission and storage of information.
- Cite specific textual evidence to support the advantages of using digital transmission and storage of information, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Evaluate advantages of using digital transmission and storage of information in text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Mathematics-

- Represent symbolically 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, and manipulate the representing symbols.
- Make sense of quantities and relationships between the wave model and the particle model of electromagnetic radiation.
- Interpret expressions that represent the wave model and particle model of electromagnetic radiation in terms of the usefulness of the model depending on the situation.
- Choose and produce an equivalent form of an expression to reveal and explain properties of electromagnetic radiation.
- Rearrange formulas representing electromagnetic radiation to highlight a quantity of interest, using the same reasoning as in solving equations.
- Represent the principles of wave behavior and wave interactions with matter to transmit and capture information and energy symbolically, considering criteria and constraints, and manipulate the representing symbols. Make sense of quantities and relationships in the principles of

wave behavior and wave interactions with matter to transmit and capture information and energy.

- Use a mathematical model to describe the principles of wave behavior and wave interactions with matter to transmit and capture information and energy and to predict the effects of the design on systems and/or interactions between systems. Identify important quantities in the principles of wave behavior and wave interactions with matter to transmit and capture information and energy, and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose

Unit 8: Electricity and Magnetism
Unit Summary
How can one explain and predict the interactions between objects and within a system of objects? In this unit of study, students' understanding of how forces at a distance can be explained by fields, why some materials are attracted to each other while other are not, how magnets or electric currents cause magnetic fields, and how charges or changing magnetic fields cause electric fields. The crosscutting concept of *cause and effect* is called out as an organizing concept. Students are expected to demonstrate proficiency *in planning and conducting investigations and developing and using models*.
Student Learning Objectives
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-PS2-5)
Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. (HS-PS3-5)

Concepts	Formative Assessment *Students who understand the concepts are able to:*
• 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. • "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	• Plan and conduct an investigation individually and collaboratively to produce data that can serve as the basis for evidence that an electric current can produce a magnetic field. • Plan and conduct an investigation individually and collaboratively to produce data that can serve as the basis for evidence that a changing magnetic field can produce an electric current. • In experimental design, decide on the types, amounts, and accuracy of data needed to produce reliable measurements, consider limitations on the precision of the data, and refine the design accordingly. • Collect empirical evidence to support the claim that an electric current can produce a magnetic field. Collect empirical evidence to support the claim that a changing

	magnetic field can produce an electric current.
• When two objects interacting through a field change relative position, the energy stored in the field is changed. • Cause-and-effect relationships between electrical and magnetic fields can be predicted through an understanding of inter- and intra-molecular forces (protons and electrons).	• Develop and use an evidence-based 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. • Suggest and predict cause-and-effect relationships for two objects interacting through electric or magnetic fields.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<u>Planning and Carrying Out Investigations</u> • 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) <u>Developing and Using Models</u> • 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)	<u>PS2.B: Types of Interactions</u> • 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-PS2-5) <u>PS3.C: Relationship between Energy and Forces</u> • <u>When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)</u>	<u>Cause and Effect</u> • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5) • <u>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)</u>

English Language Arts	Mathematics
Conduct short as well as more sustained research projects to answer a	Reason abstractly and quantitatively. (HS-PS3-5) **MP.2**

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-PS2-5),(HS-PS3-5) **WHST.9-12.7** 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-PS3-5) **WHST.11-12.8** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-5), (HS-PS3-5) **WHST.9-12.9** 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-PS3-5) **SL.11-12.5**	Model with mathematics. (HS-PS3-5**MP.4**) 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-PS2-5) **HSN.Q.A.1** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-5) **HSN.Q.A.2** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-5) **HSN.Q.A.3**

Activities
Phet Simulation (phet.colorado.edu) "Magnets and Electromagnets": Explore the interactions between a compass and bar magnet. Discover how you can use a battery and wire to make a magnet! Can you make it a stronger magnet? Can you make the magnetic field reverse? "Charges and Fields": Move point charges around on the playing field and then view the electric field, voltages, equipotential lines, and more. "Faraday's Law": Investigate Faraday's law and how a changing magnetic flux can produce a flow of electricity! - Design their own experiments. - Create an updateable poster of all physics quantities and their units. - Create and record a lesson for a middle school class. - Research and present a topic that goes beyond what the book explains. - participate in in-class demonstrations - work in groups to solve problems on chalk boards

- use the computers to research topics before they are formally taught

TOWNSHIP OF UNION PUBLIC SCHOOLS

Forensic Science

Curriculum Guide

2016

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TOWNSHIP OF UNION PUBLIC SCHOOLS

Administration

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Assistant Superintendent........Ms. Annie Moses

School Business Administrator........Mr. Manuel Viera

Director of Personnel........Mr. Gerry Benaquista

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Director of Athletics, Physical Education and Nurses........Ms. Linda Ionta

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DEPARTMENT SUPERVISORS

English/Social Studies 2-5 .... Mr. Robert Ghiretti

Mathematics/Science 2-5 .... Ms. Theresa Matthews

Language Arts/Library Services 9-12 .... Ms. Randi Moran

Science 6-12 .... Ms. Maureen Guilfoyle

Math 6-12 .... Dr. Jeremy Cohen

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World Language/ESL/ Career Education .... Ms. Yvonne Lorenzo

Art/Music .... Mr. Ronald Rago

Physical Education/Health .... Ms. Linda Ionta

School Counseling K-12 .... Ms. Nicole Ahern

English/Math/Science/Social Studies K-2 .... Ms. Maureen Corbett

Curriculum Committee
Academic Area

Maureen Guilfoyle, Supervisor of Science

Dr. Richard Massarelli
Dr. Edward J. Boffa

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Board Members

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Mission Statement

The mission of the Township of Union Public Schools is to build on the foundations of honesty, excellence, integrity, strong family, and community partnerships. We promote a supportive learning environment where every student is challenged, inspired, empowered, and respected as diverse learners. Through cultivation of students' intellectual curiosity, skills and knowledge, our students can achieve academically and socially, and contribute as responsible and productive citizens of our global community.

Philosophy Statement

The Township of Union Public School District, as a societal agency, reflects democratic ideals and concepts through its educational practices. It is the belief of the Board of Education that a primary function of the Township of Union Public School System is formulation of a learning climate conductive to the needs of all students in general, providing therein for individual differences. The school operates as a partner with the home and community.

Statement of District Goals

- Develop reading, writing, speaking, listening, and mathematical skills.
- Develop a pride in work and a feeling of self-worth, self-reliance, and self discipline.
- Acquire and use the skills and habits involved in critical and constructive thinking.
- Develop a code of behavior based on moral and ethical principals.
- To be able to work with others cooperatively.
- Acquire a knowledge and appreciation of the historical record of human achievement and failures and current societal issues.
- Acquire a knowledge and understanding of the physical and biological sciences.
- Efficient and effective participation in economic life and the development of skills to enter a specific field of work.
- Appreciate and understand literature, art, music, and other cultural activities.
- Develop an understanding of the historical and cultural heritage.
- Develop a concern for the proper use and/or preservation of natural resources.
- Develop basic skills in sports and other forms of recreation.

Course Description

Forensic Science is an all-encompassing term which refers to the application of science and technology to law. This course will focus on the integration of science and technology for the purpose of solving crimes and enforcing criminal and civil law. This course will allow the student to apply their knowledge of biology, chemistry and physics to analyze evidence, evaluate crime scenes and solve crimes.

Forensic Science will allow the student to understand the importance of science and technology in everyday life. Students will also be introduced to many careers that support and relate to forensic science. Many of these careers that are related to forensic science encourage students to continue their education to the doctorate level, however, there are also related careers that the student can pursue from high school.

Utilizing student centered learning, cooperative learning, technology, practical laboratory activities, cross curricular and STEM activities, this full year course will introduce the student to advanced concepts in the Sciences while seeking to increase scientific literacy.

Recommended Textbooks

Saferstein, Richard, Forensic Science: An Introduction, Pearson Prentice Hall, NJ 2008

Saferstein, Richard, Basic Laboratory Excercises for Forensic Science, Pearson Prentice Hall, NJ 2008

Ancillary materials supplied as needed

Course Proficiencies

Students will be able to…

1. Describe the history, origin, and progression of criminalistics and forensic science.
2. Describe a crime scene setup, legal ramifications and documentation of a crime scene.
3. Identify the types and uses of physical evidence via organic analysis and microscopic analysis.
4. Cite the differences between man made and natural hair fibers and morphology of each.
5. Discuss how serology, nature of blood, blood typing and staining patterns of blood play a role in blood analysis.
6. Interpret findings of DNA profiling.
7. Apply the history/ origin/ fundamental principles of fingerprinting to the laboratory methods of detecting fingerprints, as well as footprints, bite marks, arson, explosives, ballistics, anthropology, drugs, toxicology and document forgery.
8. Apply the practical laboratory/ investigative techniques learned in class to analyze a staged crime scene, along with various clues and evidence for identification

Curriculum Units

Unit 1: History and Introduction to Criminalistics/ Forensics

Unit 2: The Crime Scene and Evidence:Identification and Collection

Unit 3: Fingerprints, Hair & Fiber Analysis

Unit 4: Drug Identification and Toxicology

Unit 5: Ballistics, Forensic Serology and Anthropology

Unit 6: Surveillance and Trace Evidence II

Unit 7: Arson, Explosives, Document analysis and forgery

Pacing Guide- Course

Content		Number of Days
Unit 1:	History and Introduction to Criminalistics/ Forensics	12
Unit 2:	The Crime Scene and Evidence: Identification and Collection	25
Unit 3:	Fingerprints, Hair & Fiber Analysis	28
Unit 4:	Drug Identification and Toxicology	24
Unit 5:	Ballistics, Forensic Serology and Anthropology	40
Unit 6:	Surveillance and Trace Evidence II	15
Unit 7:	Arson, Explosives, Document analysis and Forgery	36

Unit 1; History and Introduction to Criminalistics/ Forensics

Essential Questions:

- What is Forensic Science?
- Who are the major contributors to the development of forensic science?
- What is a crime laboratory and what services do they provide?
- Are there any important court decisions that define forensic science?
- What are expert witnesses?

Instructional Objectives/ Concepts:

- Define forensic science/ criminalistics.
- List areas of forensic science that require expertise in specific realms of science and technology.
- Name and know contributions of scientists to the development of forensic science.
- Cite examples of the type of crime labs that exist at different government levels within the United States
- Explain the admissibility of scientific evidence in the courtroom with respect to judicial decisions.
- Understand and explain the roles, responsibilities and qualifications of the expert witness.

Strategies and Activities may include:	*Evaluations may include:*
• Guest Speakers • Crime Scene Analysis / Reenactment • Power Point Presentations • Student Presentations • Actual Case Studies from News Media • Overhead transparencies • Demonstrations • Web Quests • Laboratory Activities: Group and Individual • Small Group Discussions • Debate	▪ Case Study Analysis ▪ Crime Scene Analysis: Lab Practical ▪ Final Exam ▪ Tests ▪ Quizzes ▪ Debate ▪ Student Presentations ▪ Lab Reports ▪ Research Paper Exit Cards Formative assessments

• Student Research/ Letter Writing, Interviews, Library Research • Unsolved Crime Scene Analysis from Actual Local Case Studies • Games: Jeopardy, • Movies • Relevant CSI episodes to material	
NGSS HS-ETS1-1, HS ETS1-3	**CCLS Literacy** RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11-12.5, WHST.11-12.10

Unit 2: The Crime Scene and Evidence: Identification and Collection

Essential Questions:

- What can be considered physical evidence and how can it be properly collected to maintain its integrity for court proceedings?
- What responsibilities do various members of law enforcement have as they arrive at a crime scene?
- How is a crime scene properly documented or recorded?
- What types of physical evidence are typically found at a crime scene?
- What is the difference between identification and comparison of physical evidence?
- What techniques are used to analyze physical evidence?
- What value is placed on physical evidence relative to criminal investigation?

Instructional Objectives/ Concepts:

- Define physical evidence.
- Discuss the role of the first responding officer as well as subsequent investigators that arrive at a crime scene.
- Understand the roles and responsibilities of the different forensic scientists that may be involved in analyzing physical evidence.
- Understand what "chain of custody" is, who is responsible for it and what the ramifications are if it is broken.
- Describe the roles of the forensic entomologist, odontologist, anthropologist and pathologist as they relate to a homicidal investigation
- Describe procedures to systematically search a crime scene for physical evidence.
- Demonstrate/describe proper techniques for collecting and packaging common types of physical evidence.
- Analyze, illustrate and label a crime scene correctly.
- Properly analyze collected physical evidence using good laboratory technique.
- List and describe the common types of evidence found at a crime scene
- Discuss the difference between identification and comparison of physical evidence.
- Discuss the difference between individual and class characteristics with examples of such as it pertains to physical evidence.
- Describe the value of physical evidence as it pertains to criminal investigation
- List and describe the various major computerized databases that relate to physical evidence.

<table>
<tr><td colspan="2">• Explain the role physical evidence plays in crime scene reconstruction during criminal investigation</td></tr>
<tr><td>Strategies and Activities may include:
• Guest Speakers
• Crime Scene Analysis / Reenactment
• Power Point Presentations
• Student Presentations
• Actual Case Studies from News Media
• Overhead transparencies
• Demonstrations
• Web Quests
• Laboratory Activities: Group and Individual
• Small Group Discussions
• Debate
• Student Research/ Letter Writing, Interviews, Library Research
• Unsolved Crime Scene Analysis from Actual Local Case Studies
• Games: Jeopardy
• Movies
• Relevant CSI episodes to material</td>
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▪ Case Study Analysis
▪ Crime Scene Analysis: Lab Practical
▪ Final Exam
▪ Tests
▪ Quizzes
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▪ Student Presentations
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Exit Cards
Formative assessments</td></tr>
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HS-ETS1-1, HS ETS1-3</td>
<td>CCLS Literacy:
RST.11-12.3, RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11-12.1.D, WHST.11.12.5, WHST.11-12.10

CCLS Mathematics
MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.3</td></tr>
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Unit 3: Fingerprints, Hair & Fiber Analysis

Essential Questions: (Fingerprints)

- How are fingerprints different between individuals?
- The work of which scientists led to our knowledge and understanding that fingerprints are a vital tool for identification?
- How are fingerprints related to forensic science and criminal investigation?
- What technological resources are available to law enforcement to identify unknown fingerprints recovered at a crime scene?

Instructional Objectives/ Concepts:

- Name those individuals who made significant contributions to the development of fingerprint technology and its ultimate acceptance as a tool for identification.
- Discuss the case of William West
- Define and describe ridge characteristics
- Explain why fingerprints are an unchangeable feature of human anatomy.
- List the three major fingerprint patterns as well as their subclasses
- Describe the differences between visible, latent, and plastic fingerprints
- List and describe methods for developing prints on both porous and non- porous objects
- Describe methods utilized to preserve a developed latent print
- Explain what automated fingerprint identification system is and how it is used in criminal investigation

Essential Questions: (Hair and Fiber Analysis)

- How does hair as physical evidence relate to forensic science and investigation?
- How do fibers as physical evidence relate to forensic science and investigation?

Instructional Objectives/ Concepts:

- Describe the anatomical structure of hair
- Know the three phases of hair growth
- Differentiate between animal and human hairs
- Describe/demonstrate proper methods of collection and packaging of both hair and fibers

- Describe how DNA can be obtained from hair samples
- Describe microscopic features of both hair and fibers that are useful for comparison and identification
- Describe properties of fibers that can be used for investigation in forensic science.

Strategies and Activities may include: • Guest Speakers • Crime Scene Analysis / Reenactment • Power Point Presentations • Student Presentations • Actual Case Studies from News Media • Overhead transparencies • Demonstrations • Web Quests • Laboratory Activities: Group and Individual • Small Group Discussions • Debate • Student Research/ Letter Writing, Interviews, Library Research • Unsolved Crime Scene Analysis from Actual Local Case Studies • Games: Jeopardy • Movies • Relevant CSI episodes to material	*Evaluations may include:* ▪ Case Study Analysis ▪ Crime Scene Analysis: Lab Practical ▪ Final Exam ▪ Tests ▪ Quizzes ▪ Debate ▪ Student Presentations ▪ Lab Reports ▪ Research Papers Exit Cards Formative assessments
NGSS HS-ETS1-1, HS-ETS1-2, HS ETS1-3 HS-LS1-1, HS-LS1-2, HS-LS3-2	**CCLS Literacy** RST.11-12.3, RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.5, WHST.11-12.10 **CCLS Mathematics** MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.3

Unit 4: Drug Identification and Toxicology

Essential Questions:

- How are drugs related to forensic science?
- How can drugs be analyzed using principles of chemistry?
- What is the Controlled Substances Act and how does it relate to drug classification?
- How does alcohol affect the human body?
- What court proceedings led to alcohol related traffic enforcement?
- How can poisoning be detected in the body?
- Why are most consumer products tamper resistant?

Instructional Objectives/Concepts:

- Differentiate between psychological and physical dependence
- List and classify commonly abused drug
- Know the type of dependency (psychological/physical) that may be caused by the more commonly abused drugs
- Know the schedules and meaning of same of the Controlled Dangerous Substances Act
- Describe both field and laboratory tests that forensic chemists may employ to identify an unknown drug
- Describe the process of gas chromatography
- Describe mass spectronomy and its usefulness in drug identification
- Describe proper techniques of collection and preservation of drug evidence
- Describe how alcohol is absorbed, travels through the body and ways it is eliminated from the body.
- Describe the human circulatory system
- Describe the design of the Breathalyzer as well as the chemical reaction which takes place in the presence of alcohol.
- Explain what a field sobriety test through words and demonstration
- Discuss laboratory procedures for blood alcohol analysis
- Know driving impairment levels at the state and federal level
- Explain the significance of *Schmerber v. California* relative to traffic enforcement.
- Discuss hair analysis as it relates to toxicology

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- Discuss major poisoning cases and how they were solved
- Know how Tylenol was tampered with, its results and how changes were subsequently made to all consumer food and drug products.
- Describe methods for isolating and identifying drugs and poisons.
- Describe the role of the toxicologist in the criminal justice system.

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Strategies and Activities may include:

- Guest Speakers
- Crime Scene Analysis / Reenactment
- Power Point Presentations
- Student Presentations
- Actual Case Studies from News Media
- Overhead transparencies
- Demonstrations
- Web Quests
- Laboratory Activities: Group and Individual
- Small Group Discussions
- Debate
- Student Research/ Letter Writing, Interviews, Library Research
- Unsolved Crime Scene Analysis from Actual Local Case Studies
- Games: Jeopardy
- Movies
- Relevant CSI episodes to material

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Evaluations may include:

- Case Study Analysis
- Crime Scene Analysis: Lab Practical
- Final Exam
- Tests
- Quizzes
- Debate
- Student Presentations
- Lab Reports
- Research Papers

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NGSS

HS-ETS1-1, HS-ETS1-2, HS ETS1-3, HS-PS1-2

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CCLS Literacy

RST.11-12.3, RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.5, WHST.11-12.10

CCLS Mathematics

MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.3

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</table>

Unit 5: Ballistics, Forensic Serology and Anthropology

Essential Questions: (Ballistics):

- What are firearms, what types of firearms are there?
- How can examination link a bullet or cartridge to a firearm?
- How is NIBIN/IBIS vital to criminal investigation?

Instructional Objectives/ Concepts:

- Differentiate between a handgun and rifle
- Know basic mechanics of revolver & semi-automatic handgun
- Describe how a barrel is rifled
- List both class and individual characteristics of bullets and cartridges
- Use with good technique a comparison microscope to compare bullets and cartridges
- Distinguish between caliber and gauge and describe how they are determined
- Describe how databases are important to law enforcement
- Describe how to determine shooting distance
- Describe Gun Shot Residue test and how it is utilized
- Describe how obliterated serial numbers can be restored
- Know proper technique to collect and package all firearm evidence
- Explain how a tool mark can be compared to a suspects tool

Essential Questions:(Forensic serology)

- How does the study of blood contribute to forensic science?
- How can body fluids be identified at a crime scene?
- How does the study of blood spatter help with crime scene reconstruction?
- In what ways can body fluids be detected at a crime scene?

Instructional Objectives/ Concepts:

- Explain the ABO blood typing system and the genetic reasoning behind it concerning antigens and antibodies.(5.5)

- Describe agglutination and how and why this happens.
- Know what a presumptive blood test is
- Explain how human blood can be differentiated from animal blood
- Use a Punnet Square to determine genotype and phenotype of offspring
- Describe how physical evidence is collected in a rape investigation.
- Describe how serologic stains are preserved and packaged for laboratory analysis.

Essential Questions:(Forensic Anthropology)

- What is forensic anthropology and odontology, and how are they used in forensic investigation?
- What is the morphology and physiology of bones and teeth?

Instructional Objectives/ Concepts:

- Describe the origin and structure of human bones and teeth.
- Discuss how the characteristics of bone and muscle help provide valuable clues in forensic investigation.
- Compare and contrast bones in regard to age, disease, and race.

Strategies and Activities may include:	*Evaluations may include:*
• Guest Speakers • Crime Scene Analysis / Reenactment • Power Point Presentations • Student Presentations • Actual Case Studies from News Media • Overhead transparencies • Demonstrations • Web Quests • Laboratory Activities: Group and Individual • Small Group Discussions • Debate • Student Research/ Letter Writing, Interviews, Library Research	▪ Case Study Analysis ▪ Crime Scene Analysis: Lab Practical ▪ Final Exam ▪ Tests ▪ Quizzes ▪ Debate ▪ Student Presentations ▪ Lab Reports ▪ Research Papers

• Unsolved Crime Scene Analysis from Actual Local Case Studies • Games: Jeopardy, • Movies(*Fracture*) • Relevant CSI episodes to material	
NGSS HS-ETS1-1, HS-ETS1-2, HS ETS1-3 HS-LS1-1, HS-LS1-2, HS-LS3-1, HS-LS3-2, HS-LS3-3 HS-PS2-1	**CCLS Literacy** RST.11-12.3, RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.9, WHST.11-12.10 **CCLS Mathematics** MP.2, MP,4, HSN-Q.A.1, HSN-Q-A.3

Unit 6: Surveillance and Trace Evidence II
Essential Questions: • How are trace elements important to forensic science? • How are trace elements detected? • What methods of surveillance are used in modern detective work? • What federal and local requirements must be met for surveillance to take place?
Instructional Objectives/Concepts: • Describe the usefulness of trace elements for the forensic comparison of various types of physical evidence. • Define the term isotope. • Define radioactivity. • Explain how elements can be made radioactive. • Describe the components of paint. • Describe the proper collection and preservation of paint evidence. • List the important forensic properties of soil. • Describe the density-gradient tube technique. • Describe the proper collection of soil evidence.

<table>
<tr>
<td>Strategies and Activities may include:
Guest Speakers
Crime Scene Analysis / Reenactment
Power Point Presentations
Student Presentations
Actual Case Studies from News Media
Overhead transparencies
Demonstrations
Web Quests
Laboratory Activities: Group and Individual
Small Group Discussions
Debate
Student Research/ Letter Writing, Interviews, Library Research
Unsolved Crime Scene Analysis from Actual Local and National Case Studies
Games: Jeopardy
Movies(Enemy of the State)
Relevant CSI episodes to material</td>
<td>Evaluations may include:
Case Study Analysis
Crime Scene Analysis: Lab
Practical
Final Exam
Tests
Quizzes
Debate
Student Presentations
Lab Reports
Research Papers
Exit Cards
Formative assessments</td>
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HS-ETS1-1, HS-ETS1-2, HS-ETS1-3
HS-PS1.2, HS-PS1.8</td>
<td>CCLS Literacy
RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.4,WHST.11-12.5, WHST.11-12.10

CCLS Mathematics
MP.2, HSN-Q.A.1, HSN-Q-A.3</td>
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Unit 7: Arson, Explosives, Document Analysis and Forgery

Essential Questions:

- What is arson?
- How can fire scenes be investigated by forensic science?
- How are explosives classified?
- How can suspected bombing scenes be investigated by forensic science?
- What are the major goals of forensic handwriting analysis?
- What major technologies are used in document and handwriting analysis?
- What are ways businesses prevent fraud and forgery?
- How is paper currency protected from counterfeiting?

Instructional Objectives/Concepts:

- Define heat of combustion and ignition temperature.
- Describe the difference between an exothermic and endothermic chemical reaction.
- List the requirements necessary to initiate and sustain combustion.
- Describe how physical evidence must be collected at the scene of a suspected arson.
- Describe the laboratory procedure used for the detection and identification of hydrocarbon residues.
- Explain how explosives are classified.
- Identify some common commercial, homemade, and military explosives.
- Describe how physical evidence must be collected at the scene of a suspected arson or explosion.
- Describe common individual characteristics associated with handwriting.
- Define "questioned document".
- List some important guidelines to be followed for the collection of known writings for comparison to a questioned document.
- Describe class and individual characteristics of a typewriter.
- Analyze typewritten passages and associate to suspect typewriter

Strategies and Activities may include:	*Evaluations may include:*
• Guest Speakers	• Case Study Analysis

• Crime Scene Analysis / Reenactment • Power Point Presentations • Student Presentations • Actual Case Studies from News Media • Overhead transparencies • Demonstrations • Web Quests • Laboratory Activities: Group and Individual • Small Group Discussions • Debate • Student Research/ Letter Writing, Interviews, Library Research • Unsolved Crime Scene Analysis from Actual Local and National Case Studies • Games: Jeopardy, • Movies (*Catch me if You Can*) • Relevant CSI episodes to material	• Crime Scene Analysis: Lab Practical • Final Exam • Tests • Quizzes • Debate • Student Presentations • Lab Reports • Research Papers • Exit Cards • Formative assessments
NGSS HS-ETS1-1, HS-ETS1-2, HS ETS1-3	**CCLS Literacy** RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.4,WHST.11-12.5, WHST.11-12.10 **CCLS Mathematics** MP.2, HSN-Q.A.1, HSN-Q-A.3

Next Generation Science Standards and Common Core Literacy Standards

EXPECTED OUTCOMES with link to NGSS and CCLS

The following list identifies the relevant standards to the course material:

- 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-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay
- 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-LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

- HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
- HS-LS3-1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
- RST.11-12.1 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.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks: analyze the specific results based on explanations in the text
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.
- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible, and corroborating or challenging conclusions with other sources of information.

- RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- WHST.11-12.1.D Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.11-12.7 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.
- WHST.11-12.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
- HSN.QA.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.QA.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- MP.2 Reason abstractly and quantitatively with mathemetics
- MP.4 Model with mathematics

PARCC Scoring Rubric

TOWNSHIP OF UNION PUBLIC SCHOOLS

Hollywood Science

Curriculum Guide

2016

Board Members

Mr. Vito Nufrio, President

Mr. David Arminio, Vice President

Dr. Guy Francis

Mr. Steven Le

Mr. Ron McDowell

Mr. Jeff Monge

Nellis Regis-Darby

Mr. Angel Salcedo

Mrs. Nancy Zuena

TOWNSHIP OF UNION PUBLIC SCHOOLS

Administration

District Superintendent..Mr. Greg Tatum

Assistant Superintendent.. Ms. Noreen Lishak

Assistant Superintendent..Ms. Annie Moses

School Business Administrator..Mr. Manuel Viera

Director of Personnel ....Mr. Gerry Benaquista

Director of Special Projects..Ms. Ann Hart

Director of Special Services .... Ms. Kim Conti

Director of Athletics, Physical Education and Nurses..Ms. Linda Ionta

District Security..Mr. Nicholas Ardito

DEPARTMENT SUPERVISORS

English/Social Studies 2-5 .... Mr. Robert Ghiretti

Mathematics/Science 2-5 .... Ms. Theresa Matthews

Language Arts/Library Services 9-12 .... Ms. Randi Moran

Science 6-12 .... Ms. Maureen Guilfoyle

Math 6-12.......... Dr. Jeremy Cohen

Social Studies/Business .... Ms. Libby Galante

World Language/ESL/ Career Education.......... Ms. Yvonne Lorenzo

Art/Music .... Mr. Ronald Rago

Physical Education/Health .... Ms. Linda Ionta

School Counseling K-12.......... Ms. Nicole Ahern

English/Math/Science/Social Studies K-2.......... Ms. Maureen Corbett

Curriculum Committee
Academic Area

Maureen Guilfoyle, Supervisor of Science

Dr. Richard Massarelli
Dr. Edward J. Boffa

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Board Members

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Appendix: Next Generation Science Standards and Common Core Literacy Standards

Mission Statement

The mission of the Township of Union Public Schools is to build on the foundations of honesty, excellence, integrity, strong family, and community partnerships. We promote a supportive learning environment where every student is challenged, inspired, empowered, and respected as diverse learners. Through cultivation of students' intellectual curiosity, skills and knowledge, our students can achieve academically and socially, and contribute as responsible and productive citizens of our global community.

Philosophy Statement

The Township of Union Public School District, as a societal agency, reflects democratic ideals and concepts through its educational practices. It is the belief of the Board of Education that a primary function of the Township of Union Public School System is formulation of a learning climate conductive to the needs of all students in general, providing therein for individual differences. The school operates as a partner with the home and community.

Statement of District Goals

- Develop reading, writing, speaking, listening, and mathematical skills.
- Develop a pride in work and a feeling of self-worth, self-reliance, and self discipline.
- Acquire and use the skills and habits involved in critical and constructive thinking.
- Develop a code of behavior based on moral and ethical principals.
- To be able to work with others cooperatively.
- Acquire a knowledge and appreciation of the historical record of human achievement and failures and current societal issues.
- Acquire a knowledge and understanding of the physical and biological sciences.
- Efficient and effective participation in economic life and the development of skills to enter a specific field of work.
- Appreciate and understand literature, art, music, and other cultural activities.
- Develop an understanding of the historical and cultural heritage.
- Develop a concern for the proper use and/or preservation of natural resources.
- Develop basic skills in sports and other forms of recreation.

Course Description

This course is designed to allow students the opportunity to enhance their investigation and understanding of Physical Science, Earth Science and the Life Sciences. This is accomplished through the analysis and critique of the scientific themes and concepts presented in select Hollywood feature films, documentaries and other relevant media.

In addition, this course is designed to develop skills in differentiating between real science and pseudo-science.

Utilizing student centered learning, cooperative learning, technology, practical laboratory activities, cross curricular and STEM activities, this full year course will introduce the student to advanced concepts in the Sciences while seeking to increase scientific literacy.

Recommended Textbooks

Ancillary materials will be provided as needed

Course Proficiencies

Students will be able to…

After completing the assigned reading, media viewing, research, laboratory activities, oral and written assessments the students will be able to…

1. Distinguish between real science and pseudo or "junk" science
2. Know the sources and effects of radiation and radioactivity on the human body.
3. Identify the differences between nuclear and non-nuclear power production.
4. Discuss the science of nuclear weapon production and disposal.
5. Understand how different forms of severe weather occur, and how technology is utilized to forecast weather.
6. Track the current and historic trends in climate and weather.
7. Explain the cause and impact of earthquakes, volcanoes, and other geological events on the planet and its inhabitants.
8. Describe how the genetic code leads to the expression of traits and be able to infer that altering the genetic code may lead to a specific genetic disorder.
9. Discuss how science can trace and identify biological agents to protect our populations from widespread disease and epidemics.
10. Understand how industry can knowingly and unknowingly contribute to environmental damage and widespread illness.

Curriculum Units

Unit 1: Pseudoscience/ Scientific Method

Unit 2: Physics/Chemistry/Biology
(Radiation, Radioactivity, Nuclear Energy)

Unit 3: Physical Science/ Earth Science
(Weather, Climate, Meteorology)

Unit 4: Biology/ Genetics/ Life Sciences

Unit 5: Biology/ Life Sciences/ Epidemiology
(Bacteria/ Viruses/ Immunology)

Unit 6: Public Health

Pacing Guide- Course

Content	Number of Days
Unit 1: Pseudoscience/ Scientific Method	20
Unit 2: Physics/Chemistry/Biology (Radiation, Radioactivity, Nuclear Energy)	40
Unit 3: Physical Science/ Earth Science (Weather, Climate, Meteorology)	25
Unit 4: Biology/ Genetics/ Life Sciences	35
Unit 5: Biology/ Life Sciences/ Epidemiology (Bacteria/ Viruses/ Immunology)	34
Unit 6: Public Health	26

Unit 1: Pseudoscience/ Scientific Method

Essential Questions:
- Is there a difference between science and pseudoscience?
- How can the scientific method be utilized in solving everyday problems?
- How is scientific inquiry used as a tool to understand the world?

Instructional Objectives/ Concepts:
- Describe the processes involved in practicing good scientific thought.
- Understand that science can help take better care of personal health, be a wiser consumer, and become a better informed citizen.
- Refine interrelationships among concepts and patterns of evidence among central scientific explanations.
- Use scientific principles and theories to build and refine standards for data collection, posing controls, and presenting evidence.
- Explain how ethics apply to science.

Strategies and Activities may include:
- Laboratory observations and experimentation
- Topical research and presentation.
- Actual Case Studies from News Media
- Overhead transparencies
- Demonstrations
- Web Quests
- Laboratory Activities: Group and Individual
- Small Group Discussions
- Debate
- Student Research/ Letter Writing, Interviews, Library Research
- Make observations
- Develop inferences

Evaluations may include:
- Case Study Analysis
- Final Exam
- Tests
- Quizzes
- Debate
- Student Presentations
- Lab Reports
- Research Paper
- Exit Cards
- Formative assessments

• Observation of following media: • *House, MD* episode • *Phenomenon* • *The Illusionist*	
NGSS HS-ETS1-1,HS-ETS1-2, HS ETS1-3 HS-PS1-2	**CCLS Literacy** RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11-12.5, WHST.11-12.10 **CCLS Mathematics** MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.3

Unit 2: Physics/ Chemistry/ Biology
(Radiation, Radioactivity, Nuclear Energy)

Essential Questions:

- What is the history of the development of radiation science?
- What are the kinds of nuclear radiation?
- What is the difference between radioactivity and radiation?
- What is half life?
- What are the ethical and moral implications of the use of nuclear science in both the military and industrial settings?

Instructional Objectives/ Concepts:

- Explain how the properties of isotopes, including half-lives, decay modes, and nuclear resonances, lead to useful applications of isotopes.
- Explain the detrimental effects of radiation exposure.
- Understand that society can dictate the direction of scientific research and development.
- Reflect on and revise understandings as new evidence emerges.
- Consider alternative theories to interpret and evaluate evidence based arguments.

Strategies and Activities may include:	*Evaluations may include:*
• Laboratory observations and experimentation • Topical research and presentation. • Actual Case Studies from News Media • Overhead transparencies • Demonstrations • Web Quests • Laboratory Activities: Group and Individual • Small Group Discussions • Debate • Student Research/ Letter Writing, Interviews, Library	• Case Study Analysis • Final Exam • Tests • Quizzes • Debate • Student Presentations • Lab Reports • Research Paper • Exit Cards • Formative assessments

Research • Make observations • Develop inferences • Observation of following media: *The China Syndrome* *Radium City* *K-19* *Fat Man and Little Boy* *CSI:Miami* episode *Dead Woman Walking*	
NGSS: HS-ETS1-1, HS-ETS1-2, HS ETS1-3, HS-PS1-8	**CCLS Literacy:** RST.11-12.3, RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11-12.1.D, WHST.11.12.5, WHST.11-12.10 **CCLS Mathematics** MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.3

Unit 3: Physical Science/ Earth Science
(Weather, Climate, Meteorology)

Essential Questions:

- What is the difference between climate and weather?
- What are factors that determine climate change?
- What are Greenhouse gases?
- What is Global Warming?
- What effect does global warming have on weather?
- What is the economic impact of global warming?
- Are there ways to alleviate global warming?

Instructional Objectives/ Concepts:

- Explain how the climate in regions throughout the world is affected by seasonal weather patterns, as well as other factors, such as the addition of greenhouse gases to the atmosphere and proximity to mountain ranges and to the ocean.
- Predict the impact on biogeochemical systems if there was an increase or decrease in internal and external energy.
- Describe the effect of the continuing changes in weather and climate patterns on populations, commerce and ecosystems.
- Interpret the relationship of increasing greenhouse gases and global temperature and weather patterns.
- Understand how ocean water temperature has a profound effect on weather and climate patterns.

Strategies and Activities may include:

- Laboratory observations and experimentation
- Utilize the Davis weather station to acquire and analyze daily local weather data.
- Topical research and presentation.
- Actual Case Studies from News Media
- Overhead transparencies

Evaluations may include:

- Case Study Analysis
- Final Exam
- Tests
- Quizzes
- Debate
- Student Presentations

• Demonstrations • Web Quests • Laboratory Activities: Group and Individual • Small Group Discussions • Debate • Student Research/ Letter Writing, Interviews, Library Research • Make observations • Develop inferences • Observation of following media: Various documentaries (*Last Days on Earth, A Global Warning)* concerning severe weather *Twister* *The Day After Tomorrow*	• Lab Reports • Research Paper • Exit Cards • Formative assessments
NGSS HS-ETS1-1, HS-ETS1-2, HS ETS1-3 HS-ESS2-4, HS-ESS2-5	**CCLS Literacy** RST.11-12.3, RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.5, WHST.11-12.10 **CCLS Mathematics** MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.3

Unit 4: Biology / Genetics / Life Sciences

Essential Questions:

- How is genetic information passed through generations?
- How can we predict the potential impact on an organism given a change in a specific DNA code?
- What is the potential value and applications of Genome Projects?
- Is a genetic disorder acquired or inherited?
- What effect can genetic engineering have on the nutritive value of food?
- How are transgenic organisms used in meeting consumer needs in the food and drug industry?
- What are the ethical implications of cloning?

Instructional Objectives/Concepts:

- Discuss how inserting, deleting, or substituting DNA segments can alter the genetic code.
- Understand how the resulting features may help, harm, or have little or no effect on the offspring's success in its environment.
- Understand that DNA molecules contain information that determines a sequence of amino acids which result in specific proteins.
- Understand that sorting and recombination of genes in reproduction result in a great variety of possible gene combinations.
- Discuss how genetic changes may lead to profound effects including terminal illness.
- Describe the process of cloning and understand why there is a world-wide ban on human cloning.
- Explain the ABO blood typing system and the genetic reasoning behind it concerning antigens and antibodies.
- Describe agglutination and how and why this happens
- Explain how human blood can be differentiated from animal blood
- Use a Punnet Square to determine genotype and phenotype of offspring

Strategies and Activities may include:

- Laboratory observations and experimentation
- Topical research and presentation.
- Actual Case Studies from News Media

Evaluations may include:

- Case Study Analysis
- Final Exam
- Tests

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Overhead transparencies
Demonstrations
Web Quests
Laboratory Activities: Group and Individual
Small Group Discussions
Debate
Student Research/ Letter Writing, Interviews, Library Research
Make observations
Develop inferences
Observation of following media:
GATTACA
Lorenzo's Oil
The Future of Food
Food, Inc.
The Island
The Eyes of Nye: Cloning & GMO

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Quizzes
Debate
Student Presentations
Lab Reports
Research Paper
Exit Cards
Formative assessments

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<td>NGSS
HS-ETS1-1, HS-ETS1-2, HS ETS1-3, HS-LS1-1, HS-LS1-2, HS-LS3-1, HS-LS3-2, HS-LS3-3</td>
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RST.11-12.3, RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.5, WHST.11-12.10
CCLS Mathematics
MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.3</td>
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Unit 5: Biology / Life Sciences / Epidemiology
(Bacteria / Viruses / Immunology)

Essential Questions:

- What is a cells response to exposure to bacteria and viruses?
- What will be the effects of virulent exposure on a given population?
- How do various agencies work together to locate, analyze and combat the incidences of epidemics and pandemics?
- How can public education affect the spread of disease?

Instructional Objectives/ Concepts:

- Describe how world travel greatly influences the spread of disease.
- Understand how socio-economic status, hygiene, and access to medical care influence the duration, severity and spread of a disease.
- Understand that cellular function is maintained through the regulation of cellular processes in response to internal and external environmental conditions.
- Understand the importance of monitoring and containing outbreaks of both bacterial and viral agents by various national and international health agencies.
- Demonstrate that science involves practicing productive social interactions with peers.
- Demonstrate that science involves using language, both oral and written, as a tool for making thinking public.

Strategies and Activities may include:

- Laboratory observations and experimentation
- Topical research and presentation.
- Actual Case Studies from News Media
- Overhead transparencies
- Demonstrations
- Web Quests
- Laboratory Activities: Group and Individual

Evaluations may include:

- Case Study Analysis
- Final Exam
- Tests
- Quizzes
- Debate
- Student Presentations
- Lab Reports

• Small Group Discussions • Debate • Student Research/ Letter Writing, Interviews, Library Research • Make observations • Develop inferences • Observation of following media: Documentaries such as: *Ebola-The Plague Fighters* *Outbreak* *Zika Documentary* *Contagion* House, MD "*Airborne*" *And the Band Played On*	• Research Paper • Exit Cards • Formative assessments
NGSS HS-ETS1-1, HS-ETS1-2, HS ETS1-3 HS-LS1-1, HS-LS1-2, HS-LS3-1, HS-LS3-2, HS-LS3-3 HS-PS2-1	**CCLS Literacy** RST.11-12.3, RST.11-12.4, RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.9, WHST.11-12.10 **CCLS Mathematics** MP.2, MP,4, HSN-Q.A.1, HSN-Q-A.3

Unit 6: Public Health

Essential Questions:

- How does scientific knowledge benefit, deepen and broaden, the public's consciousness of moral and ethical and health issues?
- How can science use language, both oral and written, as a tool for making thinking public?
- How do certain chemicals, pathogens, and high energy radiation, seriously impair normal cell functions and the health of the organism?
- How do natural and human made chemicals circulate with water in the hydrologic cycle?

Instructional Objectives/Concepts:

- Understand that scientists engage in multiple forms of discussion in order to process, make sense of, and learn from other's ideas, observations, and experiences.
- Understand that science represents ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.
- Describe how a disease is the result of a malfunctioning system, organ, and cell, and relate this to possible treatment interventions.
- Analyze and explain the sources and impact of chemicals on a specific water supply.

Strategies and Activities may include: • Laboratory observations and experimentation • Topical research and presentation. • Actual Case Studies from News Media • Overhead transparencies • Demonstrations • Web Quests • Laboratory Activities: Group and Individual • Small Group Discussions • Debate • Student Research/ Letter Writing, Interviews, Library Research	*Evaluations may include:* • Case Study Analysis • Final Exam • Tests • Quizzes • Debate • Student Presentations • Lab Reports • Research Paper • Exit Cards • Formative assessments

• Make observations • Develop inferences • Observation of following media: Documentary: *Secrets Through the Smoke* Feature films: *The Insider* *A Civil Action* *Erin Brockovich*	
NGSS: HS-ETS1-1, HS-ETS1-2, HS-ETS1-3 HS-PS1.2, HS-PS1.8, HS-LS1-2, HS-LS1-4	**CCLS Literacy** RST.11-12.7, RST.11-12.8, RST.11-12.9, WHST.11.12.4,WHST.11-12.5, WHST.11-12.10 **CCLS Mathematics** MP.2, HSN-Q.A.1, HSN-Q-A.3

Next Generation Science Standards and Common Core Literacy Standards

EXPECTED OUTCOMES with link to NGSS and CCLS

The following list identifies the relevant standards to the course material:

- 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-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay
- 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-LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

- HS-LS3-1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate
- HS-ESS2-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
- RST.11-12.1 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.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks: analyze the specific results based on explanations in the text
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible, and corroborating or challenging conclusions with other sources of information.
- RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- WHST.11-12.1.D Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.11-12.7 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.
- WHST.11-12.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
- HSN.QA.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.QA.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- MP.2 Reason abstractly and quantitatively with mathematics
- MP.4 Model with mathematics

PARCC Scoring Rubric

TOWNSHIP OF UNION PUBLIC SCHOOLS

Geophysics
Curriculum Guide
2016

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TOWNSHIP OF UNION PUBLIC SCHOOLS

Administration

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Assistant Superintendent..Ms. Annie Moses

School Business Administrator..Mr. Manuel Viera

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DEPARTMENT SUPERVISORS

English/Social Studies 2-5 .... Mr. Robert Ghiretti

Mathematics/Science 2-5 .... Ms. Theresa Matthews

Language Arts/Library Services 9-12 .... Ms. Randi Moran

Science 6-12 .... Ms. Maureen Guilfoyle

Math 6-12.................... Dr. Jeremy Cohen

Social Studies/Business .... Ms. Libby Galante

World Language/ESL/ Career Education.................... Ms. Yvonne Lorenzo

Art/Music .... Mr. Ronald Rago

Physical Education/Health .... Ms. Linda Ionta

School Counseling K-12.................... Ms. Nicole Ahern

English/Math/Science/Social Studies K-2.................... Ms. Maureen Corbett

Curriculum Committee
Academic Area

Maureen Guilfoyle, Supervisor of Science

Stephen Piotrowski
Adam Raffaele

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Administration

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Mission Statement

The mission of the Township of Union Public Schools is to build on the foundations of honesty, excellence, integrity, strong family, and community partnerships. We promote a supportive learning environment where every student is challenged, inspired, empowered, and respected as diverse learners. Through cultivation of students' intellectual curiosity, skills and knowledge, our students can achieve academically and socially, and contribute as responsible and productive citizens of our global community.

Philosophy Statement

The Township of Union Public School District, as a societal agency, reflects democratic ideals and concepts through its educational practices. It is the belief of the Board of Education that a primary function of the Township of Union Public School System is formulation of a learning climate conductive to the needs of all students in general, providing therein for individual differences. The school operates as a partner with the home and community.

Statement of District Goals

- Develop reading, writing, speaking, listening, and mathematical skills.
- Develop a pride in work and a feeling of self-worth, self-reliance, and self discipline.
- Acquire and use the skills and habits involved in critical and constructive thinking.
- Develop a code of behavior based on moral and ethical principals.
- To be able to work with others cooperatively.
- Acquire a knowledge and appreciation of the historical record of human achievement and failures and current societal issues.
- Acquire a knowledge and understanding of the physical and biological sciences.
- Efficient and effective participation in economic life and the development of skills to enter a specific field of work.
- Appreciate and understand literature, art, music, and other cultural activities.
- Develop an understanding of the historical and cultural heritage.
- Develop a concern for the proper use and/or preservation of natural resources.
- Develop basic skills in sports and other forms of recreation.

UHS Geophysics CURRICULUM

Course Description

The Geophysics course is designed for the non-science major, as a general survey course, to fulfill the third year science requirement. The course is inquiry based. Laboratory investigations, Internet research, and projects are utilized to develop science knowledge that will be interesting and applicable to the non-science major. In addition, students will develop skills such as identifying problems; forming hypotheses; data collection & data analysis; and making inferences. The curriculum reinforces and extends concepts learned in physics and chemistry, and introduces relevant topics in human biology, environmental science, natural disasters, and forensics, which are aligned with the new Next Generation Science Standards.

Goal

The goal of Geophysics is to produce students that have a basic understanding of aspects of science that are relevant to their lives, which will enable them to find answers to questions that may arise from everyday experiences.

Recommended Textbooks

Hewitt, Lyons, Suchocki, Yeh. 2007. Conceptual Integrated Science. Pearson Education Inc. San Francisco.

UHS Geophysics CURRICULUM

Students will be able to…

1. Differentiate the steps of the scientific method by performing labs and working in collaborative groups effectively.
2. Write a proper lab report after conducting an experiment.
    a. Conclusions will be 5 paragraph essays and address district literacy goals.
    b. Lab reports will interpret and create data tables and graphs.
3. Utilize math skills, including measuring, using the metric system, performing calculations, graphing, and data analysis.
4. Display a basic understanding of Velocity, Acceleration, Gravity, Momentum, Density, and Newton's three laws of motion.
5. Discuss matter, the structure of the atom, and how elements combine to form compounds. Evaluate the connection between the foods they eat, or chemicals they put into their bodies and their effect in terms of common health issues or risk factors that may occur.
6. Explain, display, and model the main systems of the human body and detail how they interact and how they play an important role in homeostasis.
7. Explain the impact of pollution on the environment and humans.
8. Understand the importance of protecting natural resources with a focus on energy. Identify sources of energy and differentiate between renewable and non-renewable energy. Review current trends of energy usage and explore methods of conservation.
9. Identify types of natural disasters, causes and impacts on populations and the environment and Distinguish between the different types of severe weather events and describe climate conditions that impact these storms including ozone depletion and global warming. Relate cause and effects of climate change and current warming trends.
10. Understand the complexity of life in the oceans from the simplest (plankton) to the most complex (marine Mammals).
11. Demonstrate and explain the causes and factors of forensic blood spatter.
12. Display the basic information and methodologies of forensic fingerprinting.

Pacing Guide- Course

Content		Number of Days
Unit 1:	Motion and Forces	30
Unit 2:	Chemistry	30
Unit 3:	Human Biology	30
Unit 4:	Environmental Science: Pollution & Energy	30
Unit 5:	Natural Disasters	30
Unit 6:	Forensic Science-Fingerprints & Blood Spatter	30

UHS Geophysics CURRICULUM

CONTENT AREA: Physics	Grade: HS	UNIT #: 1	UNIT NAME: Motion and Forces

Unit 1 Motion and Forces

This unit will explain the how Linear and Circular motion can impact everyday occurrences. The student will define, explore, compare, and assess the various aspects of motion and forces in physics and how they pertain to common occurrences of daily life to explain biological and technology concepts. Students will address and explore:

- Motion (Linear motion, Speed, Velocity, Acceleration, Center of mass, Force, Mass
- Newton's laws of motion
- Energy & Momentum
- Gravity
- Heat
- Waves-Sound & Light

#	STUDENT LEARNING OBJECTIVES	CORRESPONDING PE
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-PS2-1**
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-PS2-2**
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-PS2-3**

UHS Geophysics CURRICULUM			
CONTENT AREA: Physics	**Grade: HS**	**UNIT #: 1**	**UNIT NAME: Motion and Forces**

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-PS2-4**
5	**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-PS3-1**
6	**Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).** [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]	**HS-PS3-2**
7	**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-PS3-3**
8	**Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).** [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [*Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.*]	**HS-PS3-4**
	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	**HS-ETS1-1**

UHS Geophysics CURRICULUM			
CONTENT AREA: Physics	Grade: HS	UNIT #: 1	UNIT NAME: Motion and Forces

	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-ETS1-2
	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-ETS1-3
	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.	HS-ETS1-4

UHS Geophysics CURRICULUM

CONTENT AREA: Physics	Grade: HS	UNIT #: 1	UNIT NAME: Motion and Forces

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Developing and Using Models

Modeling 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-PS2-1-4),(HS-PS3-1-4)

Planning and Carrying Out Investigations

Planning 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

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)

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)

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-PS2-1-4), (HS-PS3-1-4)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1-4)
- Systems can be designed to cause a desired effect. (HS-PS2-3)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-1-4), (HS-PS3-1-4)
- 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-ETS1-4)

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3)

Energy and Matter

the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-1-4), (HS-PS3-1-4) **Analyzing and Interpreting Data** Analyzing 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-PS2-1-4), (HS-PS3-1-4) **Using Mathematics and Computational Thinking** Mathematical 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. • Use mathematical representations of phenomena to describe explanations. (HS-PS2-2),(HS-PS2-3) • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** Constructing 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.	• These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) **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** **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	• 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 cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World • 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-ETS1-1) (HS-ETS1-3) • 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) *Connections to Nature of Science* **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)

• Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-1-4), (HS-PS3-1-4) • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2), (HS-PS2-1-4), (HS-PS3-1-4) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3), (HS-PS2-1-4), (HS-PS3-1-4) **Obtaining, Evaluating, and Communicating Information** Obtaining, 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. • Communicate scientific and technical information (e.g. about 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-PS2-1), (HS-PS2-2), (HS-PS2-3) *Connections to 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)	surrounding environment. (HS-PS3-3),(HS-PS3-4) **ETS1.A: Defining and Delimiting an Engineering Problem** • 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. *(secondary to HS-PS2-3)* • 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. *(secondary to HS-ESS3-2),(secondary HS-ESS3-4)* • 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. *(secondary to HS-PS2-3)*	

UHS Geophysics CURRICULUM

CONTENT AREA: Physics	Grade: HS	UNIT #: 1	UNIT NAME: Motion and Forces

Connections to other DCIs in this grade-band:

HS.PS3.A (HS-PS2-4); **HS.PS3.C** (HS-PS2-1); **HS.ESS1.A** (HS-PS2-1),(HS-PS2-2),(HS-PS2-4), (HS-PS3-1), (HS-PS3-4); **HS.ESS1.B** (HS-PS2-4); **HS.ESS1.C**(HS-PS2-1),(HS-PS2-2),(HS-PS2-4);**HS.ESS2.A** (HS-PS3-1), (HS-PS3-2), (HS-PS3-3); **HS.ESS2.C** (HS-PS2-1),(HS-PS2-4); **HS.ESS2.D** (HS-PS3-4); **HS.ESS3.A** (HS-PS2-4), (HS-PS3-3); **HS.PS1.A** (HS-PS3-2); **HS.PS1.B** (HS-PS3-1),(HS-PS3-2); **HS.PS2.B** (HS-PS3-2),(HS-PS3-5); **HS.LS2.B** (HS-PS3-1);

Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include: **Physical Science:** HS-PS2-3, HS-PS3-3
Connections to HS-ETS1.B: Developing Possible Solutions Problems include: **Earth and Space Science:** HS-ESS3-2, HS-ESS3-4 **Life Science:** HS-LS2-7, HS-LS4-6
Connections to MS-ETS1.C: Optimizing the Design Solution include: **Physical Science:** HS-PS1-6, HS-PS2-3

Common Core State Standards Connections:
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-PS3-4)

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-PS3-3), (HS-PS3-4), (HS-ETS1-1),(HS-ETS1-3)

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-ETS1-1),(HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)

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-PS3-4)

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-PS3-4)

WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1), (HS-PS2-5), (HS-PS3-4)

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),

UHS Geophysics CURRICULUM			
CONTENT AREA: Physics	**Grade: HS**	**UNIT #: 1**	**UNIT NAME:** Motion and Forces

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4), (HS-PS3-1-4), (HS-ETS1-1), (HS-ETS1-3), (HS-ETS1-4)
MP.4	Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4), (HS-PS3-1-4), (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3), (HS-ETS1-4)
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-PS3-1), (HS-PS3-3)
HSN.Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4) , (HS-PS3-1), (HS-PS3-3)
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-PS3-1), (HS-PS3-3)
HSA.SSE.A.1	Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)
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)
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)
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)
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)

Sample Activities, Lessons, and Lab
Define speed by using the equation s=d/t. Solve equations and calculate speed given the distance being traveled and the time of travel. Rearrange the speed equation to solve for distance and time.

UHS Geophysics CURRICULUM			
CONTENT AREA: Physics	**Grade: HS**	**UNIT #: 1**	**UNIT NAME:** Motion and Forces

Sample Activities, Lessons, and Lab
Compare and contrast rates of speed for class members performing four tasks. Construct and interpret graphs.
Calculate Acceleration. Identify the impact of gravity on weight. Define freefall.
Perform calculations using the formula for freefall.
Explain Newton's first law. Define inertia.
Create simple models to demonstrate the benefits of seatbelts using Newton's first law of motion.
Define Newton's second law using f=ma. Measure and describe the relationship between the force acting on an object, the mass of the object, and the rate of acceleration
Perform calculations using the formula: force equals mass times acceleration.
Explain that forces always occur in pairs that are equal in strength and opposite in direction.
Discuss why seatbelts are worn in cars and what happens during car collisions. Perform egg toss lab and analyze it, including how it relates to airbags in cars.
Define density by its equation and explain why objects or the same material will always have the same density. Explain displacement and relate it to volume.
LAB: Perform calculations to determine velocity and acceleration using matchbox cars.
LAB: Carry out a free fall experiment with measurements and calculations.
LAB: Examine and Explore Newton's 1st Law with Carts or Hot Wheels Cars.
LAB: Examine and Explore Newton's 2nd and 3rd Law with Carts or Hot Wheels Cars.
LAB: Examine and Explore Newton's 2nd and 3rd Law with Balloon Rockets making calculations and measurements.
LAB: Explore Newton's 3rd Law with an experiment using two different mass vehicles.
LAB: Explore Density with different wood of the same dimensions

UHS Geophysics CURRICULUM

CONTENT AREA: Chemistry	Grade: HS	UNIT #: 2	UNIT NAME: Unit 2: Chemistry

Unit 2 Chemistry and Human Biology

- This unit will explain the investigations of Matter and Chemistry.
- The student will assess (using scientific, economic, and other data) the details & potential impact of
  - Investigating Matter (Chemistry, Phase Changes, Physical and Chemical Matter Properties, Elements & the Periodic Table, Elements to Compounds

#	STUDENT LEARNING OBJECTIVES	CORRESPONDING PE
1	**Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [*Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.*]	HS-PS1-1
2	**Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]	HS-PS1-2
3	**Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*]	HS-PS1-3
4	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.**	HS-ETS1-1
5	**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-ETS1-2

UHS Geophysics CURRICULUM			
CONTENT AREA: Chemistry	Grade: HS	UNIT #: 2	UNIT NAME: Unit 2: Chemistry

6	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-ETS1-3
7	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.	HS-ETS1-4

UHS Geophysics CURRICULUM

CONTENT AREA: Chemistry	Grade: HS	UNIT #: 2	UNIT NAME: Unit 2: Chemistry

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling 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. • Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations 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-PS1-3) **Constructing Explanations and Designing Solutions** Constructing 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 knowledge, principles, and theories. • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models,	**PS1.A: Structure and Properties of Matter** • Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1) • The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1),(HS-PS1-2) • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3) **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-ETS1-1) • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers	**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-PS1-1),(HS-PS1-2),(HS-PS1-3) **Systems and System Models** • 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-ETS1-4) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ETS1-1), (HS-ETS1-3)

theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2) **Asking Questions and Defining Problems** Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences 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. • Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS1-3) • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** Constructing 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 knowledge, principles, and	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)	

CONTENT AREA: Chemistry	Grade: HS	UNIT #: 2	UNIT NAME: Unit 2: Chemistry

theories. • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)		

Connections to other DCIs in this grade-band:

HS.LS1.C (HS-PS1-1), (HS-PS1-2); **HS.ESS2.C** (HS-PS1-2),(HS-PS1-3);
Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include: **Physical Science:** HS-PS2-3, HS-PS3-3
*Connections to HS-ETS1.B: Developing Possible Solutions Problems include:***Earth and Space Science:** HS-ESS3-2, HS-ESS3-4 **Life Science:** HS-LS2-7, HS-LS4-6
*Connections to MS-ETS1.C: Optimizing the Design Solution include:***Physical Science:** HS-PS1-6, HS-PS2-3

Common Core State Standards Connections:ELA/Literacy -

RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)

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-PS1-3)

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-ETS1-1), (HS-ETS1-3)

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-ETS1-1), (HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3)

CONTENT AREA: Chemistry	Grade: HS	UNIT #: 2	UNIT NAME: Unit 2: Chemistry

WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2)
WHST.9-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2)
WHST.9-12.7	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-PS1-3)
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-PS1-3)
WHST.9-12.9	Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)
Mathematics -	
MP.2	Reason abstractly and quantitatively. (HS-ETS1-1), (HS-ETS1-3), (HS-ETS1-4)
MP.4	Model with mathematics. (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3), (HS-ETS1-4)
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-PS1-2), (HS-PS1-3)
HSN.Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-3)

Sample Activities, Lessons, and Lab
Identify the different phases of matter and classify various substances as solid, liquid or gasses.
Explain solids liquids and gasses in terms of density of molecules, volume, shape, and particle movement.
Explain that all matter has mass and takes up space. Energy has no mass and takes up no space.
Using the internet, research one modern atomic theorist and complete one of several performance assessment options. Present findings to the class. Presentations can be in several formats but should utilize both a visual and auditory component and lead to discussions.
Identify various models of the atom and describe the one used today.

UHS Geophysics CURRICULUM			
CONTENT AREA: Chemistry	**Grade: HS**	**UNIT #: 2**	**UNIT NAME: Unit 2: Chemistry**

Explain particle charges and what is meant by a neutral atom.
Construct simple models of atoms of different elements using pipe cleaners, beads, and pom-poms.
Use the periodic table to identify atomic number and atomic mass. Complete periodic table fill in sheets to organize information.
Define physical and chemical change and list examples of each.
Use the Periodic Table to identify "A" families and periodic trends.
Use the internet to research some common chemical compounds used in everyday life. Construct models of these compounds using cut circles of construction paper, glue, and popsicle sticks, with different colors representing different elements.
LAB: Perform calculations to determine number of atoms in products and reactants.
LAB: Identify the five main types of chemical reactions.
LAB: Create a 3-D Compound with a Research Paper.
LAB: Describe how mixtures are formed.
LAB: Explain the difference between heterogeneous and homogeneous mixtures.
LAB: Describe the process by which solutes dissolve in solvents.
LAB: Perform related lab experiments, create graphs, write up lab reports.

UHS Geophysics CURRICULUM

CONTENT AREA: Geophysics	Grade: HS	UNIT #: 3	UNIT NAME: Unit 3: Human Biology

Unit 3 Human Biology

- This unit will explain the Basics of Human Biology.
- The student will assess (using scientific, economic, and other data) the details & potential impact of
  - Human Biology I –Control & Development –(Organization, Homestasis, The Brain, The Nervous System, The Senses, Hormones, and the Skeleton & Muscles)
  - Human Biology II –Care & Maintenance-(Body System Integration, Circulatory System, Respiration, Digestion, Excretion, and Body Defenses)

#	STUDENT LEARNING OBJECTIVES	CORRESPONDING PE
1	**Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.** [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [*Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.*]	HS-LS1-2
2	**Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [*Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.*]	HS-LS1-3
3	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.**	HS-ETS1-1
4	**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-ETS1-2
5	**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-ETS1-3

UHS Geophysics CURRICULUM			
CONTENT AREA: Geophysics	Grade: HS	UNIT #: 3	UNIT NAME: Unit 3: Human Biology

6	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.	HS-ETS1-4

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling 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-LS1-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations 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-LS1-3) **Asking Questions and Defining Problems** Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking**	**LS1.A: Structure and Function** • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2) • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) **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-ETS1-1) • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers	**Systems and System Models** • 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-LS1-2), (HS-ETS1-4) **Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3) --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ETS1-1), (HS-ETS1-3)

Mathematical and computational thinking in 9-12 builds on K-8 experiences 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. • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** Constructing 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 knowledge, principles, and theories. • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3) ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** • Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)	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)	

CONTENT AREA: Human Biology	Grade: HS	UNIT #: 3	UNIT NAME: Unit 3: Human Biology

Connections to other DCIs in this grade-band:

HS.LS3.A (HS-LS1-1)
Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include: **Physical Science:** HS-PS2-3, HS-PS3-3
*Connections to HS-ETS1.B: Developing Possible Solutions Problems include:***Earth and Space Science:** HS-ESS3-2, HS-ESS3-4 **Life Science:** HS-LS2-7, HS-LS4-6
*Connections to MS-ETS1.C: Optimizing the Design Solution include:***Physical Science:** HS-PS1-6, HS-PS2-3

Common Core State Standards Connections: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-LS1-2), (HS-LS1-3)
RST.11-12.2	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-LS1-2), (HS-LS1-3)
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-ETS1-1), (HS-ETS1-3)
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-ETS1-1), (HS-ETS1-3)
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-2), (HS-LS1-3)
WHST.9-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-2), (HS-LS1-3)
WHST.9-12.7	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-LS1-2), (HS-LS1-3)
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-LS1-2), (HS-LS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-2), (HS-LS1-3)

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-LS1-2), (HS-LS1-3)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1), (HS-ETS1-3), (HS-ETS1-4), (HS-LS1-2), (HS-LS1-3)

MP.4 Model with mathematics. (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3), (HS-ETS1-4), (HS-LS1-2), (HS-LS1-3)

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-LS1-2), (HS-LS1-3)

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS1-2), (HS-LS1-3)

- Human Biology I –Control & Development –(Organization, Homestasis, The Brain, The Nervous System, The Senses, Hormones, and the Skeleton & Muscles)

Human Biology II –Care & Maintenance-(Body System Integration, Circulatory System, Respiration, Excretion, and Body Defenses)

Sample Activities, Lessons, and Lab
Define and Explore how there is Control and Development in the Human Body
Define and Model how homeostasis takes place in the body
Map and Model the Human Brain and Nervous System
Correlate the senses to the brain and nervous system
Map and Define the major hormones
Define, draw, and model the skeletal and musculature system and relate how they work together
Map and Model the Circulatory system – Trace the path of blood
Map and Model the Respiration System and relate its function to the circulatory system
Define the importance of excretion and relate it to health/nutrition/digestion learned in health class
Define the different body defenses and explore how the body takes different paths to destroy vectors of disease and infection

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CONTENT AREA: Human Biology	**Grade: HS**	**UNIT #: 3**	**UNIT NAME: Unit 3: Human Biology**

LAB: Perform a hands on lab on how the body carries out homeostasis with different body activities
LAB: Perform measurements and calculations to determine responses of the brain and nervous system
LAB: Identify the five main senses and relate how intricate our senses are in relating information to the brain and nervous system
LAB: Model and Map out the major hormones and their functions
LAB: Describe how muscles and bones interact with a hands on lab and lab report.
LAB: Explain and measure the different aspects of the circulatory system
LAB: Measure and Define respiratory capability and compare among individuals
LAB: Research and relate the importance of excretion and abnormalities that can occur
LAB: Draw a model of the bodies defenses and examine how this happens with a model exercise

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CONTENT AREA: Environmental Science	Grade: HS	UNIT #: 4	UNIT NAME: Unit 4: Environmental Science Pollution & Energy

Unit 4 Environmental Science: Pollution & Energy

- This unit will explain the unintended consequences of an ever growing human population and its impact on the environment. The student will compare over time the impact of human activity through; Pollution and human sources, Fossil Fuels, Non-Renewable Energy, Renewable Energy.
- The student will assess, explore, understand, address, and identify (using scientific, economic, and other data) the potential environmental impact of
  - Explain the impact of pollution on the environment and humans.
  - Understand the importance of protecting natural resources with a focus on energy. Identify sources of energy and differentiate between renewable and non-renewable. Identify and review how fossil fuels are formed and their impact on the planet. Review current trends of energy usage and explore methods of conservation.

#	STUDENT LEARNING OBJECTIVES	CORRESPONDING PE
1	**Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]	**HS-ESS3-1**
2	**Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*** [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]	**HS-ESS3-2**
3	**Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] *[Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]*	**HS-ESS3-3**

UHS Geophysics CURRICULUM			
CONTENT AREA: Environmental Science	Grade: HS	UNIT #: 4	UNIT NAME: Unit 4: Environmental Science Pollution & Energy

4	**Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*** [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]	HS-ESS3-4
5	**Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.** [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [*Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.*]	HS-ESS3-5
6	**Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [*Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.*]	HS-ESS3-6
7	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.**	HS-ETS1-1
8	**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-ETS1-2
9	**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-ETS1-3

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CONTENT AREA: Environmental Science	Grade: HS	UNIT #: 4	UNIT NAME: Unit 4: Environmental Science Pollution & Energy

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences 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 computational models in order to make valid and reliable scientific claims. (HS-ESS3-3), (HS-ESS3-4) (HS-ESS3-5), (HS, ESS3-6) **Asking Questions and Defining Problems** Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences 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-ESS3-3)	**ESS2.D: Weather and Climate** • Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(secondary to HS-ESS3-6)* **ESS3.A: Natural Resources** • Resource availability has guided the development of human society. (HS-ESS3-1) • All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2) **ESS3.B: Natural Hazards** • Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) **ESS3.C: Human Impacts on Earth Systems** • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) • Scientists and engineers can make major contributions by developing technologies that produce less pollution and	**Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1) • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2) **Stability and Change** (pp. 98-101) • 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-ESS3-3) • Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) **Cause and Effect** (pp. 87-89) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6) **_Connections to Engineering, Technology, and Applications of Science_**

CONTENT AREA: Environmental Science	Grade: HS	UNIT #: 4	UNIT NAME: Unit 4: Environmental Science Pollution & Energy

• Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) **Constructing Explanations and Designing Solutions** Constructing 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 knowledge, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1) • Design 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-ESS3-4) • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate	waste and that preclude ecosystem degradation. (HS-ESS3-4) **ESS3.D: Global Climate Change** • Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5) • Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) **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), *(secondary HS-ESS3-4), (secondary to HS-LS2-7)* **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	**Influence of Science, Engineering, and Technology on Society and the Natural World** • Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3) • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2), (HS-ESS3-4) • New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3), (HS-ETS1-1), (HS-ETS1-3) • Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-3) ***Connections to Nature of Science*** **Science is a Human Endeavor** • Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) **Science Addresses Questions About the Natural and Material World** • Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) • Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)

CONTENT AREA: Environmental Science	Grade: HS	UNIT #: 4	UNIT NAME: Unit 4: Environmental Science Pollution & Energy

and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2) ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** • Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5) • New technologies advance scientific knowledge. (HS-ESS3-5) **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based on empirical evidence. (HS-ESS3-5) • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)	be needed. (HS-ETS1-2)	• Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

Connections to other DCIs in this grade-band:

HS.PS1.B (HS-ESS3-3); **HS.PS3.B** (HS-ESS3-2), (HS-ESS3-5); **HS.PS3.D** (HS-ESS3-2), (HS-ESS3-5); **HS.LS1.C** (HS-ESS3-5); **HS.LS2.A** (HS-ESS3-2), (HS-ESS3-3); **HS.LS2.B** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-6); **HS.LS2.C** (HS-ESS3-3), (HS-ESS3-4),(HS-ESS3-6); **HS.LS4.D** (HS-ESS3-2), (HS-ESS3-3), (HS-ESS3-4), (HS-ESS3-6); **HS.ESS2.A** (HS-ESS3-2), (HS-ESS3-3), (HS-ESS3-6); **HS.ESS2.D** (HS-ESS3-5); **HS.ESS2.E** (HS-ESS3-3)

CONTENT AREA: Environmental Science	Grade: HS	UNIT #: 4	UNIT NAME: Unit 4: Environmental Science Pollution & Energy

Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include:
Physical Science: HS-PS2-3, HS-PS3-3
Connections to HS-ETS1.B: Developing Possible Solutions Problems include:
Earth and Space Science: HS-ESS3-2, HS-ESS3-4 **Life Science:** HS-LS2-7, HS-LS4-6
Connections to MS-ETS1.C: Optimizing the Design Solution include:
Physical Science: HS-PS1-6, HS-PS2-3

Common Core State Standards Connections:
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-ESS3-1), (HS-ESS3-2), (HS-ESS3-4), (HS-ESS3-5)

RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS3-5)

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-ESS3-5), (HS-ETS1-1), (HS-ETS1-3)

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-ESS3-2), (HS-ESS3-4), (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ESS3-1), (HS-ESS3-2), (HS-ESS3-3), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6), (HS-ETS1-1), (HS-ETS1-3)

MP.4 Model with mathematics. (HS-ESS3-3), (HS-ESS3-6) , (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3)

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

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CONTENT AREA: Environmental Science	**Grade: HS**	**UNIT #: 4**	**UNIT NAME: Unit 4: Environmental Science Pollution & Energy**

	interpret the scale and the origin in graphs and data displays. (HS-ESS3-1), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)
HSN.Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-1), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)
HSN.Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-1), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)

Sample Activities, Lessons, and Lab
Identify types of water, air, soil, and noise pollution. (Multiple Lessons)
Explain why water is a precious resource and describe our main sources of fresh water. List the major sources of air pollution.
Describe some possible health effects of air pollution.
Explain what causes indoor air pollution and how it can be prevented.
Define what Radon is and why it's a concern for homeowners.
Differentiate between Renewable and Non-Renewable Energy.
List and Define the types of Energy used in the United States and how they differ.
Explore the benefits and drawbacks of Fossil Fuels.
Research and define how Renewable energy can be an alternative to Fossil Fuels.
Explore, Research, and calculate energy usage in the United States.
Cooperate and create a research project in which energy use and alternatives are defined and mapped out for the United States.
LAB: Research how water pollution is addressed with a sample oil spill lab using vegetable oil and materials that can clean it.
LAB: Using petri dishes and Vaseline, put out passive air samplers to examine particulate matter indoors.
LAB: Sample and test different soils to see which are more polluted as related to location and local activities.
LAB: Calculate the cost and use of fossil fuels in the US and compare it to other countries.
LAB: Research and calculate the cost and use of alternative energy and compare it to Non-Renewable energy
LAB: Create a model of how non-renewable energy is extracted and refined.
LAB: Research and create a model with an explanation of how renewable energy is created.

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CONTENT AREA: Earth Science-Natural Disasters	Grade: HS	UNIT #: 5	UNIT NAME: Unit 5: Natural Disasters

Unit 5 Natural Disasters

- This unit will identify types of natural disasters, causes and impacts on populations and the environment and Distinguish between the different types of severe weather events and describe climate conditions that impact these storms including ozone depletion and global warming. It will relate cause and effects of climate change and current warming trends.
- The student will assess, explore, understand, address, and identify (using scientific, economic, and other data) the potential impact of;
  - The different types of storms in the United States (Hurricanes, Tornadoes, Flash Floods, and Earthquakes)
  - How humans examine and measure each storm types
  - Technology development that protects human establishments from the natural disaster elements
  - Relating the storms to trends in climate change and current weather trends

#	STUDENT LEARNING OBJECTIVES	CORRESPONDING PE
1	**Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scalesto 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-ESS2-1**
2	**Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.** [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]	**HS-ESS2-2**
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-ESS2-3**

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CONTENT AREA: Earth Science-Natural Disasters	**Grade: HS**	**UNIT #: 5**	**UNIT NAME: Unit 5: Natural Disasters**

4	**Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.** [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] *[Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]*	**HS-ESS2-4**
5	**Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]	**HS-ESS3-1**
6	**Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.** [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [*Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.*]	**HS-ESS3-5**
7	**Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [*Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.*]	**HS-ESS3-6**
8	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.**	**HS-ETS1-1**
9	**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-ETS1-2**

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CONTENT AREA: Earth Science-Natural Disasters	Grade: HS	UNIT #: 5	UNIT NAME: Unit 5: Natural Disasters

10	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-ETS1-3

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 9–12 builds on K–8 experiences 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 computational models in order to make valid and reliable scientific claims. (HS-ESS2-2)

Asking Questions and Defining Problems
Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Developing and Using Models
Modeling in 9–12 builds on K–8 experiences 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 world(s).

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1), (HS-ESS2-3)
- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

Disciplinary Core Ideas

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-ESS2-2)
- 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 geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

ESS2.D: Weather and Climate

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this

Crosscutting Concepts

Cause and Effect (pp. 87-89)

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4), (HS-ESS3-1)

Energy and Matter

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

Stability and Change (pp. 98-101)

- 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), (HS-ESS3-3)
- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2), (HS-ESS3-4)

Connections to Engineering, Technology, and Applications of Science

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-ESS2-3)

Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences 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. • Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) • Use mathematical representations of phenomena to describe explanations. (HS-ESS3-1) **Constructing Explanations and Designing Solutions** Constructing 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 knowledge, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1) • Design 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-ESS3-4) • Apply scientific ideas to solve a design problem, taking	energy's re-radiation into space. (HS-ESS2-2)(HS-ESS2-4) • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7) • Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6),(HS-ESS2-4) • Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(secondary to HS-ESS3-6)* **ESS3.B: Natural Hazards** • Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) **ESS3.D: Global Climate Change** • Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5) **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), *(secondary to HS-PS2-3)* • Humanity faces major global challenges today, such as the	**Influence of Engineering, Technology, and Science on Society and the Natural World** • 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), (HS-ETS1-1) (HS-ETS1-3) • Modern civilization depends on major technological systems. (HS-ESS3-1)

into account possible unanticipated effects. (HS-PS2-3) • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3) **Engaging in Argument from Evidence** Engaging 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 world(s). Arguments may also come from current scientific or historical episodes in science. • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2) ***Connections to Nature of Science*** **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) • Science arguments are strengthened by multiple lines	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), *(secondary to HS-ESS3-2), (secondary HS-ESS3-4)* **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), *(secondary to HS-PS2-3)*	

of evidence supporting a single explanation. (HS-ESS2-4)		

Connections to other DCIs in this grade-band:

HS.PS2.B (HS-ESS2-1), (HS-ESS2-3);); **HS.PS3.A** (HS-ESS2-4); **HS.PS3.B** (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS3-5); **HS.PS3.D** (HS-ESS2-3), (HS-ESS3-5); **HS.PS4.B** (HS-ESS2-2); **HS.LS1.C** (HS-ESS3-5); **HS.LS2.B** (HS-ESS2-2), (HS-ESS3-6); **HS.LS2.C** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS3-6); **HS.LS4.D** (HS-ESS2-2), (HS-ESS3-6); **HS.ESS1.C** (HS-ESS2-4); **HS.ESS2.A** (HS-ESS3-6); **HS.ESS2.C** (HS-ESS3-6); **HS.ESS2.D** (HS-ESS3-5); **HS.ESS2.E** (HS-ESS3-3); **HS.ESS3.C** (HS-ESS2-2), (HS-ESS2-4); **HS.ESS3.D** (HS-ESS2-2), (HS-ESS2-4)

Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include:

Physical Science: HS-PS2-3, HS-PS3-3

Connections to HS-ETS1.B: Developing Possible Solutions Problems include:

Earth and Space Science: HS-ESS3-2, HS-ESS3-4 **Life Science:** HS-LS2-7, HS-LS4-6

Connections to MS-ETS1.C: Optimizing the Design Solution include:

Physical Science: HS-PS1-6, HS-PS2-3

Common Core State Standards Connections:

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-ESS2-2), (HS-ESS2-3), (HS-ESS3-1), (HS-ESS3-5)

RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2), (HS-ESS3-5)

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-ESS3-5), (HS-ETS1-1), (HS-ETS1-3)

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-ETS1-1), (HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)

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-ESS2-1), (HS-ESS2-3), (HS-ESS2-4)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS3-1), (HS-ESS3-5), (HS-ESS3-6), (HS-ETS1-1), (HS-ETS1-3)

MP.4 Model with mathematics. (HS-ESS2-3), (HS-ESS2-4), (HS-ESS3-6), (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3),

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-ESS2-1), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS3-1), (HS-ESS3-5), (HS-ESS3-6)

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS3-1), (HS-ESS3-5), (HS-ESS3-6)

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS3-1), (HS-ESS3-5), (HS-ESS3-6)

Sample Activities, Lessons, and Lab
Define the effects of Tornadoes and Hurricanes and compare them. Define the scales and compare how their creation can impact humans.
Define the effects of Earthquakes and examine how they are measured in relation to damage and strength
Explore the cause and effect of Tsunamis and how they have impacted many Asian countries in the past years
Describe how volcanoes can impact local and global environment, weather, and economies.
Model how flash floods unleash a massive amount of power that can be devastation to life and property.
Research and relate how Climate change inputs energy into the atmosphere
Examine and explore the connection between climate change and El Nino to Storms
LAB: Students will examine and map out wind maps and forecasts of storms and their tracks for Hurricanes and Tornadoes (www.stem-works.com)
LAB: Students will attempt to build an Earthquake Proof structure and test it against shaking
LAB: Create a 3-D Model of Flood water and measure damage
LAB: In a small scale, students will create waves and examine wave height to depth and record and graph the changes.
LAB: Students will map earthquakes the impact of tsunamis and their reach of devastation
LAB: Research and describe storm abnormalities that can be attributed to climate change and make a presentation.

UHS Geophysics CURRICULUM

CONTENT AREA: Forensic Science	Grade: HS	UNIT #: 6	UNIT NAME: Unit 6: Basic Forensics

Unit 6 Basic Forensics

- This unit will identify how some forensic science techniques are carried out and students will
  - Demonstrate and explain the causes and factors of forensic blood spatter.
  - Display the basic information and methodologies of forensic fingerprinting.

#	STUDENT LEARNING OBJECTIVES	CORRESPONDING PE
1	**Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship amongthe 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-PS2-1**
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-PS2-2**
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-PS2-3**
4	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.**	**HS-ETS1-1**
5	**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-ETS1-2**

CONTENT AREA: Geophysics	Grade: HS	UNIT #: 5	UNIT NAME: Unit 5: Basic Forensics

6	**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-ETS1-3**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 experiences 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 computational models in order to make valid and reliable scientific claims. (HS-PS2-1)

Asking Questions and Defining Problems

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences 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 world(s).

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3)
- Use a model to provide mechanistic accounts of

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)

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), *(secondary to HS-PS2-3)*
- 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), *(secondary to HS-ESS3-2), (secondary HS-ESS3-4)*

Crosscutting Concepts

Cause and Effect (pp. 87-89)

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1)

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)

Connections to Engineering, Technology, and Applications of Science

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-ESS2-3)

Influence of Engineering, Technology, and Science on Society and the Natural World

- 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-ETS1-1) (HS-ETS1-3)

phenomena. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences 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. • Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3) • Use mathematical representations of phenomena to describe explanations. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3) **Constructing Explanations and Designing Solutions** Constructing 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 knowledge, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3) • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated	**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), *(secondary to HS-PS2-3)*	

CONTENT AREA: Geophysics	Grade: HS	UNIT #: 5	UNIT NAME: Unit 5: Basic Forensics

sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based on empirical evidence. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3) • Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3) • Science includes the process of coordinating patterns of evidence with current theory. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3) • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-PS2-1), (HS-PS2-2), (HS-PS2-3) **Connections to Nature of Science** Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena Theories and laws provide explanations in science. (HS-PS2-1) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1)		

Connections to other DCIs in this grade-band:

HS.PS3.C (HS-PS2-1); **HS.ESS1.A** (HS-PS2-1), (HS-PS2-2); **HS.ESS1.C** (HS-ESS2-4), (HS-PS2-1), (HS-PS2-2); **HS.ESS2.C** (HS-PS2-1);
Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include:
Physical Science: HS-PS2-3, HS-PS3-3
Connections to HS-ETS1.B: Developing Possible Solutions Problems include:
Earth and Space Science: HS-ESS3-2, HS-ESS3-4 **Life Science:** HS-LS2-7, HS-LS4-6
Connections to MS-ETS1.C: Optimizing the Design Solution include:
Physical Science: HS-PS1-6, HS-PS2-3

Common Core State Standards Connections:
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)

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)

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-ETS1-1), (HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3)

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)

WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-PS2-1), (HS-PS2-2), (HS-ETS1-1), (HS-ETS1-3)

MP.4 Model with mathematics. (HS-PS2-1), (HS-PS2-2), (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3),

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),

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1), (HS-PS2-2),

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1), (HS-PS2-2),

HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1)

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CONTENT AREA: Geophysics	Grade: HS	UNIT #: 5	UNIT NAME: Unit 5: Basic Forensics

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)
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)
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)
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)

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CONTENT AREA: Geophysics	**Grade: HS**	**UNIT #: 5**	**UNIT NAME: Unit 5: Basic Forensics**

Sample Activities, Lessons, and Lab
Summarize the history of fingerprinting.
Describe some characteristics of fingerprints.
Identify basic types of fingerprints.
Explain the Reliability and identification of fingerprints.
Collect fingerprints.
Describe some fingerprint identification technologies.
Lift fingerprints and match latent fingerprints.
Define Blood Spatter and what its causes are.
Define and Model how blood spatter can differ under different circumstances.
LAB: Teams will use synthetic Blood and make blood spatter marks on large Banner paper. -Compare and contrast velocity and acceleration of the blood marks -Calculate the possible force and direction that make the blood spatter mark. -Perform calculations using Newton's Laws to evaluate the Blood Spatter.
LAB: Students Record and Examine their own finger prints and hand prints
LAB: Students will take finger prints of another individual and compare them to theirs with analysis
LAB: Students will examine and explore techniques to lift latent prints from different sources using different techniques