Plainfield Public School District

Science Curriculum: High School Physics

Next Generation Science Standards

Science, engineering, and technology influence and permeate every aspect of modern life. Some knowledge of science and engineering is required to engage with the major public policy issues of today as well as to make informed everyday decisions, such as selecting among alternative medical treatments or determining how to invest public funds for water supply options. In addition, understanding science and the extraordinary insights it has produced can be meaningful and relevant on a personal level, opening new worlds to explore and offering lifelong opportunities for enriching people's lives. In these contexts, learning science is important for everyone, even those who eventually choose careers in fields other than science or engineering.

Mission: *Scientifically literate individuals possess the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity.*

Vision: The science standards are designed to help realize a vision for education in the sciences and engineering in which students, over multiple years of school, actively engage in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields. The learning experiences provided for students should engage them with fundamental questions about the world and with how scientists have investigated and found answers to those questions. Throughout grades K-12, students should have the opportunity to carry out scientific investigations and engineering design projects related to the disciplinary core ideas

For additional information go to: http://www.state.nj.us/education/aps/cccs/science/

High School

Scope and Sequence

Marking Period 1	
Big Idea: • Determining position of an object with constant acceleration as a function of time.	Big Idea: • Deconstructing and reconstructing the vertical and horizontal components of 2-D vectors.
Big Idea: • Understanding that force is directly proportional to an objects acceleration under the conditions described by Newton's 2^{nd} Law of Motion (i.e. F=ma).	Big Idea: • Testing and applying the concept that the acceleration due to gravity for all objects independent of mass.

Marking Period 2	
Big Idea: • Understanding momentum and how it is conserved in elastic collisions.	Big Idea: • Introduction to conservation of energy and understanding how it can be quantified in different forms (e.g. kinetic, potential, etc.)
Big Idea: • Understanding circular motion and conservation of angular momentum.	Big Idea: • Using the properties of energy to make experimental predictions of different objects and then gathering data to assess the accuracy of said prediction.

Marking Period 3	
Big Idea: • Understand the properties of waves as a form of transferring energy without permanently transferring matter.	Big Idea: • Understand the relationships between wavelength, frequency, and velocity of a wave.
Big Idea: • Understand how relative frequency of a wave can be used to determine the relative velocity of the wave and be able to apply that knowledge to determine the age of the universe.	Big Idea: • Understand light is electromagnetic radiation that is able to carry information. Additionally, understand the properties it has when interacting with objects of different indices of refraction.

Marking Period 4	
Big Idea: • Introduction to the interrelation of electricity and magnetism.	Big Idea: • Understanding and being able to map electrical and magnetic fields.
Big Idea: • Understanding the basic principles of electrical resistance and how it inversely affects the amount of current through a circuit.	Big Idea: • Being able to understand and construct basic circuits and being able to make proper predictions about the flow of electricity.

Time/ Terms	Big Idea:
Marking Period 1	**Big Idea:** • Determining position of an object with constant acceleration as a function of time. • Deconstructing and reconstructing the vertical and horizontal components of 2-D vectors. • Understanding that force is directly proportional to an objects acceleration under the conditions described by Newton's 2^{nd} Law of Motion (i.e. F=ma). • Testing and applying the concept that the acceleration due to gravity for all objects independent of mass.
	Topic: • Force and Motion (Unit 1 NGSS) • Fundamental Forces (Unit 2 NGSS)
	Goals: **Foundations of Physics**: By the end of the year, students will be able to understand the fundamentals of physics, involving the interrelations of force, energy, matter, and motion. **Predicting and Testing Physical Model:** By the end of the year, students will be able to use information such as mass and initial velocity to make prediction about the object after a given duration of time. Students will additionally be able to measure these results in a laboratory setting and analyze the accuracy of their predictions. **Forms of Energy:** By the end of the year, students will be able to understand the different types of energy (e.g. kinetic, potential, thermal, electromagnetic, etc.) and understand how energy changes states during different processes. **Analyzing Data**: By the end of the year, students will be able to gather and analyze data through usage of scientific techniques, application of technology, and mathematical reasoning.

	Standards/Concepts/CPI Students will be able to:	Essential Questions/Enduring Understanding	Objectives/Activities/ Procedures/ Assessment/Required Materials/Resources
	<u>NGSS (Next Gen Content Stds)</u> **HS-PS2-1.-** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. **HS-PS2-2.-** 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. **HS-PS2-3.-**Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. **HS-PS2-4**. 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,	**Essential Questions:** • How can physical relations be represented mathematically with proper notation and units? • How can an object's position be properly described as a function of time? • How does the net force of an object affect the change in the objects velocity for a given mass? • How does the gravitational field affect objects based on their position and relative velocity (e.g. Why are people on Earth stuck here while astronauts appear to be weightless?) • How does the gravitational field of an object affect objects based on their position and mass (e.g. How does the weight (force of gravity) of an astronaut of a specific mass (100 kg including gear) change at specific distances from Earth as the shuttle flies toward the moon?) **Enduring Understandings:** • Knowing how to apply consistent	**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. • Represent forces in diagrams mathematically using appropriate labelled vectors with direction and units during the analysis of a situation. • 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. • 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. • Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. **Activities and Procedures** • 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

	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-ETS1.B:** Both physical models and computers can be used in various ways to aid in the engineering design process. *** PLEASE REFER TO NGSS website FOR DETAILS.**	and appropriate units for physical relations. • Knowing how to combine vectors to determine a resulting 'net' vector and be able to apply these concepts to physical representations of force and velocity. • Knowing how to properly determine the position of an object when given its position over time. • Knowing how friction is a force proportional to the normal force and opposes the x-component of the applied force. • Knowing that—without additional forces—gravity accelerates all objects vertically at -9.8m/s^2 independently of any horizontal motion. • Knowing how to isolate a variable within a physics equation so it can be expressed as a function comprised of independent variables. • Knowing how to graph—for a given function— position as a function of time, velocity as a function of time, and acceleration as a function of time. • Newton's Law of Universal Gravitation provides the mathematical models to describe and predict the effects of	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. • 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. • Use mathematical representations of phenomena to describe or 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. **Assessments** • Bi-weekly tests • Daily 'Do Now' • Cumulative Tests • Measuring Acceleration due to Gravity lab. • Drawing Projectiles based on Initial angle

		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.
			project.
			• Lab- Determining the Optimal Angle for Launching an Object
			
			Additional Resources/ Materials
			
			• Textbook
			  • Conceptual Physics – Hewitt
			  • Physics 6^{th} Ed. – Giancoli
			• Google Classroom
			• Pasco lab equipment
			• Computer Simulations: http://phet.colorado.edu/

<table>
<tr>
<td rowspan="3">Time/ Terms

Marking Period 2</td>
<td>Big Idea:
Understanding momentum and how it is conserved in elastic collisions.
Introduction to conservation of energy and understanding how it can be quantified in different forms (e.g. kinetic, potential, etc.)
Understanding circular motion and conservation of angular momentum.
Using the properties of energy to make experimental predictions of different objects and then gathering data to assess the accuracy of said prediction.
To understand how the kinematics of rotational motion can be applied to celestial objects.</td>
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<tr>
<td>Topic:
Energy and Momentum (Unit 4 NGSS)
Kepler’s Law (Unit 3 NGSS)</td>
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<td>Goals:

Foundations of Physics: By the end of the year, students will be able to understand the fundamentals of physics, involving the interrelations of force, energy, matter, and motion.

Predicting and Testing Physical Model: By the end of the year, students will be able to use information such as mass and initial velocity to make prediction about the object after a given duration of time. Students will additionally be able to measure these results in a laboratory setting and analyze the accuracy of their predictions.

Forms of Energy: By the end of the year, students will be able to understand the different types of energy (e.g. kinetic, potential, thermal, electromagnetic, etc.) and understand how energy changes states during different processes.

Analyzing Data: By the end of the year, students will be able to gather and analyze data through usage of scientific techniques, application of technology, and mathematical reasoning.</td>
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	Standards/Concepts /CPI Students will be able to:	Essential Questions/Enduring Understanding	Objectives/Activities/ Procedures/ Assessment/Required Materials/Resources
	Next Generation Science Standards: **HS-PS3-2-** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). **HS-PS3-1-** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. **HS-PS3-3** Design,	**Essential Questions:** • How does energy manifest in different forms (i.e. kinetic, potential) while preserving conservation? • How does doing work upon an object in a closed system affect the potential energy of the system? • How does the property of momentum affect an object during elastic and inelastic collisions? • How do the properties of kinematics apply to an object undergoing rotational motion? • How does Newton's Law of Universal Gravity relate the attractive force of two bodies based on their masses and their relative distances to each other? **Enduring Understandings:** • Knowing how to determine the total energy of a closed system through recognizing and analyzing the different forms of energy and using conservation of energy to determine different properties of the system. • Knowing how to build a device applies concepts of potential and kinetic energy, force, and momentum to construct a device that will provide protection to an object such as an egg for an inelastic	**Objectives** • Understand energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. (HS-PS3-2) • Investigate on the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) • Mathematically show 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). (HS-PS3-2) • 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) • Display an understanding that 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 and how kinetic energy depends on mass and speed, allow the concept of

	build, and refine a device that works within given constraints to convert one form of energy into another form of energy. **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-ESS1-4** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system	collision. • Knowledge of momentum, where they would be able to determine the initial and final momentum of a system to determine the amount of energy converted to heat. • Knowing Kepler's 3 Laws of Orbiting Bodies and how they are consistent with the principles of angular momentum and Newton's Law of Universal Gravity.	conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) • Be able to apply that the availability of energy limits what can occur in any system. (HS-PS3-1) • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) **Activities/ Procedures** • Students should ultimately be able to develop models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles, or objects, and energy associated with the relative position of particles, or objects. • Students should be able to qualitatively show that an object in a gravitational field has a greater amount of potential energy as it is put into higher in that field by investigating how an object, such as a ball, when released from successively higher and higher positions hits the ground at greater and greater velocities (kinetic energy). Kinetic Energy $\mathrm{KE}=\frac{1}{2}mv^2$ Potential Energy $PE_{gravitational} = mgh$

			Work $W = Fd$
			
			• Students should understand that changes of energy in a system are described in terms of energy flows into, out of, and within the system. They should also be able to describe the components of a system
			
			Assessments
			• Bi-weekly tests
			• Daily 'Do Now'
			• Cumulative Tests
			• Lab- Measuring Kinetic Energy Lost Through Friction.
			• Engineer and describe a system to minimize the impact on an object during an inelastic collision (e.g. Egg Drop Project)
			
			Additional Resources/ Materials
			
			• Textbook
			    • Conceptual Physics – Hewitt
			    • Physics 6^{th} Ed. – Giancoli
			• Google Classroom
			• Pasco lab equipment
			• Computer Simulations: http://phet.colorado.edu/

Time/ Terms Marking Period 3	**Big Idea:** • Understand the properties of waves as a form of transferring energy without permanently transferring matter. • Understand the relationships between wavelength, frequency, and velocity of a wave. • Understand how relative frequency of a wave can be used to determine the relative velocity of the wave and be able to apply that knowledge to determine the age of the universe. • Understand light is electromagnetic radiation that is able to carry information. Additionally, understand the properties it has when interacting with objects of different indices of refraction.		
	Topic: • Wave Properties (Unit 6 of NGSS) • Electromagnetic Radiation (Unit 7 of NGSS)		
	Goals **Foundations of Physics**: By the end of the year, students will be able to understand the fundamentals of physics, involving the interrelations of force, energy, matter, and motion. **Predicting and Testing Physical Model:** By the end of the year, students will be able to use information such as mass and initial velocity to make prediction about the object after a given duration of time. Students will additionally be able to measure these results in a laboratory setting and analyze the accuracy of their predictions. **Forms of Energy:** By the end of the year, students will be able to understand the different types of energy (e.g. kinetic, potential, thermal, electromagnetic, etc.) and understand how energy changes states during different processes. **Analyzing Data**: By the end of the year, students will be able to gather and analyze data through usage of scientific techniques, application of technology, and mathematical reasoning.		
	Standards/Concepts /CPI	**Essential Questions/Enduring Understanding**	**Objectives/Activities/ Procedures/ Assessment/Required Materials/Resources**

	Students will be able to:		
	NGSS (Next Gen Content Stds) **HS-PS2-3.**- Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. **HS-PS3-4.**- Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. **HS-PS4-5.-** Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and	**Essential Questions:** • How are the properties of a wave (wavelength, velocity, and frequency) effected by the medium through which they travel and the method of which they are produced. • How does the frequency of an electromagnetic wave affect its properties in the way it is used, observed, and ability to interact with other objects? • How do two waves interact with each other when they collide in the same or opposite direction? • How is the properties of a wave affected by the relative motion of the observer? **Enduring Understandings:** • 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	**Objectives** • How is the wavelength and frequency of a wave determined by the medium in transfers through? • How can empirical evidence be used 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? • 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

	capture information and energy. **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-ETS1-3**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-PS4-2**. Evaluate questions about the advantages of using a digital transmission and storage of information. * **PLEASE REFER TO YOUR CCSS HANDBOOK FOR**	various media. • 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. • 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	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. • 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. • 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

	DETAILS.	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.	frequency. **Activities/ Procedures** • Students should learn how to calculate and draw frequency and wavelength, then should draw a wavetrain that would have a frequency for a given velocity. • Students will calculate and draw overtones of a given wave and draw images of their interference. • Computer simulation and physics demonstration using jump ropes and slinkies to display transverse and longitudinal waves, nodes, standing waves, overtones, and constructive/destructive interference. • Show using two linked, coiled springs of different materials to observe how wave behavior changes as it propagates from one medium to the next. **Assessments** • Bi-weekly tests • Daily ‘Do Now’ • Cumulative Tests • Lab – Animating the Constructive/Destructive Interference Patterns of 2 Colliding Waves

			• Project – Calculate the dimensions for an instrument to play certain frequencies and then construct that instrument.
			Additional Resources/ Materials
			• Textbook
			  ◦ Conceptual Physics – Hewitt
			  ◦ Physics 6^{th} Ed. – Giancoli
			• Google Classroom
			• Pasco lab equipment
			• Computer Simulations: http://phet.colorado.edu/

Time/ Terms	Big Idea:
Marking Period 4	• Introduction to the interrelation of electricity and magnetism. • Understanding and being able to map electrical and magnetic fields. • Understanding the basic principles of electrical resistance and how it inversely affects the amount of current through a circuit. • Being able to understand and construct basic circuits and being able to make proper predictions about the flow of electricity. • Be able to determine the geological properties of the Earth using topics of kinematics through investigation.
	Topic: • Electricity and Magnetism (Unit 8 NGSS) • Physics and Geosphere (Unit 5)
	Foundations of Physics: By the end of the year, students will be able to understand the fundamentals of physics, involving the interrelations of force, energy, matter, and motion. **Predicting and Testing Physical Model:** By the end of the year, students will be able to use information such as mass and initial velocity to make prediction about the object after a given duration of time. Students will additionally be able to measure these results in a laboratory setting and analyze the accuracy of their predictions. **Forms of Energy:** By the end of the year, students will be able to understand the different types of energy (e.g. kinetic, potential, thermal, electromagnetic, etc.) and understand how energy changes states during different processes. **Analyzing Data**: By the end of the year, students will be able to gather and analyze data through usage of scientific techniques, application of technology, and mathematical reasoning.

	Standards/Concepts /CPI Students will be able to:	Essential Questions/Enduring Understanding	Objectives/Activities/ Procedures/ Assessment/Required Materials/Resources
	NGSS (Next Gen Content Stds) **HS-PS4-3.-**Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. **HS-PS2-4.-**Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. **HS-PS3-5.-**Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	**Essential Questions:** • What force keeps you from passing through the ground? • How is the electromagnetic force related to the gravitational force? • How does the position of resistors affect the amount of current traveling through a circuit? • How does the electromagnetic field appear to look for an unbalanced particle. **Enduring Understandings:** • 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	**Objectives** • 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. • 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). **Activities/ Procedures** • Students can map the magnetic field around a bar magnet with a compass or iron filings. Students should observe how distance from the

	HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. **HS-ESS2-3** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. **HS-ESS1-5** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. **HS-ESS2-2-**Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth	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. • 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.	magnet affects the field lines. They should also observe the directionality of the field lines. • Students can deflect a compass needle with a current carrying wire. Students might analyze how distance, current strength, and current direction affect the compass needle. • Students can put a bar magnet through a solenoid and measuring the current in the wire. Students could also experiment with the number of loops, radius of the coil, gauge of wire, or length of the coil. • Students can design and build a motor or generator. They might also observe a premade toy motor. • Students can create a basic electromagnet by wrapping an iron nail in coiled wire and connecting the ends of the wire to a battery. Students could explore how changing the number of coils, length of the nail, polarity of the nail, or thickness of the nail affects the magnetic field. This will allow students to see how a magnetic field can be measured by how many washers/paperclips the electromagnet can pick up. • *Students can build a basic battery with lemon juice, pennies, sand paper, and construction paper and use it to power an LED bulb. Students should understand that "electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.* • Students should investigate and construct a simple mag-lev train and explore what variables (mass, magnetic field strength, etc.) affect the

	systems. *** PLEASE REFER TO YOUR CCSS HANDBOOK FOR DETAILS.**		speed and running efficiency of the train. • Using field-mapping kits with silver oxide pens and conductive gridded paper, students could map electromagnetic fields and examine any change in electrical potential energy. **Assessments** • Bi-weekly tests • Daily 'Do Now' • Cumulative Tests • Lab – Constructing Circuits to create a Specified Resistance. • Project – Investigate Properties of the Aurora Borealis **Additional Resources/ Materials** • Textbook • Conceptual Physics – Hewitt • Physics 6th Ed. – Giancoli • Google Classroom • Pasco lab equipment • Computer Simulations: http://phet.colorado.edu/