HILLSBOROUGH TOWNSHIP SCHOOL DISTRICT

SCIENCE CURRICULUM

PHYSICS

AUGUST 2021

Physics
Course Overview

The Physics course of study is designed to develop the skills of abstract reasoning, problem solving, and interpretation of physical data for students in science. Many topics in classical and modern physics are explored and investigated, including classical mechanics, wave motion, electricity and magnetism, light and modern physics. A balance between theory, concepts, experimental work, math and engineering applications, and project work is sustained throughout the course. Emphasis is placed on the development of skills in science practices and problem solving techniques. Laboratory work is an integral component of the program.

The curriculum will be introduced through an inquiry based process to address conceptual and mathematical ideas in physics. Understanding of the scientific processes and theories designed to provide answers to the questioning mind are fostered through the use of hands-on demonstrations, analysis of video clips, exploration of online simulations and student interaction.

The study of Physics course enables students to develop an appreciation for science as a quest to know and understand the physical world. It helps the student understand the underlying issues surrounding the use of modern technology which has its basis in physics. The intended outcome of this course is the development of an ability to think in a critical manner using both concrete and abstract examples from physics as models for real world phenomena. The physics course includes applications of physics and interdisciplinary connections with mathematics, chemistry, biology, social studies, and physical education.

The crosscutting concepts of patterns; cause and effect, scale, proportion, and quantity, systems and system models, interdependence of science, engineering, and technology, and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas.

In the physics performance expectations, students are expected to demonstrate grade-appropriate proficiency in the practices of science and engineering by asking questions and defining problems; developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.

The Physics curriculum meets the requirements of the New Jersey Student Learning Standards for Science and helps to prepare students to meet and exceed the standards assessed by the NJDOE state assessments through higher order application of various skills required for complete understanding of physics.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Unit Title	**Time Frame/Pacing**
1D Motion	3-4 Weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- The motion of olympic racewalkers
- Creation of the Hawaiian Archipelago
- Usain Bolt's world record 100 meter sprint
- Dropping a hammer and feather in a vacuum

Essential Question:

- How do physicists use graphs to differentiate between types of motion?
- How does a physicist develop and use a mathematical model of motion?
- What specific language do physicists use to describe motion?
- How can models of motion be used to determine whether an object's motion will be stable or changing?

Enduring Understandings

- Two models that physicists can use to describe the motion of an object are motion with constant velocity and motion with constant acceleration.
- Physicists create motion graphs to describe and analyze motion. Finding the slope of a position vs. time graph, velocity vs. time graph, or acceleration vs. time is one way to quantify an object's motion.
- Velocity and acceleration have both magnitude and direction. A physicist's definition of these terms differs from their use in everyday language.
- Accelerated motion can be modelled using the equations for uniform accelerated motion. These equations can be used to determine information about an object's prior motion or make a prediction about an object's future motion.
- In the absence of air resistance, all objects in freefall near the surface of the Earth accelerate downwards at a constant rate of 9.8 m/s/s.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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.

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts**

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Physics CP/H Curriculum

Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** • 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. **Obtaining, Evaluating, and Communicating Information** • 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). **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 trade off considerations.	**PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. **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. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • 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.	**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. **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. • 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.

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Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking
Math • MP.2 Reason abstractly and quantitatively. • MP.4 Model with mathematics. • HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. • HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. • HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. • HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. • HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. • HSA.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. • HSA.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. • HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. • HSS-IS.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). **ELA** • 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.11-12.8 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. • WHST.9-12.1 Write arguments focused on discipline-specific content. • WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. **Computer Science and Design Thinking** • 8.1.12.DA.1 Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. • 8.1.12.DA.2 Describe the trade-offs in how and where data is organized and stored. • 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Career Readiness, Life Literacies, and Key Skills

- 9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice.
- 9.4.12.IML.3 Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
- 9.4.12.IML.4 Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.
- 9.4.12.TL.2 Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Social-Emotional Learning Competencies

- **Responsible Decision-Making:**
  - Develop, implement, and model effective problem-solving and critical thinking skills.
  - Identify the consequences associated with one's actions in order to make constructive choices.
- **Relationship Skills:** Demonstrate the ability to prevent and resolve interpersonal conflicts in constructive ways.

Learning Targets	Investigations/Resources	Formative Assessment
Use a physicist's language of motion to differentiate between types of 1D motion based on written descriptions of motion and position vs. time, velocity vs. time graphs, and acceleration vs. time graphs.	Graphing walking/racewalking/running Language of Motion Scenarios Motion Graph Matching Usain Bolt's 100 meter data	Student created graphs Acting out scenarios Comparing how well students' graphs match Small group/whole class discussion
Determine physical quantities related to the motion of an object moving with a constant velocity by analyzing data and applying the model for motion with constant velocity.	Graphing walking/racewalking/running Constant velocity cars Radar gun data Hawaiian Archipelago analysis	Student created graphs Student derived velocities Small group discussions
Determine physical quantities related to the motion of an object moving with a constant acceleration by analyzing data and applying the model for motion with constant acceleration.	Usain Bolt's 100 meter data Pullback car activity Freefall Lab Determining a person's reaction time	Small group/whole class discussion Teacher Check In Value of freefall acceleration Value of reaction time
Apply equations for uniform accelerated motion to determine information about an object's prior motion or make a prediction about an object's	Usain Bolt's 100 meter data Pullback car Uniform Accelerated Motion Practice Problems	Usain Bolt's Acceleration and velocity Acceleration and velocity of pullback car Teacher Check In

future motion.		
Model the motion of an object in freefall using the model for constant acceleration with an acceleration of 9.8 m/s/s.	Feather vs. Bowling Ball Freefall Lab Determining a person's reaction time Freefall Practice Problems	Small group/whole class discussion Graphs of motion and/or value of freefall acceleration Value of reaction time Teacher Check In

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• 1D Motion Common Assessment	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

Hillsborough Township Public Schools
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Unit Title	Time Frame/Pacing
Forces	4-5 Weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- Astronaut motion in the ISS
- Observing and analyzing low friction soccer disk
- Car crash security footage
- Bullet dropped vs. Bullet fired
- Scale readings while jumping
- Shuffleboard

Anchoring Activity:

- Newton's 3rd Law force sensor data
- Chew Toy Activity
- Newton's 2nd Law discovery
- Material friction analysis

Essential Question:

- How do physicists represent forces acting on an object?
- What conditions are necessary in order to cause an object's motion to change?
- How do physicists model the forces that two objects exert on each other?
- Why is it important to differentiate mass and weight?
- How can we create models to analyze motion in more than one direction?

Enduring Understandings

- Physicists represent the forces on an object using force diagrams.
- When the forces on an object are balanced, the object will move with constant velocity. When the forces on an object are unbalanced, the object will accelerate.
- When the forces on an object are unbalanced, the magnitude of the acceleration is determined by the sum of the forces acting on the object and the mass of the object.
- While interacting, two objects exert forces of equal magnitude and opposite direction on each other.
- The magnitude of the force of friction between two objects is determined by the material that each object is made of and the normal force that the

objects exert on each other.
- Mass determines the amount of matter that an object is made of. An object's weight is the force of gravity acting on that object and is in part determined by the mass of the object.
- Modelling motion in multiple directions requires breaking up motion in independent orthogonal components.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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.

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Asking Questions and Defining Problems • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. **Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** • 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.,	**PS2.A: Forces and Motion** • PS2.A: Forces and Motion - Newton's second law accurately predicts changes in the motion of macroscopic objects. • PS2.B: Types of Interactions - 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.	**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. **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Systems can be designed to cause a desired effect. **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. • Models (e.g., physical, mathematical, computer models) can be used to simulate

number of trials, cost, risk, time), and refine the design accordingly. **Obtaining, Evaluating, and Communicating Information** • 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). **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 tradeoff considerations.		systems and interactions—including energy, matter, and information flows—within and between systems at different scales. **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.

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
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- HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
- HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by in hand in simple cases and using technology for more complicated cases.
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ELA

- 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.
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Computer Science and Design Thinking

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Career Readiness, Life Literacies, and Key Skills

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Social-Emotional Learning Competencies

- **Self Awareness:**
  - Recognize one's feelings and thoughts.
  - Recognize the importance of self-confidence in handling daily tasks and challenges.
- **Self Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Learning Targets	Investigations/Resources	Formative Assessment
Analyze the forces exerted on an object and apply Newton's 1st Law to predict whether an object will move with constant velocity or accelerate.	Astronauts on ISS Low friction soccer disk Car crash security footage Force Diagram practice Newton's Laws qualitative practice	Small group/whole class discussion Drawings on whiteboards Small group/whole class discussion Teacher check in/student self assessment Teacher check in/student self assessment
Identify and model the forces exerted on an object using force diagrams.	Low friction soccer disk Force Diagram practice Newton's Laws qualitative practice Scale readings while jumping	Drawings on whiteboards Teacher check in/student self assessment Teacher check in/student self assessment Force diagrams on whiteboards.
Translate between a force diagram model and a mathematical model to create a Newton's 2nd Law equation for an object.	Chew toy activity Scale readings while jumping Newton's 2nd Law discovery Newton's 2nd Law quantitative practice Shuffleboard Friction problem solving	Teacher check in/student self assessment Scale reading values Equation for Newton's 2nd Law Exit ticket Distance determination Exit ticket
Apply Newton's Laws to mathematically determine unknown forces being exerted on an object.	Scale readings while jumping Newton's 2nd Law quantitative practice Shuffleboard Material friction analysis Friction problem solving	Scale reading values Exit ticket Distance determination Coefficient of friction graphs and values Exit ticket
Describe and utilize the relationship between the force of friction between two objects, the normal force between two objects, and the materials objects are made of (coefficient of friction).	Shuffleboard Material friction analysis Friction problem solving	Distance determination Coefficient of friction graphs and values Exit ticket
Synthesize a mathematical procedure using Newton's Laws and the Friction Equation in order to determine the materials objects are/should be made of.	Shuffleboard Material friction analysis Friction problem solving	Distance determination Coefficient of friction graphs and values Exit ticket

Apply Newton's Laws to situations where forces are pointing in multiple directions by deconstructing forces at angles into x and y components using trigonometry.	Force table lab Forces at angle practice problems Static equilibrium puzzle	Teacher check in/student self assessment Teacher check in/student self assessment Puzzle answers

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)
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Unit Title	**Time Frame/Pacing**
Circular Motion and Gravitation	2-3 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- Sparkler and Drill
- Speed Skater Wipeouts
- Wall of Death
- Gravitron
- Slot Cars
- Yo-yo
- Astronaut movement on the moon
- Space-time sheet
- Stuff in Space - Satellite Database

Essential Questions:

- How do physicists use Newton's Laws to model the motion of an object moving in a circle?
- What factors determine whether or not an object will move in a stable, circular path?
- How should our mathematical model for the force of gravity change when we analyze the force of gravity on an astronomical scale?
- How does an object exert a gravitational force on another object without being in direct contact with the other object?

Enduring Understandings

- For an object to move in a circle, the forces acting on the object must be unbalanced towards the center of the circle.
- When objects move in a circle, there is a component of the velocity that points tangential to the circle and a component of the acceleration that points towards the center.
- When an object is moving in a circle, the amount by which the forces must be unbalanced is given by the centripetal force equation.
- The generalized mathematical model for the force of gravity between two objects is given by Newton's Law of Universal Gravitation.
- A massive object alters space around it by creating a gravitational field. This gravitational field exerts a force on other massive objects.
- When an object is orbiting another object, the force of gravity acts as the centripetal force.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

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- 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-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
- HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
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• Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.		connections of components to reveal its function and/or solve a problem.

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Computer Science and Design Thinking

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Social-Emotional Learning Competencies

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  - Recognize one's feelings and thoughts.
  - Recognize the importance of self-confidence in handling daily tasks and challenges.
- **Self Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.

Learning Targets	Investigations/Resources	Formative Assessment
Identify forces acting on an object moving in a circle and describe the motion of the object qualitatively, using Newton's 1st Law.	Introduction to circular motion activity Analyzing incorrect arguments Circular motion practice problems	Whiteboard and Google Doc Contents Force diagram selections Teacher check in/student self assessment
Draw the tangential component of velocity and centripetal component of acceleration for an object moving in a circle.	Introduction to circular motion activity Circular motion practice problems	Google Doc contents and Exit Ticket Teacher check in/student self assessment
Use the equation for centripetal force to calculate the conditions necessary for an object to move in a circle.	Slot car analysis Whirligig Lab Circular motion practice problems	Velocity/coefficient of friction for slot cars Mass of whirligig Teacher check in/student self assessment
Apply Newton's Law of Universal Gravitation to	Guided Practice	Content on Whiteboards

find the gravitational force between two objects.	Planet Halves Gravitation Practice Problems	Gravitational force calculation for selected planet Teacher check in/student self assessment
Determine the gravitational field created by massive objects.	Planet Halves Gravitation Practice Problems Satellite Lab	Gravitational field calculation for selected planet Teacher check in/student self assessment Value for mass of Earth
Combine Newton's Law of Universal Gravitation and with the centripetal force model of circular motion to analyze orbital motion.	Gravitation Practice Problems Satellite Lab	Teacher check in/student self assessment Value for mass of Earth

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)
Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this: • Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Circular Motion and Gravitation Common Assessment	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Unit Title	**Time Frame/Pacing**
Work, Power, Energy	2.5 - 3 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- Pendulum (like a bowling ball) moving back and forth, never returning to initial height
- Roller Coasters - transformation and conservation of energy

Essential Questions:

- What is energy?
- What are the forms of mechanical energy?
- What is meant by work?
- How is energy transferred and transformed?

Enduring Understandings

- Energy is neither created nor destroyed; it changes form.
- The total energy in the universe remains the same.
- In order for energy in a closed system to change, work must be done.
- When work is done, a force exerted on an object causes movement over some distance.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).
- HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- 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.

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts**

Hillsborough Township Public Schools
Physics CP/H Curriculum

Asking Questions and Defining Problems

- Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Developing and Using Models

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Planning and Carrying Out Investigations

- 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.

Using Mathematics and Computational Thinking

- Create a computational model or simulation of a phenomenon, designed device, process, or system.

Constructing Explanations and Designing Solutions

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated

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.
- 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.

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.
- Energy cannot be created or destroyed, but

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.

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.
- 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.

Stability and Change

- Systems can be designed for greater or lesser stability.

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.
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

sources of evidence, prioritized criteria, and tradeoff considerations.	it can be transported from one place to another and transferred between systems. • Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. • The availability of energy limits what can occur in any system. • 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). **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. **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.	
Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking		

Hillsborough Township Public Schools
Physics CP/H Curriculum

Math

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and origin in graphs and data displays.
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
- HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

ELA

- WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- SL.11-12.5 Make strategic use of digital media in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Computer Science and Design Thinking

- 8.1.12.DA.1 Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
- 8.2.12.ED.1 Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
- 8.2.12.ED.5 Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints.

Career Readiness, Life Literacies, and Key Skills

- 9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice.
- 9.4.12.TL.2 Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Social-Emotional Learning Competencies

- **Self Awareness:**
  - Recognize one's feelings and thoughts.
  - Recognize one's personal traits, strengths, and limitations.
- **Self Management:** Understand and practice strategies for managing one's own emotions, thoughts, and behaviors.

Learning Targets	Investigations/Resources	Formative Assessment

Use energy bar charts to model energy conservation. Identify the type of energy in a system. Calculate the amount of energy in a system.	Bowling ball demonstration Introduction to the Conservation of Energy Energy Skate Park PhET Conservation of energy Lab Conservation of Energy using a marble launcher Design (and build) a roller coaster	Periodic check-ins made by teacher during lab and practice Exit Ticket(s) - Bowling Ball Pendulum Prediction
Evaluate work through the physics lens. Identify how a force can change the energy in a system. Calculate the amount of work done by a force. Calculate the amount of work using the work-energy theorem.	Work & Power Up the Stairs activity Qualitative Work Practice - using appropriate mathematical equation to determine the amount of work	Quiz assessing use of mathematical equations to calculate work, energy, and change in energy.
Design and build a device that converts one form of energy into another (focus on mechanical energy).	Designing and building a roller coaster	Assessment of calculations. Success of roller coaster in getting a marble safely from the start of the roller coaster to the bottom.

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Work, Power, Energy	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Unit Title	**Time Frame/Pacing**
Impulse & Momentum	3 - 3.5 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- Car crashes; crumple zones in cars; air bags
- Newton's cradle

Essential Questions:

- What material is the best for protection (in phone cases, in padding for boxing gloves or football helmets, etc.) and why?
- What is momentum and how is it conserved?
- How can one predict an object's continued motion, changes in motion, or stability?

Enduring Understandings

- The total momentum in a closed system (like a collision) is conserved.
- Kinetic energy is only conserved in an elastic collision.
- Impulse is the product of a force that can change the momentum of an object or system over a certain period of time.
- Newton's laws of motion can be used to further support the relationship(s) between impulse and momentum.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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 science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
- 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.

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts**
Asking Questions and Defining Problems	**PS2.A Forces and Motion**	**Cause and Effect**

- Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Developing and Using Models

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Planning and Carrying Out Investigations

- 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.

Using Mathematics and Computational Thinking

- Create a computational model or simulation of a phenomenon, designed device, process, or system.

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 tradeoff considerations.

- 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 of the system.

PS2.B Types of Interactions

- 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.

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.

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.

- 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.

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.
- 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.

Stability and Change

- Systems can be designed for greater or lesser stability.

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.
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
- HSA.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.
- HSA.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales
- HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

ELA

- WHST.11-12.7 Conduct short as well as more sustained research projects to answer a 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.

Computer Science and Design Thinking

- 8.1.12.DA.1 Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
- 8.2.12.ED.1 Use research to design and create a product or system that addresses a problem and make modification based on input from potential consumers.
- 8.2.12.ED.2 Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback.
- 8.2.12.ED.5 Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints.
- 8.2.12.ED.6 Analyze the effects of changing resources when designing a specific product or system.

Career Readiness, Life Literacies, and Key Skills

- 9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CT.1 Identify problem-solving strategies use in the development of an innovative product or practice.

Social-Emotional Learning Competencies

- **Self Awareness:**
  - Recognize one's personal traits, strengths, and limitations.

- Recognize the importance of self-confidence in handling daily tasks and challenges.

- **Self Management:** Understand and practice strategies for managing one's own emotions, thoughts, and behaviors.

Learning Targets	Investigations/Resources	Formative Assessment
Determine when an object has momentum. Calculate the magnitude of the momentum.	Guided notes; give examples of objects with and without momentum Impulse and Momentum Practice sets	Assess problems from practice sets
Describe what happens when an object experiences a change in momentum (impulse). Calculate the magnitude of the change in momentum and determine the direction of this change.	Impulse and Momentum Lab	Students will use lab data to determine which materials would work best for protection and be able to correctly explain why
Design and build a device that will minimize the force that a cell phone experiences.	Smartphone Drop	Success of drop Students will describe the success of their device using appropriate vocabulary
Apply conservation of momentum to elastic and inelastic collisions. Use the appropriate mathematical relationships to determine momentum, mass, and/or velocity of the object involved in the collision.	PhET Collisions Lab Conservation of Momentum Lab	Application of lab results

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	Assessment Modifications and/or Accommodations

	(ELL, Special Education, Gifted, At-Risk of Failure, 504)
• Impulse & Momentum Common Assessment	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

Hillsborough Township Public School
Physics CP/H Curriculum

Unit Title	**Time Frame/Pacing**
Electrostatics	3 - 3.5 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Anchoring Activity:

- Methods of Charging Exploration - using charge interactions and electrostatic force to create movement (ex: using charged rod to move water)

Phenomena:

- Lightning - how it occurs/why the car is a safe place to be

Essential Questions:

- What underlying forces explain the variety of interactions observed?
- How do charges interact?

Enduring Understandings

- Matter is made of electric charges, and electric charges exert forces on one another.
- Total charge in a system is conserved.
- The interactions between microscopic particles is comparable to the interactions between macroscopic particles.
- Electrostatics force is a field force that can be either attractive or repulsive.
- The electric force is affected by the charge of the objects and distance between two objects.
- Electric charges produce fields that exert forces and store energy.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
- HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts**

Hillsborough Township Public School
Physics CP/H Curriculum

Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** • 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. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. **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 tradeoff considerations.	**PS1.A Structure and Properties of Matter** • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. **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. • 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.	**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. **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. • 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. **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. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.
Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking		
Math • MP.2 Reason abstractly and quantitatively.		

- MP.4 Model with mathematics.
- HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and origin in graphs and data displays.
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
- HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context.
- HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

ELA

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

Computer Science and Design Thinking

- 8.1.12.DA.1 Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change
- 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena

Career Readiness, Life Literacies, and Key Skills

- 9.4.2.CI.1 Demonstrate openness to new ideas and perspectives.
- 9.4.2.CT.1 Gather information about an issue, such as climate change, and collaboratively brainstorm ways to solve the problems.
- 9.4.2.CT.3 Use a variety of types of thinking to solve problems.
- 9.4.2.IML.2 Represent data in a visual format to tell a story about the data.

Social-Emotional Learning Competencies

- **Self Management:** Recognize the skills needed to establish and achieve personal and educational goals.
- **Social Awareness:**
  - Demonstrate an understanding of the need for mutual respect when viewpoints differ.
  - Recognize and identify the thoughts, feelings, and perspectives of others.

Learning Targets	Investigations/Resources	Formative Assessment
Correctly identify the method of charging and how charges will distribute as a result of the	Methods of Charging Exploration Electroscope Lab	Methods of Charging Quiz Electric Charge Quiz

method employed. Diagram the correct charge distribution.	Charge Distribution PPT Electric Charge Practice	
Diagram the electrostatic force between two or more charges. Determine the magnitude and direction of the electrostatic force between two or more charges.	Electric Force sim with oPhysics Balloon Lab Electrostatic Force practice	Lab Quiz- Coulomb's Law
Demonstrate how a charge affects the space (and other charges) around it. Determine the magnitude and direction of an electric field created by a charged object.	Electric Field Hockey PhET Van de Graaff generator	Exit Ticket - diagramming electric fields; calculating magnitude of electric field(s)

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)
Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this: • Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Electrostatics Common Assessment	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

Hillsborough Township Public Schools
Physics CP/HCurriculum

Unit Title	**Time Frame/Pacing**
Electric Circuits	3.5 Weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- A toaster can turn bread into toast
- When a person touches a high voltage wire with a plastic broom they receive an electrical shock

Anchoring Activity:

- Doughy Resistors Lab
- Modeling an electric circuit with an online simulation

Essential Questions:

- How does Ohm's Law describe the relationships between potential difference, electric current, and resistance?
- What factors affect the resistance of an object?
- Why is knowledge of electricity so important in our society?

Enduring Understandings

- Electric current is caused by the flow of electrons.
- Electric current is affected by the voltage difference between two locations and the electrical resistance between two locations.
- Electric voltage is a mathematical model to explain how much energy a charge would have at a certain location.
- Electrical resistance depends on the material and shape of an object.
- The brightness of a lightbulb is dependent on its power output.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).
- HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Hillsborough Township Public Schools
Physics CP/HCurriculum

3-Dimensional Learning Components		
Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**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. **Planning and Carrying Out Investigations** • 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. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. **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 tradeoff considerations.	**PS3.A: Definitions of Energy** • 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) • Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion 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.)	**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. **Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1) • 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). **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. • 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. **Stability and Change** • Systems can be designed for greater or

		lesser stability. **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. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
- HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context.
- HSA.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
- HSA.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.
- HSA.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
- HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

ELA

- RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

- WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- 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.11-12.8 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.
- WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Computer Science and Design Thinking

- 8.2.12.ITH.1 Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
- 8.2.12.ITH.2 Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.
- 8.2.12.ITH.3 Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.

Career Readiness, Life Literacies, and Key Skills

- 9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
- 9.4.8.TL.1 Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
- 9.4.8.TL.2 Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
- 9.4.8.TL.3 Select appropriate tools to organize and present information digitally.

Social-Emotional Learning Competencies

- **Self Management:** Recognize the skills needed to establish and achieve personal and educational goals.
- **Social Awareness:**
  - Demonstrate an understanding of the need for mutual respect when viewpoints differ.
  - Recognize and identify the thoughts, feelings, and perspectives of others.

Learning Targets	Investigations/Resources	Formative Assessment
Students will analyze how the shape of a resistor	Doughy Resistors	Lab Quiz - Resistance

affects is electrical resistance.		
Students will use Ohm's Law to explain the makeup of different electrical measuring tools.	Ohm's Law Lab	Lab Quiz - Ohm's Law
Students will computationally think about electric circuits.	Ohm's Law Problem Solving	Do Now - Voltage, Current & Resistance
Students will analyze the energy usage of different household appliances and use that information to make decisions about lowering community energy usage.	Analyzing Electrical Appliances	Exit Ticket - How Much Wattage is Used in Common Household Appliances?

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)
Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this: • Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Circuits CA	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

Hillsborough Township Public Schools
Physics CP/HCurriculum

Unit Title	**Time Frame/Pacing**
Magnetism	2.5 Weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- A loop of current carrying wire can spin when held near a magnet

Anchoring Activity:

- Magnetic Field around a Wire Lab
- Class discussion: What causes magnetism?

Essential Question:

- How do electric charges interact with magnetic fields?
- How do magnetic fields affect moving charges?
- What are the energy transformations that occur in a system with an electric motor?
- How are electricity and magnetism related?

Enduring Understandings

- A moving charge creates a magnetic field.
- Both permanent magnets and electromagnets have their magnetic fields because of moving charges.
- A changing magnetic field in a loop of wire can cause an electric current.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
- HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- 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.

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**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.

Planning and Carrying Out Investigations

- 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.

Obtaining, Evaluating, and Communicating Information

- 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).

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

PS2.A: Forces and Motion

- 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 sliding 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.)

PS2.B: Types of Interactions

- Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.] (HS-PS2-5.)

PS3.A: Definitions of Energy

- 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

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.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Systems can be designed to cause a desired effect.

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

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.

trade off considerations.	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.) • Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.] (HS-PS3-5.)	

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
- HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

ELA

- RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

- RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- 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.
- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

Computer Science and Design Thinking

- 8.2.12.ITH.1 Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
- 8.2.12.EC.1 Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made.
- 8.2.12.EC.2 Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.

Career Readiness, Life Literacies, and Key Skills

- 9.4.12.TL.1 Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task (e.g., W.11-12.6.).
- 9.4.12.TL.2 Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).

Social-Emotional Learning Competencies

- **Self Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.
- **Social Awareness**
  - Demonstrate an awareness of the differences among individuals, groups, and others' cultural backgrounds.
  - Demonstrate an awareness of the expectations for social interactions in a variety of settings.

Learning Targets	Investigations/Resources	Formative Assessment
Students will analyze the direction of the magnetic fields around a current carrying wire	Magnetic Fields Lab	Lab Quiz - Mapping B-Fields

Students will use the right hand rule to model the electric forces in an electric motor.	Modeling an Electric Motor	Exit Ticket - How Does a Motor Work?
Students will create a model explaining how a power plant transfers energy.	How does a Power Plant work?	Teacher Check-in: How Do We Get Our Power?

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)
Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this: • Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Magnetism CA	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Unit Title	**Time Frame/Pacing**
Waves and Light	5 Weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- Noise-canceling headphones can quiet outside noise
- The leaves of a negatively charged electroscope will fall down when ultraviolet light is incident on the electroscope.

Anchoring Activity:

- PhET Waves on a String Inquiry
- PhET Photoelectric Effect Lab

Essential Questions:

- What is a wave and how is it different from matter?
- How can light be described as both a wave and a particle?
- How are sound waves and light waves alike? How are they different?

Enduring Understandings

- The amplitude of a wave describes the energy in a wave.
- A wave is a transfer of energy, not matter.
- The speed of a wave depends on the medium it is traveling through.
- Sound is a physical wave that requires a medium while light is an electromagnetic wave that can move through a vacuum.
- Light can be described as a particle and a wave.
- Light can be absorbed, reflected, or refracted when it is incident on a surface.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]
- HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a

particle model, and that for some situations one model is more useful than the other. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]

- HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]
- HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Asking Questions and Defining Problems • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. **Using Mathematics and Computational Thinking** • Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. **Engaging in Argument from Evidence** • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	**PS4.A: Wave Properties** • The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1) • Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2), (HS-PS4-5) • [From the 3–5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • 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. • Systems can be designed to cause a desired effect. **Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including

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. • 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).	unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3) **PS4.B: Electromagnetic Radiation** • Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3) • When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4) • Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)	energy, matter, and information flows—within and between systems at different scales. **Stability and Change** • Systems can be designed for greater or lesser stability.

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.
- HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

- HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

ELA

- RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- 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.

Computer Science and Design Thinking

- 8.2.12.ITH.1 Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
- 8.2.12.EC.1 Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made.
- 8.2.12.EC.2 Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.
- 8.2.12.EC.1 Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made.
- 8.2.12.EC.2 Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.
- 8.2.12.EC.3 Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
- 8.2.12.ETW.4 Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.

Career Readiness, Life Literacies, and Key Skills

- 9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
- 9.4.8.TL.1 Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
- 9.4.8.TL.2 Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
- 9.4.8.TL.3 Select appropriate tools to organize and present information digitally.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Social-Emotional Learning Competencies		

• **Responsible Decision-Making:**
  ○ Develop, implement, and model effective problem-solving and critical thinking skills.
  ○ Identify the consequences associated with one's actions in order to make constructive choices.
• **Relationship Skills:** Demonstrate the ability to prevent and resolve interpersonal conflicts in constructive ways.		

Learning Targets	**Investigations/Resources**	**Formative Assessment**
Students will qualitatively explain how the interference of waves can explain various phenomena.	PhET Waves on a String Inquiry	Exit Ticket: Wave in the Ocean
Students will design a laboratory experiment to analyze the relationship between frequency, wavelength, and the speed of a wave.	Standing Waves Lab	Lab Quiz: Standing Waves on a Slinky
Students will design a laboratory experiment to determine the speed of sound.	Boomwhackers/Resonance Lab	Lab Quiz: Resonance
Students will quantitatively and qualitatively describe the energy transfers in the photoelectric effect.	PhET Photoelectric Effect	Do Now: Metal incident on Sodium
Students will analyze absorption and emission spectra to detect various elements in stellar clouds.	Absorption and Emission Spectra Scavenger Hunt	Exit Ticket - Spectra
Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)		
Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this: • Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.		
Common Assessment(s)	**Assessment Modifications and/or Accommodations**	

	(ELL, Special Education, Gifted, At-Risk of Failure, 504)
• Waves and Light CA	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

Hillsborough Township Public Schools
Physics CP/H Curriculum

Unit Title	**Time Frame/Pacing**
Engineering & Rockets	2 Weeks (depending on number of students & teams)

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- Most recent launch footage

Essential Questions:

- What is the best design to ensure a rocket gets maximum height?
- What is the best design to ensure a rocket gets maximum flight time?
- What are the big physics ideas we need to use to plan for a successful launch?
- What is required to get to the moon?

Enduring Understandings

- Mistakes happen, and they provide opportunities to improve and innovate.
- A successful launch is the result of an iterative process of learning from previous launch attempts.
- Research is an integral part of creation.
- It's ok to "think outside the box".

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that can account for societal needs and wants.
- HS-ETSI-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.

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts**
Asking Questions and Defining Problems	**ETS1.A: Defining and Delimiting Engineering**	**Cause and Effect**

- Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Engaging in Argument from Evidence

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

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.
- 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).

Constructing Explanations and Designing Solutions

- Design, evaluate, and/or refine a solution to

Problems

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

ETS1.B: Developing Possible Solutions

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

ETS1.C: Optimizing the Design Solution

- Criteria may need to be broken down into

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- 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.
- Systems can be designed to cause a desired effect.

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.

Stability and Change

- Systems can be designed for greater or lesser stability.

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.

a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	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)	

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and qualitatively.
- MP.4 Model with mathematics.

ELA

- 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 science or technical text, verifying the data when possible and corroborating or challenging conclusion with other sources of information.
- RST.11-12.9 Synthesize information from a range of sources into a coherent understanding of a process, phenomeno, or concept, resolving conflicting information when possible.

Computer Science and Design Thinking

- 8.1.12.DA.1 Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.2.12.ED.1 Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
- 8.2.12.ED.2 Create scaled engineering drawings for a new product or system and make modifications to increase optimization based on feedback.
- 8.2.12.ED.5 Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).

Career Readiness, Life Literacies, and Key Skills

- 9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

Social-Emotional Learning Competencies

- **Responsible Decision-Making:**
  - Develop, implement, and model effective problem-solving and critical thinking skills.

- Identify the consequences associated with one's actions in order to make constructive choices.

- **Relationship Skills:** Demonstrate the ability to prevent and resolve interpersonal conflicts in constructive ways.

Learning Targets	Investigations/Resources	Formative Assessment
Design and build a rocket that will achieve the highest vertical displacement.	Students will use class time to organize, plan, build and test their rockets.	Modeling a Successful Launch (no lost or broken parts, successful parachute deployment)
Define problems in order to optimize rocket height.	Students will use class time to organize, plan, build and test their rockets.	Evidence of Improved Launch (time)

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth..

Common Assessment(s)	Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)
• Self-Assessment • Completed rocket	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.