Pascack Valley Regional High School District

Pascack Hills High School, Montvale, New Jersey
Pascack Valley High School, Hillsdale, New Jersey

Course Name: Conceptual Physics

Born On: August, 2015
Revised On: August, 2020
Revised On: August, 2022
Current Revision: August, 2023
Board Approval: 8/28/2023

Scope and Sequence

New Jersey Curricular Mandates for Science Instruction

Disabled & LGBT:
18A:35-4.35 - History of disabled and LGBT persons included in middle and high school curriculum. A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards.

Diversity, Equity, and Inclusion (DEI):
C.18A:35-4.36a - Curriculum to include instruction on diversity and inclusion. 1. a. Beginning in the 2021-2022 school year, each school district shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards. b. The instruction shall: (1) highlight and promote diversity, including economic diversity, equity, inclusion, tolerance, and belonging in connection with gender and sexual orientation, race and ethnicity, disabilities, and religious tolerance; (2) examine the impact that unconscious bias and economic disparities have at both an individual level and on society as a whole; and (3) encourage safe, welcoming, and inclusive environments for all students regardless of race or ethnicity, sexual and gender identities, mental and physical disabilities, and religious beliefs. c. The Commissioner of Education shall provide school districts with sample learning activities and resources designed to promote diversity and inclusion.

Amistad Law:
N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

Climate Change:
2020 NJSLS-Science: Earth's climate is now changing faster than at any point in the history of modern civilization, primarily as a result of human activities. Global climate change has already resulted in a wide range of impacts across New Jersey and in many sectors of its economy. The addition of academic standards that focus on climate change is important so that all students will have a basic understanding of the climate system, including the natural and human-caused factors that affect it. The underpinnings of climate change span across physical, life, as well as Earth and space sciences. The goal is for students to understand climate science as a way to inform decisions that improve quality of life for themselves, their community, and globally and to know how engineering solutions can allow us to mitigate impacts, adapt practices, and build resilient systems.

Dissection Law
N.J.S.A. 18A:35-4.25 and N.J.S.A. 18A:35-4.24 authorizes parents or guardians to assert the right of their children to refuse to dissect, vivisect, incubate, capture or otherwise harm or destroy animals or any parts thereof as part of a course of instruction.

Conceptual Physics
Unit 1: DC Circuits
Time Allotted: Approximately 7-8 Weeks
New Jersey Student Learning Standards (NJSLS)
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.] **HS-ETS1-2**. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
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. • Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • Evaluate 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** • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. **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. **ESS3.C: Human Impacts on Earth Systems** • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. **ETS1.A: Defining and Delimiting an Engineering Problem** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. *(secondary)* **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.	**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. **Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. - *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering and Technology on Society and the Natural World** • Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

	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.	• Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
• How can electricity be generated? • What model can be used to effectively describe electrical circuits? • How are resistance, voltage, current and power determined in an electrical circuit? • What are all of the requirements for a safe electrical circuit in your house? • What are the pros and cons of alternative-fuel sources for a car?	• Represent the relationship among charge, current, voltage, resistance and power with words, graphs, pictures/diagrams, and equations. • Construct a simple and complex 1-battery circuit. • Use a multimeter to measure current and voltage. • Calculate resistance of a single resistor or several in combination. • Draw schematic diagrams. • Apply Kirchhoff's loop and junction rules to quantitatively find unknown values of current and/or voltage in various segments or branches of the circuit. • Predict the effect of changing configurations of the circuit on values of current and voltage, bulb brightness, and equivalent resistance. • Make predictions about bulb brightness by quantitatively and/or qualitatively evaluating power. Boundary Statements: - Circuits are limited to a single DC power supply (no capacitors or multiple power supplies). - Loads are limited to (or assumed to be) Ohmic resistors.	- Activity: Create a basic circuit to light a single bulb - Lab: Ohm's Law, to determine the relationship between voltage and current for a resistor as well as a light bulb (non-ohmic). - Activity:The Handheld Generator to understand the role and function of a battery in a circuit. - Activity: Conductors and insulators to understand what charge is, and how it moves in the circuit. - Activity: learn how to use voltmeters and ammeters to measure Voltage and Current in a basic or complex circuit - Lab: Determine the effect that Series and Parallel loads connections on current, voltage, and bulb brightness (power). - Lab: Determine the relationship of current entering a junction to that leaving that junction. (Junction Rule) - Lab: Determine the relationship of voltage supplied to a loop to that dropped at the loads in that loop. (Loop Rule) - Activity: Validate the equations for Equivalent Resistance with experimental evidence - Activity: Associate Brightness and Power using experimental values as evidence - Activity: Energy Audit (do an	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting Lab Reports for each lab conducted - Assessment of Engineering Design Process skill by building the project, including supporting documentation. - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test. - Physics Benchmark #1

	- Connectors (lead wires) are assumed to be perfect conductors.	evaluation of household energy use) - Project: Design and wire a household circuit meeting defined constraints and requirements. - Project: Design and build a fan-powered race car meeting defined constraints and requirements. - Project: compare the effectiveness of alternative energy sources (hydrogen-fuel, wind or solar) to that of a typical battery to lift a given mass vertically. - Project: Design, customize and create your own light-up greeting card that is powered with a mini battery, an LED (or multiple LEDs), and a circuit made of copper tape. - Project: Make a wearable textile that lights up and has a specific purpose. *Scientist Spotlight:* • **Thomas Edison** – How his hearing disability helped make him an inventor. • **Dr. Ozak Esu** – Electronic and Electrical Engineer with a PhD in renewable energy.	
Resources/Materials	- The Physics Classroom tutorials, concept builders, and interactives - Crash Course - Bozeman Science - PhET - Khan Academy - Explore Learning interactives - The AP Physics Workbook - guided practice (student and teacher versions downloadable from AP Classroom) - Software: Pasco Capstone, Excel, Word		
ELA Companion Standards	**RST.11-12.1.** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. **RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.		

	RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.7.** 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. **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. **WHST.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST.11-12.7**. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **WHST.11-12.9**. Draw evidence from informational texts to support analysis, reflection, and research.
Interdisciplinary Connections	***ELA/Literacy*** **SL.11-12.1**. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. ***Mathematics*** **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.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 problems **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by in hand simple cases and using technology for more complicated cases **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histogram, and box plots)
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.IML.3** Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data **9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments **9.1.12.CFR.2**: Summarize causes important to you and compare organizations you seek to support to other organizations with similar missions.

	9.1.12.CFR.3: Research companies with corporate governance policies supporting the common good and human rights. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.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 (peers) **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) **8.2.12.C.3.** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). **8.2.12.C.4** Explain and identify interdependent systems and their functions. **8.2.12.D.1.** Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● When possible, modify assignments so the ELL student writes less, has simpler questions to answer, fewer spelling words, etc. ● Provide models of completed homework assignments, projects, etc. ● Assign a native language partner. ● Use sentence/paragraph frames to assist with writing peer review. ● Provide extended time for written responses and reports.	● Use scaffolds, such as prompting, to assist with the design process. ● Provide extended time for written responses and reports. ● Use a graphic organizer to categorize concepts. ● Get a written list of instructions ● Receive large project as smaller tasks with individual deadlines ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm to help with time management ● Work with a partner	● Use a graphic organizer to categorize concepts. ● Provide an outline for research and design tasks. ● Provide extended time for written responses and reports. ● Incorporate student choice ● Provide peer mentoring to improve techniques ● Use effort and achievement rubrics ● Assure students they can be successful ● Promote mastery or challenging tasks ● Allow students many opportunities for practice and learning ● Use scaffolding for complex tasks ● Evaluate students on the basis of mastery and not one another. Classroom activities should be	● Take on an additional or more complex design challenge. ● Interview someone in the field of technology education about how they use the design process in their profession. ● Offer choices, once finished with a basic task, with personal interest being the key.

		noncompetitive	

Conceptual Physics		
Unit 2: SHM, Waves, & Sound		
Time Allotted: If time permits		
New Jersey Student Learning Standards (NJSLS)		

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
HS-PS4-2: Evaluate questions about the advantages of using a digital transmission and storage of information.
HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and
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-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Using Mathematics and Computational Thinking • Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. **Analyzing and Interpreting Data** • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Constructing Explanations and Designing Solutions** • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. **PS3.D: Energy in Chemical Processes** • Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. *(secondary)* **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. • 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. **PS4.B: Electromagnetic Radiation** • Photoelectric materials emit electrons when they absorb light of a high-enough frequency.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Stability and Change** • Systems can be designed for greater or lesser stability. • Systems can be designed to cause a desired effect. - *Connections to Engineering, Technology, and Applications of Science*

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.

Obtaining, Evaluating, and Communicating Information
- 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).

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Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Theories and laws provide explanations in science.
- Laws are statements or descriptions of the relationships among observable phenomena.

PS4.C: Information Technologies and Instrumentation
- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.

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.

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.

Influence of Science, Engineering, and Technology on Society and the Natural World
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
- Modern civilization depends on major technological systems.
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Interdependence of Science, Engineering, and Technology
- Science and engineering complement each other in the cycle known as research and development (R&D).

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- Why does the length of a grandfather clock pendulum matter? - Why does a police siren sound different when it is moving toward you than when it is moving away from you? - What happens when two waves meet? - How is resonance responsible for the Tacoma Narrows Bridge collapse? - How is sound produced?	- Predict which properties determine the period of a simple harmonic oscillator - Experimentally confirm the relationships between all variables associated with the period of a simple harmonic oscillator - Express transverse and longitudinal waves using narrative, pictorial, and graphical representations	- Experimentally determine the period of a mass oscillating on a spring - Experimentally determine the period of an oscillating pendulum - Transverse vs longitudinal wave demonstration - Experimentally determine wave speed using slinkies and springs - Experimentally determine the speed of a wave using standing waves on strings - Experimentally determine the speed of sound using air column standing waves	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting Lab Reports for each lab conducted - Assessment of Engineering Design Process skill by building the project, including supporting documentation. - Assessment of test skills (Problem Solving, Creating

	- Determine period, frequency, and wavelength of a periodic mechanical wave using graphical and visual representations - Design an experiment to determine the relationship between wave speed, wavelength, and frequency - Model the interaction of two waves pulses (superposition) - Use superposition to describe the formation of standing waves - Describe and predict the properties of standing waves (nodes and antinodes) formed from incident and reflected waves (strings and air columns) - Describe the properties of sound waves - Experimentally determine the speed of sound through air - Experimentally prove the relationships among variables responsible for creating standing waves on strings and in an air column - Calculate the wavelengths and frequencies of standing waves based on specific boundary conditions (harmonics) - Describe the doppler effect phenomenon using only qualitative means - Describe beat frequency using both quantitative and qualitative means Boundaries: Limited to: - SHM systems are limited to pendulums and horizontal springs with a focus on only period	- Doppler Effect Demonstration - Beat Frequency Demonstration - Engineering Design Project: design a concert hall such that each person sitting in the hall can hear a similar sound regardless of their seat. *Scientist Spotlight:* • **Wanda Diaz-Merced**: How a blind astronomer/astrophysicist learned to visualize space through sound. • **Jamila Abass** – Software engineer and CEO of M-Farm; an online platform for small farmers to connect with buyers and exchange information on crops.	and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test.

	- No discussion of Hooke's Law or sinusoidal motion - No calculations for Doppler Effect - Superposition limited to two waves/pulses		
Resources/Materials	- Data Collection & Analysis Software - Word Processing Software - Graph Paper, Ruler, Calculator - Course Textbook - The Physics Classroom tutorials, concept builders, and interactives - Bozeman Science - PhET - Khan Academy - Selected Problem sets from various ancillary materials		
ELA Companion Standards	**RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **RST.11-12.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.8.** 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.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.2**. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.11-12.4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST.11-12.6**. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information **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. **WHST.11-12.10**. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.		
Interdisciplinary Connections	***ELA/Literacy*** **SL.11-12.1**. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.		

	SL.11-12.2. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.11-12.5.** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. ***Mathematics*** **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.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 problems **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by in hand simple cases and using technology for more complicated cases **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histogram, and box plots)
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.IML.3** Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data **9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments **9.4.2.DC.1** Explain differences between ownership and sharing of information. **9.4.2.DC.2** Explain the importance of respecting digital content of others. **9.4.2.CI.1** Demonstrate openness to new ideas and perspectives **9.4.2.CI.2** Demonstrate originality and inventiveness in work **9.4.8.CT.1** Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective. **9.4.8.CT.2** Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option **9.4.8.IML.4** Ask insightful questions to organize different types of data and create meaningful visualizations. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Use technology to enhance productivity, increase collaboration, and communicate effectively.

	● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.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 (peers) **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) **8.2.12.C.3.** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). **8.2.12.D.1.** Design and create a prototype to solve a real-world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Modifications			
Multi-Lingual Learners	**Special Education**	**At-Risk**	**Gifted and Talented**
● Provide multiple types of instruction - written/oral/pictorial. ● Use body movement and gestures to further explain concepts to students. ● Assign a native language partner if possible	● Provide adequate scaffolds for all long-term assignments. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Modify lab reports to include additional data analysis outside of assignment requirements. ● Engage in a more complex problem solving and graphical interpretation

Conceptual Physics

Unit 3: 1-D Kinematics

Time Allotted: Approximately 5-6 Weeks

New Jersey Student Learning Standards (NJSLS)

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-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Analyzing and Interpreting Data • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Constructing Explanations and Designing Solutions** • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. - *Connections to Nature of Science* **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. • Laws are statements or descriptions of the relationships among observable phenomena.	**PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. **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. **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** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. - *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- How can the motion of objects be predicted and/or explained? - How can we use models to help us understand motion? - How can the idea of frames of reference allow two people to tell the truth yet have conflicting reports?	- Express the motion of an object using narrative, pictorial, mathematical, and graphical representations - Design an experimental investigation of the motion of an object - Analyze experimental data describing the motion of an	- Experimentally determine the velocity of an object moving at constant velocity - Determine the acceleration of an object using pictorial representation of data - X vs t and v vs t graphing exercise - Free Fall lab to measure acceleration due to gravity of a vertically-moving object - Engineering Design Project requiring students to design and develop a car	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting Lab Reports for each lab conducted - Assessment of Engineering Design Process skill by building the Bottle Rocket

	object and express the results - Make predictions about the motion of a object based on the fact that acceleration is equal to the change in velocity per unit time, and velocity is equal to the in position per unit time - Create mathematical models and analyze graphical relationships for acceleration, velocity, and position of an object and use them to calculate properties of the object's motion Boundaries: limited to - situations with constant acceleration - analysis of position vs. time and velocity vs. time graphs	that will move as far and as straight as possible (minimum negative acceleration) while moving down a level hallway *Diversity, Equity, and Inclusion*: • Changing Attitudes to disability in engineering • James Hermus – How learning challenges shaped a mechanical engineer's path.	Racer, including supporting documentation. - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test.
Resources/Materials	- Data Collection & Analysis Software - Word Processing Software - Graph Paper, Ruler, Calculator - Course Textbook - The Physics Classroom tutorials, concept builders, and interactives - Bozeman Science - PhET - Khan Academy - Selected Problem sets from various ancillary materials		
ELA Companion Standards	**RST.11-12.1.** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. **RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **RST.11-12.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.5.** Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. **RST.11-12.6.** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.		

	RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. **WHST.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.2**. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.11-12.6**. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information **WHST.11-12.9**. Draw evidence from informational texts to support analysis, reflection, and research. **WHST.11-12.10**. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Interdisciplinary Connections	***ELA/Literacy*** **SL.11-12.1**. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.11-12.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.11-12.5.** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. **SL.11-12.6.** Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate ***Mathematics*** **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.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 problems **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by in hand simple cases and using technology for more complicated cases **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histogram, and box plots)
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.IML.3** Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data **9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments

	9.2.12.CAP.7: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.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 (peers) **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) **8.2.12.C.3.** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). **8.2.12.D.1.** Design and create a prototype to solve a real-world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Provide multiple types of instruction - written/oral/pictorial. ● Use body movement and gestures to further explain concepts to students. ● Assign a native language partner if possible	● Provide adequate scaffolds for all long-term assignments. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Modify lab reports to include additional data analysis outside of assignment requirements. ● Engage in a more complex problem solving and graphical interpretation

Conceptual Physics

Unit 4: Forces in linear motion

Time Allotted: Approximately 6-7 Weeks

New Jersey Student Learning Standards (NJSLS)

HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object 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-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Analyzing and Interpreting Data • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Constructing Explanations and Designing Solutions** • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. - *Connections to Nature of Science* **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. • Laws are statements or descriptions of the relationships among observable phenomena.	**PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. **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. **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** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. - *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
How do Newton's Laws of Motion explain the motion of objects in a wide variety of situations? How do Newton's Laws of Motion explain	• Represent the relationship among mass, acceleration, and force with words, graphs, pictures/diagrams, and equations. • Use Newton's second law to	- Activity: Determine the relationship between Fg and. m - Lab: Determine the relationships between acceleration, net force and mass.(Newton's Second Law)	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting Lab Reports for each lab conducted

the role of safety devices in a vehicle, such as seatbelts, airbags, crumple zones, anti-lock brakes, and more?	accurately predict changes in the motion of macroscopic objects. ● Diagram the various forces acting on an object, identifying which impact the object's motion. ● Describe how unbalanced forces on an object are responsible for changes in motion. ● Quantitatively identify and/or calculate mass, speed, position, force, and acceleration. ● Predict the outcome of investigations with moving objects. ● Describe how inanimate objects can exert forces. ● Distinguish and describe weight, mass, and inertia. Boundary Statements: This is limited to - Two body systems which are connected - Constant acceleration - Use of v-t graphs (not a-t graphs) - Only forces that are not at angles to the line of action (no trig).	- Activity: Determine the relationship between the angle of an incline and the force required to maintain equilibrium - Activity: Determine the mass of an unknown object suspended at static equilibrium with multiple forces acting at various angles - Lab: Determine the relationship between acceleration of a cart and the angle of the incline - Lab: Determine the coefficient of Kinetic Friction between an object and a surface. - Lab: Determine the coefficient of Static Friction between an object and a surface in two ways. - Lab: Determine the acceleration of a vertically-hanging mass (Atwood's Machine) - Lab: For a modified Atwood's Machine, determine the maximum mass, m2, that will cause m1 to meet certain criteria (such as, to stay at rest on the incline or to accelerate up (or down) the incline at a particular rate). - Project: Build an air-pressure launched (Bottle Rocket) Racer that meets specific constraints and requirements. - Project: Create a method of stopping a marble that meets specific constraints and requirements. - Project: Design a satellite and a launch vehicle to carry it to the moon, both of which meet specific constraints and requirements. - Project: Design a parachute that keeps a 50-g mass falling with the smallest "g" possible.	- Assessment of Engineering Design Process skill by completing the unit project, including supporting documentation. - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test.

		- Project: Design a floatation device that can carry a moderate load (household goods, pets, or children under 50 pounds) during a flood, and safely navigate a short distance (powered by an electric motor?) - Project: Design a device that will transport ___ down a ramp at constant speed, while meeting specific constraints and requirements. *Scientist Spotlight*: • **Dr. Hakeen Oluseyi** – Astrophysicist and founder for the African Astronomical Society, & One Telescope Project.	
Resources/Materials	- The Physics Classroom tutorials, concept builders, and interactives - Crash Course - Bozeman Science - PhET - Khan Academy - Explore Learning interactives - The AP Physics Workbook - guided practice (student and teacher versions downloadable from AP Classroom) - Software: Pasco Capstone, Excel, Word		
ELA Companion Standards	**RST.11-12.1.** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. **RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **RST.11-12.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.5.** Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. **RST.11-12.6.** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. **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. **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. **WHST.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.2**. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.11-12.4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST.11-12.5.** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.11-12.6**. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information **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. **WHST.11-12.10**. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Interdisciplinary Connections	***ELA/Literacy*** **SL.11-12.1**. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.11-12.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.11-12.3**. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used. **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.11-12.5.** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. **SL.11-12.6.** Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate ***Mathematics*** **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.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 problems **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by in hand simple cases and using technology for more complicated cases **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histogram, and box plots)
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.IML.3** Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data **9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.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 (peers) **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) **8.2.12.C.3.** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). **8.2.12.C.4** Explain and identify interdependent systems and their functions. **8.2.12.D.1.** Design and create a prototype to solve a real-world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Modifications			
Multi-Lingual Learners	**Special Education**	**At-Risk**	**Gifted and Talented**
● When possible, modify assignments so the ELL student writes less, has simpler questions to answer, fewer spelling words,	● Use scaffolds, such as prompting, to assist with the design process. ● Provide extended time for written responses and reports.	● Use a graphic organizer to categorize concepts. ● Provide an outline for research and design tasks.	● Take on an additional or more complex design challenge. ● Interview someone in the field of technology education about how

etc. ● Provide models of completed homework assignments, projects, etc. ● Assign a native language partner. ● Use sentence/paragraph frames to assist with writing peer review. ● Provide extended time for written responses and reports.	● Use a graphic organizer to categorize concepts. ● Get a written list of instructions ● Receive large project as smaller tasks with individual deadlines ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm to help with time management ● Work with a partner	● Provide extended time for written responses and reports. ● Incorporate student choice ● Provide peer mentoring to improve techniques ● Use effort and achievement rubrics ● Assure students they can be successful ● Promote mastery or challenging tasks ● Allow students many opportunities for practice and learning ● Use scaffolding for complex tasks ● Evaluate students on the basis of mastery and not one another. Classroom activities should be noncompetitive	they use the design process in their profession. ● Offer choices, once finished with a basic task, with personal interest being the key.

Conceptual Physics

Unit 5: Momentum

Time Allotted: Approximately 5-6 Weeks

New Jersey Student Learning Standards (NJSLS)

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-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Using Mathematics and Computational Thinking ● Use mathematical representations of phenomena to describe explanations. **Constructing Explanations and Designing Solutions** ● Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. ● Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of	**PS2.A: Forces and Motion** ● Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. ● If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. **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.	**Systems and System Models** ● When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. - *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering, and Technology on Society and the Natural World** ● New technologies can have deep impacts on society and the environment, including some that were not

evidence, prioritized criteria, and tradeoff considerations.	**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.	anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What makes one car more safe to drive than another? - How do the mass and velocity of two objects affect the results of their collision?	- Express the momentum of an object and conservation of momentum using narrative, pictorial, mathematical, and graphical representations - Design an experimental investigation of the momentum of an object - Analyze experimental data describing the momentum of an object and express the results - Make predictions about momentum changes of a system based on the fact that the total momentum of a system is conserved. - Create mathematical models and analyze graphical relationships for momentum, impulse, and force of an object/system and use them to calculate properties of the object/system's momentum Boundaries: limited to - Linear collisions - Collisions involving two objects - Analysis of velocity-time and force-time graphs - One-equation solutions (no perfectly elastic collisions)	- Engineering Design Project: Design a vertically-launched water-bottle rocket that carries a specified payload with the longest possible hangtime. - Lab Purpose: Determine the relationship between velocity and momentum. - Lab Purpose: Find the relationship between mass and momentum. - Lab Purpose: Find the relationship between impulse and change in momentum. - Lab Purpose: Given 2 colliding carts of various masses, determine the relationship between the total initial momentum and the total final momentum. - Answering conceptual questions about momentum (narrative representations of conservation of momentum) - Creating and interpreting velocity-time and force-time graphs (graphical representations of conservation of momentum) - Solving quantitative problems involving momentum and conservation of momentum (mathematical representations of conservation of momentum) - Project: Identify where people need protection from collisions and design a protective solution for one of these situations. - Project: Do car crash analysis/reconstruction.	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting Lab Reports for each lab conducted - Assessment of Engineering Design Process skill by building the project, including supporting documentation. - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test. - Physics Benchmark #2

		- Project: Design a rocket to launch __m vertically while carrying the maximum payload. - Project: Design a crumple zone to protect a passenger during a collision.	
Resources/Materials	- Data Collection & Analysis Software - Word Processing Software - Graph Paper, Ruler, Calculator - Course Textbook - The Physics Classroom tutorials, concept builders, and interactives - Bozeman Science - PhET - Khan Academy - The AP Physics Workbook - guided practice (student and teacher versions downloadable from AP Classroom) - Selected Problem sets from various ancillary materials		
ELA Companion Standards	**RST.11-12.1.** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. **RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **RST.11-12.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.5.** Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. **RST.11-12.6.** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. **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. **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. **WHST.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.2**. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.11-12.4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST.11-12.5.** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.		

	WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information **WHST.11-12.7**. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **WHST.11-12.9**. Draw evidence from informational texts to support analysis, reflection, and research. **WHST.11-12.10**. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Interdisciplinary Connections	***ELA/Literacy*** **SL.11-12.1**. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.11-12.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. ***Mathematics*** **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.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 problems **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by in hand simple cases and using technology for more complicated cases **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histogram, and box plots)
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.IML.3** Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data **9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation.

	● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.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 (peers) **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) **8.2.12.C.3.** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). **8.2.12.D.1.** Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Provide multiple types of instruction - written/oral/pictorial. ● Use body movement and gestures to further explain concepts to students. ● Assign a native language partner if possible	● Provide adequate scaffolds for all long-term assignments. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Modify lab reports to include additional data analysis outside of assignment requirements. ● Engage in a more complex problem solving and graphical interpretation

Conceptual Physics

Unit 6: Mechanical Energy, Conservation, and Power

Time Allotted: Approximately 3-5 Weeks

New Jersey Student Learning Standards (NJSLS)

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 motions of particles (objects) and energy associated with the relative position 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.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting 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. **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. • Evaluate 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** • 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.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. **ESS3.C: Human Impacts on Earth Systems** • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. **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	**Energy and Matter** • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. • 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. **Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. - *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

	to the extent possible and stated in such a way that one can tell if a given design meets them. *(secondary)* **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. **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.	• Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
How is energy transferred and conserved? How are forces related to energy? How does the flow of energy affect the object/system? How do you know when to apply conservation of mechanical energy? Why is the first hill of a roller coaster always the biggest one?	- Express the energy of an object and conservation of energy using narrative, pictorial, mathematical, and graphical representations - Design an experimental investigation of the energy of an object - Analyze experimental data describing the energy of an object and express the results - Make predictions about energy changes of a system based on the fact that the total energy of a system is conserved unless work is done - Create mathematical models and analyze graphical relationships for energy, work, force, and displacement of an object/system and use them to calculate properties of the object/system's energy Boundaries: limited to - Gravitational potential and kinetic energies - Analysis of work-energy bar	- Engineering Design Project: Rube Goldberg, Rocket, Roller coaster, etc. - Lab Purpose: Determine the relationship between total mechanical energy at the highest and lowest point of a pendulum. - Lab Purpose: Determine the relationship between the compression of a spring and the maximum height of a projectile. - Lab Purpose: Determine the relationship between the initial height of a cart on an incline and the velocity of the cart at the bottom of the incline. - Answering conceptual questions about energy (narrative representations of energy conservation) - Creating and interpreting energy graphs (graphical representations of energy conservation) - Solving quantitative problems involving energy (mathematical representations of energy conservation)	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting Lab Reports for each lab conducted - Assessment of Engineering Design Process skill by building the project, including supporting documentation. - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test.

	charts, energy-time, force-displacement, and work-time graphs		
Resources/Materials	- Data Collection & Analysis Software - Word Processing Software - Graph Paper, Ruler, Calculator - Course Textbook - The Physics Classroom tutorials, concept builders, and interactives - Bozeman Science - PhET - Khan Academy - The AP Physics Workbook - guided practice (student and teacher versions downloadable from AP Classroom) - Selected Problem sets from various ancillary materials		
ELA Companion Standards	**RST.11-12.1.** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. **RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **RST.11-12.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.5.** Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. **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.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.2**. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.11-12.4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST.11-12.5.** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.11-12.6**. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information **WHST.11-12.9**. Draw evidence from informational texts to support analysis, reflection, and research.		
Interdisciplinary Connections	***ELA/Literacy*** **SL.11-12.1**. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.		

	SL.11-12.2. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.11-12.3**. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used. **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.11-12.5.** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. **SL.11-12.6.** Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate ***Mathematics*** **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.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 problems **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by in hand simple cases and using technology for more complicated cases **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histogram, and box plots)
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.IML.3** Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data **9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.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 (peers) **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) **8.2.12.C.3.** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). **8.2.12.D.1.** Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Provide multiple types of instruction - written/oral/pictorial. ● Use body movement and gestures to further explain concepts to students. ● Assign a native language partner if possible	● Provide adequate scaffolds for all long-term assignments. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Modify lab reports to include additional data analysis outside of assignment requirements. ● Engage in a more complex problem solving and graphical interpretation

Conceptual Physics

Unit 7: Magnetism

Time Allotted: Approximately 4-5 Weeks

New Jersey Student Learning Standards (NJSLS)

HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices

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.

Developing and Using Models

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

Constructing Explanations and Designing Solutions

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

Disciplinary Core Ideas

PS2.B: Types of Interactions

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

PS3.A: Definitions of Energy

- "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *(secondary)*

PS3.C: Relationship Between Energy and Forces

- When two objects interacting through a field change relative position, the energy stored in the field is changed.

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.

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.

Cross-Cutting Concepts

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.

Connections to Engineering, Technology, and Applications of Science

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

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What creates a magnetic field? - How can magnetic fields be used in technology?	- Express the strength of a magnetic field using narrative, pictorial, mathematical, and graphical representations - Design an experimental investigation of the strength of a magnetic field. - Analyze experimental data describing the strength of a magnetic field and express the results - Make predictions about the strength of a magnetic field produced by an electromagnet based on the fact that current and magnetic field strength are directly proportional. Boundaries: limited to - Situations involving bar magnets, straight current carrying wires, solenoids and electromagnets - Analysis of magnetic field strength vs distance graphs	- Engineering Design Project: Design and build an electric powered maglev racer that will travel 2 meters along a level track. - Lab Purpose: Determine the strongest part of a bar magnet - Lab Purpose: Find the relationship between distance from a bar magnet and the magnetic field strength of the bar magnet. - Lab Purpose: Determine the factors that influence the strength of an electromagnet - Answering conceptual questions about magnetism (narrative representations of magnetism) - Creating and interpreting magnetic field strength vs distance from a bar magnet graphs (graphical representations of magnetism) - Solving quantitative problems involving electromagnets (mathematical representations of magnetism) - Project: Design and build your own electric instrument - Project: Design and build a doorbell. *Diversity, Equity, and Inclusion*: • How magnets help severely paralyzed individuals operate a tongue-controlled wheelchair.	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting Lab Reports for each lab conducted - Assessment of Engineering Design Process skill by building the project, including supporting documentation. - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test.
Resources/Materials	- Data Collection & Analysis Software - Word Processing Software - Graph Paper, Ruler, Calculator - Course Textbook - The Physics Classroom tutorials, concept builders, and interactives - Bozeman Science - PhET - Khan Academy - The AP Physics Workbook - guided practice (student and teacher versions downloadable from AP Classroom)		

	- Selected Problem sets from various ancillary materials
ELA Companion Standards	**RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **RST.11-12.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.6.** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. **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. **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. **WHST.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.2**. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.11-12.4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST.11-12.5.** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.11-12.6**. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information **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. **WHST.11-12.10**. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Interdisciplinary Connections	***ELA/Literacy*** **SL.11-12.1**. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.11-12.3**. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used. **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.

	SL.11-12.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. **SL.11-12.6.** Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate ***Mathematics*** **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.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 problems **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by in hand simple cases and using technology for more complicated cases **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histogram, and box plots)
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.IML.3** Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data **9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.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 (peers) **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) **8.2.12.C.3.** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics).

	8.2.12.D.1. Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Modifications			
Multi-Lingual Learners	**Special Education**	**At-Risk**	**Gifted and Talented**
● Provide multiple types of instruction - written/oral/pictorial. ● Use body movement and gestures to further explain concepts to students. ● Assign a native language partner if possible	● Provide adequate scaffolds for all long-term assignments. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Modify lab reports to include additional data analysis outside of assignment requirements. ● Engage in a more complex problem solving and graphical interpretation

Conceptual Physics

Unit 8: 2-D, Circular, and Gravitational Motion

Time Allotted: If time permits

New Jersey Student Learning Standards (NJSLS)

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.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena to describe explanations.

Constructing Explanations and Designing Solutions

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

Analyzing and Interpreting Data

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Connections to Nature of Science

Disciplinary Core Ideas

PS2.A: Forces and Motion

- Newton's second law accurately predicts changes in the motion of macroscopic objects.

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.

ESS1.B: Earth and the Solar System

- Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.

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.

Cross-Cutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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.

Scale, Proportion, and Quantity

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Connections to Engineering, Technology, and Applications of Science

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

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	**ETS1.C: Optimizing the Design Solution**	**Interdependence of Science, Engineering, and Technology**
• Theories and laws provide explanations in science. • Laws are statements or descriptions of the relationships among observable phenomena.	• 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.	• Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- Why do we feel like we are being crushed at the bottom of a roller coaster loop? - Why is it so important to slow down when driving around curves in rainy, snowy, or icy weather? - Why do we feel pulled toward Earth, but not toward a pencil? - How are satellites launched and how do they stay in their orbits?	- Express the motion of an object in two dimensions using narrative and pictorial representations - Create and use force diagrams to analyze physical situations dealing with universal gravitation and uniform circular motion both qualitatively and quantitatively - Calculate the gravitational field around an object - Calculate the gravitational force between any two objects using Newton's Law of Universal Gravitation - Identify and calculate the net force (Centripetal Force) acting on an object that keeps it moving in uniform circular motion - Apply prior knowledge of Newton's Laws to determine the centripetal force and centripetal acceleration of an object traveling along a circular path - Experimentally determine the coefficient of friction needed to hold a rotating object in place - Calculate the apparent weight and G-force felt by a person undergoing circular motion (ex.	- Experimentally determine the tangential velocity and string tension of an object on a string moving in uniform circular motion - Experimentally determine the gravitational field of Earth (if not already done) - Experimentally verify the relationship between all variables in Newton's Law of Universal Gravitation (online simulation and excel graphing) - Experimentally determine the coefficient of friction between an object a surface holding the object in place while rotating - Engineering Design Project: design and develop a model of a space station that when rotated will simulate the gravitational field of Earth or another planet - Engineering Design Project: Design and develop a model of a single loop roller coaster that will make the rider feel between 0.5 and 3 g's. *Scientist Spotlight*: • **Sally Ride** – First American Woman in space. • **Jane Rigby** – Operations Project Scientist for NASA's James Webb Space telescope	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting Lab Reports for each lab conducted - Assessment of Engineering Design Process skill by building the Bottle Rocket Racer, including supporting documentation. - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test. - Physics Benchmark #3

	roller coaster loops and hills) - Describe common features of the motions of orbiting objects, including their elliptical paths around the sun. - Explain how orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. Boundaries: Limited to: - No calculations for projectile motion at angles - Projectile motion limited to horizontal launch only - Tension, Gravity, Normal Force, and Friction acting as centripetal force - Level surfaces only for friction assisted turns - No Kepler's laws	• **Mae Carol Jemison** – An American engineer, physician, and former NASA astronaut. First African American woman to travel into space.	
Resources/Materials	- Data Collection & Analysis Software - Word Processing Software - Graph Paper, Ruler, Calculator - Course Textbook - The Physics Classroom tutorials, concept builders, and interactives - Bozeman Science - PhET - Khan Academy - Selected Problem sets from various ancillary materials		
ELA Companion Standards	**RST.11-12.1.** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. **RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **RST.11-12.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.5.** Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.		

	RST.11-12.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. **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. **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. **WHST.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.2**. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.11-12.4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST.11-12.5.** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.11-12.6**. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information **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. **WHST.11-12.10**. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
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Modifications			
Multi-Lingual Learners	**Special Education**	**At-Risk**	**Gifted and Talented**
● Provide multiple types of instruction - written/oral/pictorial. ● Use body movement and gestures to further explain concepts to students. ● Assign a native language partner if possible	● Provide adequate scaffolds for all long-term assignments. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Modify lab reports to include additional data analysis outside of assignment requirements.

	setting, such as a quiet room with few distractions • Sit where they learn best (for example, near the teacher) • Use an alarm to help with time management • Work with a partner		• Engage in a more complex problem solving and graphical interpretation

Conceptual Physics		
Projects: A Culminating Unit		
Time Allotted: Approximately 3-4 Weeks		
New Jersey Student Learning Standards (NJSLS)		
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]		
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
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** • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. **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. **ESS3.C: Human Impacts on Earth Systems** • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)* **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	**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. **Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. - *Connections to Engineering,Technology, and Applications of Science* **Influence of Science, Engineering and Technology on Society and the Natural World** • Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. • Engineers continuously modify these technological systems by applying scientific knowledge and

	they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. *(secondary)*	engineering design practices to increase benefits while decreasing costs and risks.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
How do the big ideas in physics interact together to create working models as well as explain how these things function? What do engineers do? How is the scientific method different from and similar to the engineering design process? What is the nature of scientific and technological progress that tends to move in gradual iterations instead of quantum jumps?	• state the steps of the engineering design process. • Draw a scale diagram of a solution to a problem. • Document their progress in coherent, concise written and/or oral format. • Use appropriate tools to collect and organize data that communicates the successes and failures of the solution to the problem. • Make changes to their solution based upon the collected data as well as feedback from peers and/or adult coaches. • Use failures as a stimulus to new approaches to the problem. • Analyze the model in terms of physics concepts; both as scientific explanations and problem solving.	- Project: Design a plane that could fly on Mars - Project: Design and build a parachute that would work on Mars. - Project: Build a Rube Goldberg Machine to complete a defined task and made with materials found in your home. - Project: Design a device to rescue an animal or person that has fallen into a well or sewer. - Project: Design a Trebuchet that meets specific constraints and requirements. - Project: Design a mousetrap car that can stop within a bullseye while meeting specific constraints and requirements. - Project: Design an Elevator to store snowmobiles in a loft during the summer - Project: Design and build a water-powered bottle rocket that can carry a load and stay aloft as long as possible. - Project: Powering the Future: Design an efficient "energy-transfer" machine incorporating solar panel(s). *Scientist Spotlight*: • **Dr. Stephen Hawking** – Theoretical physicist with motor neuron disease who focused on the origins and structure of the universe.	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by answering questions on a written test These questions would be based upon the project, and the teacher may choose to allow students to use their project documentation during the test. - Assessment of Engineering Design Process skill by building the one of the suggested projects (or one with similar scope), including supporting documentation. - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking the Unit Test These questions would be based upon the project and teachers may choose to allow students to use their project documentation during the test.

Resources/Materials	- Crafts materials supplied in the classroom or gleaned from home - Software: Pasco Capstone, Excel, Word		
ELA Companion Standards	**RST.11-12.1.** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. **RST.11-12.2.** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **RST.11-12.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. **RST.11-12.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.5.** Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. **RST.11-12.6.** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. **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. **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. **WHST.11-12.1**. Write arguments focused on discipline-specific content. **WHST.11-12.2**. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.11-12.4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST.11-12.5.** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.11-12.6**. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information **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. **WHST.11-12.10**. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.		

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	● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.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 (peers) **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) **8.2.12.C.3.** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). **8.2.12.C.4** Explain and identify interdependent systems and their functions. **8.2.12.D.1.** Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● When possible, modify assignments so the ELL student writes less, has simpler questions to answer, fewer spelling words, etc. ● Provide models of completed homework assignments, projects, etc. ● Assign a native language partner. ● Use sentence/paragraph frames to assist with writing peer review. ● Provide extended time for written responses and reports.	● Use scaffolds, such as prompting, to assist with the design process. ● Provide extended time for written responses and reports. ● Use a graphic organizer to categorize concepts. ● Get a written list of instructions ● Receive large project as smaller tasks with individual deadlines ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm to help with time management ● Work with a partner	● Use a graphic organizer to categorize concepts. ● Provide an outline for research and design tasks. ● Provide extended time for written responses and reports. ● Incorporate student choice ● Provide peer mentoring to improve techniques ● Use effort and achievement rubrics ● Assure students they can be successful ● Promote mastery or challenging tasks ● Allow students many opportunities for practice and learning ● Use scaffolding for complex tasks ● Evaluate students on the basis of mastery and not one another. Classroom activities should be noncompetitive	● Take on an additional or more complex design challenge. ● Interview someone in the field of technology education about how they use the design process in their profession. ● Offer choices, once finished with a basic task, with personal interest being the key.

Additional Resources to promote DEI:

- Structure Matters: Twenty-One Teaching Strategies to Promote Student Engagement and Cultivate Classroom Equity
- Race Matters
- Inclusive Teaching