

Pascack Valley Regional High School District

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

Course Name: Physics

Born On: August, 2026
Board Approval: 8/24/26

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.

Physics		
Unit Title	Approx # of weeks	Months
Benchmark #1		
Kinematics & Dynamics	8 Weeks	September - October
Circular Motion & Space Science	6 Weeks	November - December
Momentum & Impulse	4 Weeks	January
Benchmark #2		
Energy, Work, & Power	5-6 Weeks	February - March
Mechanical Waves & Electromagnetic Radiation	4 Weeks	March - April
Geophysics	2-3 Weeks	April
Electricity & Magnetism	5 Weeks	May - June
Benchmark #3		

Physics

Unit 1: Kinematics & Dynamics

Related Phenomena: Texting and Driving

This dramatization of texting while driving provides a concrete, high-stakes context in which students can see why understanding forces and motion matters in their own lives. It allows students to analyze how unbalanced forces (braking, collisions) and the resulting accelerations are linked to reaction time and stopping distance, illustrating the critical difference between balanced and unbalanced forces. Using this phenomenon grounds kinematics and dynamics in a real-world scenario that connects directly to student safety and decision-making.

- Driving Question: How do forces and motion determine what happens when a driver needs to stop suddenly while texting and driving?
- From Patterns Physics: Ad free link <https://safesha.re/3u7l> and Source link <https://www.youtube.com/watch?v=yjQGc6m8mw0>

Pacing: 8 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.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Developing and Using Models • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems,	PS2.A: Forces and Motion • Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2), (HS-PS2-3) 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) • Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6),	Cause and Effect–Mechanism and Explanation: • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1), (HS-PS2-5) • Systems can be designed to cause a desired effect. (HS-PS2-3). Systems and System Models • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) Stability and Change: • Much of science deals with constructing explanations of how things change and how they remain stable. • Change and rates of change can be quantified and modeled over very short or very long periods of time.

and/or solve problems.

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.

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.
- Apply concepts of statistics and probability (including determining function fits to data, slope, and intercept) to scientific questions and problems.
- Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Constructing Explanations and Designing Solutions

- Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, and theories).
- Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena.
- Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

(secondary to HS-PS1-1), (secondary to HS-PS1-3)

ETS1.A: Defining and Delimiting Engineering Problems

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3)

ETS1.C: Optimizing the Design Solution

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS2-3)

Connections to Nature of Science Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Theories and laws provide explanations in science. (HS-PS2-1), (HS-PS2-4)
- Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1), (HS-PS2-4)

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.			
Interdisciplinary Connections		W.AW.11–12.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. SL.PE.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. 1.5.12prof.Cn10a: Document the process of developing ideas from early stages to fully elaborated ideas. N.VM.1. Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v). N.VM.3. Solve problems involving velocity and other quantities that can be represented by vectors. F.IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. S.ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. S.ID.8. Compute (using technology) and interpret the correlation coefficient of a linear fit.	
Career Readiness, Life Literacies, and Key Skills		9.1.12.PB.2: Prioritize financial decisions by considering alternatives and possible consequences. 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills. 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.	
Computer Science and Design Thinking		8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. 8.2.12.ED.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).	
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What is the relationship between forces and motion? - How can we predict an object's motion using data, graphs, and models? - How does the balance or imbalance of forces affect an object's acceleration? - How do reaction time and braking distance connect to the forces acting on a moving vehicle? - How can understanding forces and motion help us make safer choices in everyday life?	Student will be able to: - Describe the difference between distance and displacement. - Explain the difference between speed and velocity. - Describe acceleration as a change in velocity over time. - Use motion graphs to describe an object's motion. - Interpret position-time and velocity-time graphs to identify changes in motion. - Collect and analyze data from investigations involving motion.	Modeling and Phenomena: #1: Observe different kinds of motion in a variety of toy cars in strobe photo demo (battery-powered, fan-powered, no power, pull-back racers). #2: Newton's first law of motion demo(s), such as Tablecloth Trick, Coin and Card, Inertia Ball, and/or Cart and Collision. #3: Changing motion using Ticker Tape Lab or Moving Man Lab. #4: Apply everything to a freefall situation and terminal velocity	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting 2-3 Lab Reports (choose from suggested tasks/activities) (Formative) - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking 1-2 quizzes (Formative) and the Unit Test. (Summative)

(driving, crossing the street, jumping from a balcony...) What distinguishes the motion of a ball rolling on a flat surface, a ball rolling down an incline, a dropped ball, and a ball falling downward?	- Identify balanced and unbalanced forces acting on an object. - Explain how balanced and unbalanced forces affect an object's motion. - Describe Newton's First, Second, and Third Laws using real-world examples. - Draw and interpret simple free-body diagrams to identify the forces acting on an object. - Explain the relationship between force, mass, and acceleration using Newton's Second Law. - Solve simple problems involving force, mass, and acceleration using appropriate equations. - Use observations, data, and graphs to explain how forces change an object's motion. - Investigate how gravity affects the motion of falling objects. - Compare the motion of objects moving at constant speed, accelerating, and slowing down. - Apply concepts of motion and forces to everyday situations such as driving, sports, amusement rides, and transportation safety. - Communicate scientific explanations using evidence collected during laboratory investigations. - Design, test, and improve a simple engineering solution that demonstrates the relationship between force and motion. - Work collaboratively to collect data, analyze results, and communicate conclusions using appropriate scientific vocabulary.	Hands-On Activities/Labs: - Given a scenario for two buggies, find a way to represent their motion on the same graph (d-t and/or v-t graphs) in Walk the Graph Lab and Constant Motion Lab - Discover Newton's First Law in Newton's First Law Lab - Investigating forces & drawing FBDs - Discover Newton's Second Law with unbalanced vs balanced force language in Balanced vs Unbalanced Force Investigation - Activity: Discover Newton's 3rd Law (measure forces on paired objects and draw FBDs)* Class Practice: - Practice translating between multiple representations including x-t, v-t, motion maps and words. - Practice writing CERs using graphs and ticker tape as evidence - Solve $v = \Delta x / \Delta t$ and $a = \Delta v / \Delta t$ problems - Activity: Which one doesn't belong? (card sort) - Dynamics problem solving Careers in Physics, Lesson 1	- Assessment of Engineering Design Projects by building the project, including supporting documentation (formative), examples: - Bottle Rocket - LinkIt! Form A (Benchmark)
Modifications			

Multi-Lingual Learners	Students with Special Needs/504s	At-Risk	Gifted and Talented
• Provide illustrated vocabulary cards and bilingual reference sheets for key kinematics and dynamics terms (e.g., displacement, velocity, acceleration, net force, inertia) to reinforce academic language during investigations and problem solving. • Allow students to demonstrate understanding of motion graphs and Newton's Laws through annotated diagrams, demonstrations, or brief oral explanations before completing extended written responses. • Give multilingual learners with lower reading proficiency the option of focusing on the diagrams and animations, but encourage them to closely read a paragraph or two of the longer texts, so they practice and better comprehend the details shared by you and their classmates. • Using classroom routines (such as Domino Discover) provides support for multilingual learners to provide different types of input, all from peers in the classroom, to students' language development. • Allow student access to translation services such as Google Translate or PaperPal • 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.	• Provide partially completed motion graphs, free-body diagrams, or problem-solving templates so students can focus on interpreting motion and force relationships without becoming overwhelmed by multiple representations. • Use color-coded vectors and motion diagrams to help students distinguish between velocity, acceleration, net force, and displacement when interpreting graphical representations of motion. • Use scaffolds, such as prompting, activating prior knowledge, reducing multiple-choice options, and think-alouds • Provide extended time for written responses, reports, and assessments • Use a graphic organizer to categorize concepts especially for written CERs • 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 • Preferential seating based on individual needs • Use a visual alarm to help with time management • Work with a partner or small group • Station rotations with various tasks and activities • Print out larger versions of text and maps to ensure visibility is not a barrier. • Include visual aids and images when necessary	• Scaffold multistep kinematics and Newton's Laws problems by providing guided problem-solving organizers that prompt students to identify known variables, draw diagrams, select equations, and evaluate the reasonableness of their answers. • Provide structured graph interpretation activities that gradually progress from identifying trends on position-time graphs to analyzing velocity-time and acceleration-time relationships before solving quantitative problems. • If students are struggling with starting models, use guiding questions. • 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 • Allow students many opportunities for practice and learning • Use scaffolding for complex tasks See MLL, point 1.	• Challenge students to analyze real crash-test data from the National Highway Traffic Safety Administration (NHTSA) or Insurance Institute for Highway Safety (IIHS) and evaluate how Newton's Laws influence vehicle safety design. • Provide opportunities to design and mathematically optimize an engineering solution (e.g., balloon-powered vehicle, fan cart, or crash-protection system) by comparing multiple design iterations using experimental data and quantitative analysis. • Encourage students to work on advanced requirements or higher achievement levels, when applicable. • Offer choices of assignments to further content knowledge, once finished with a basic task, with personal interest being the key.

• Assign a native language partner. • Provide extended time for written responses and reports.	• Show demonstrations and videos for kinesthetic and auditory learners • Provide word bank		
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Physics

Unit 2: Circular Motion & Space Science

Related Phenomena: Global Positioning System

This phenomenon allows students to understand a real-world application that they use on a daily basis which covers the following unit concepts: circular motion, gravitation, orbital trajectories, electromagnetic signals, and relativity.

- Driving Question: How do satellites remain in motion above Earth's surface and how does the Global Positioning System transmit information to Earth?
- [How GPS Works](#) – YouTube Link "Virtual Brain"

Pacing: 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-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-ESS1-1: Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.)

HS-ESS1-2: Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

HS-ESS1-4: Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

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 Asking Questions and Defining Problems • Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. • Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Constructing Explanations and Designing Solutions	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.A: The Universe and Its Stars • The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years	Cause and Effect • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Energy and Matter • Energy cannot be created or destroyed – only moved between one place and another place, between objects and/or fields, or between systems. 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).

- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Developing and Using Models

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

Obtaining, Evaluating, and Communicating Information

- Communicate scientific 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).

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Using Mathematics and Computational Thinking

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and the distances from Earth.
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.

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

PS3.D: Energy in Chemical Processes and Everyday Life

- Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary)

PS4.B: Electromagnetic Radiation

- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary)
- Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary).

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

• Use mathematical representations of phenomena to describe explanations. ----- Connections to Nature of Science ----- Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena • Theories and laws provide explanations in science. • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. • Laws are statements or descriptions of the relationships among observable phenomena. • Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.		
Interdisciplinary Connections <i>ELA, Math, SS, Health, V&P Arts</i>	RI.CR.11–12.1. Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. W.AW.11–12.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. W.WR.11–12.5. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. W.SE.11–12.6. 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 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 (MLA or APA Style Manuals). SL.II.11–12.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. SL.PI.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.	

	A.REI.A.1: Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. A.REI.B.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. F.IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.		
Career Readiness, Life Literacies, and Key Skills	9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision-making. 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth. 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.		
Computer Science and Design Thinking	8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints.		
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- On which part of a merry-go-round are the riders traveling the fastest? - Why can cars and trucks both take a curve at the same maximum speed? - Why can people of different sizes all ride the same amusement park rides? - Why do we feel pulled toward Earth, but not toward a pencil? - How are satellites launched and how do they stay in their orbits? - What do all orbiting objects in our solar system have in common? - What is the life cycle of a star? - Why do cosmologists say that everything is made of star dust? - What is the Big Bang Theory, and how does it describe the origin and evolution of the universe? - How do gravitational interactions shape the structure	Student will be able to: - Define gravity as the force that attracts objects toward one another. - Describe how gravity keeps planets, moons, and satellites in orbit - Explain why an object moving in a circle must have a force directed toward the center of the circle. - Describe the relationship between speed, radius, and circular motion using real-world examples. - Interpret simple diagrams showing circular motion and identify the direction of velocity and centripetal force. - Use diagrams and free-body diagrams to identify the forces acting on objects moving in circular paths. - Explain how gravity acts as the centripetal force that keeps planets and satellites in orbit. - Describe how satellites remain in orbit around Earth. - Identify common examples of circular motion found in everyday life.	<i>Please link resources when available:</i> Modeling/Phenomena - Tangential velocity demo for objects at different radii with constant periods - F_c always points inward demo (pushing on a ball, curved track, etc.) - Mathematical proof of $mg = G \frac{m_1 m_2}{d^2}$ & Universal Gravitation practice problems Hands On Activities - 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)	<i>Please link assessment examples when available</i> - Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting 2-3 Lab Reports (choose from suggested tasks/activities) (formative) - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking 1-2 quizzes (formative) and the Unit Test (Summative) - Assessment of Engineering Design Projects by building the kinetic impactor project, including supporting documentation. (Formative)

and dynamics of our solar system? How do humans take advantage of Earth's gravitational field?	- Describe Kepler's Laws as patterns that explain how planets move around the Sun. - Use simple mathematical relationships to compare the motion of orbiting objects. - Explain how the distance between an object and Earth affects the strength of gravitational attraction. - Describe the life cycle of a star, including how stars produce energy through nuclear fusion. - Explain how stars create the elements that make up planets and living things. - Describe the evidence that supports the Big Bang Theory, including galaxy motion, light spectra, and cosmic microwave background radiation. - Interpret graphs, diagrams, and models that describe the expansion of the universe. - Analyze data, models, and simulations to explain the motion of planets, moons, and satellites. - Communicate scientific explanations about gravity, space, and the universe using evidence collected from investigations, models, and scientific sources. - Work collaboratively to investigate questions about space science, collect and analyze evidence, and communicate scientific conclusions. - Design, test, and evaluate a simple engineering solution related to space exploration, satellite technology, or planetary defense using scientific evidence to justify improvements.	- Kepler's Laws – Explore Learning Gizmo & Concept Question follow-up Class Practice - Tangential velocity concept reinforcement & calculations problem set - Centripetal force and acceleration problem set - Horizontal centripetal forces problem set (F_t, F_N, and F_f only for now) - conceptual understanding only - Vertical Loops and Hills circular motion problem set (include concept of weightlessness - $F_N = 0$) - conceptual understanding only - Universal Gravitation practice problems - Satellite Motion Problem Set (F_g acting as F_c) - Big Bang research assignment – find and evaluate sources of evidence supporting the Big Bang theory – must touch on the following at minimum: redshift of most galaxies when viewed from Earth, observed background cosmic radiation, & composition of stars - Final Project: Design and build an apparatus that simulates the action of a kinetic impactor – will use concepts from energy, momentum, and space science units	
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Modifications			
Multi-Lingual Learners	Students with Needs/504s	At-Risk	Gifted and Talented
• Provide labeled diagrams and bilingual vocabulary reference sheets for circular motion, gravitation, orbital mechanics, and astronomy concepts (e.g., centripetal force, orbital radius, gravitational field, redshift, fusion) to reinforce academic language throughout investigations. • Allow students to demonstrate understanding of satellite motion, Kepler's Laws, or the Big Bang through annotated diagrams, physical models, or brief oral explanations before completing extended written assignments. • Give multilingual learners with lower reading proficiency the option of focusing on the diagrams and animations, but encourage them to closely read a paragraph or two of the longer texts, so they practice and better comprehend the details shared by you and their classmates. • Using classroom routines (such as <i>Domino Discover</i>) provides support for multilingual learners to provide different types of input, all from peers in the classroom, to students' language development. • Allow student access to translation services such as Google Translate or PaperPal • When possible, modify assignments so the ELL student	• Provide partially completed orbital diagrams, free-body diagrams, and guided calculation templates for gravitation and circular motion problems to reduce cognitive load while maintaining conceptual rigor. • Use color-coded diagrams and vector models to distinguish gravitational force, centripetal force, velocity, and acceleration when analyzing circular motion and satellite orbits. • Use scaffolds, such as prompting • 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 • Print out larger versions of text and maps to ensure visibility is not a barrier. • For students who do better with kinesthetic learning, it might be more effective to do demonstrations with the students instead of showing videos. • Word bank	• Scaffold multistep orbital mechanics and universal gravitation calculations using structured problem-solving organizers that guide students through identifying known variables, drawing diagrams, selecting equations, and interpreting solutions. • Provide graphic organizers that connect Newton's Law of Gravitation, circular motion, Kepler's Laws, and satellite motion to help students recognize relationships between concepts before solving quantitative problems. • If students are struggling with starting models, use guiding questions. • 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 • Allow students many opportunities for practice and learning	• Challenge students to investigate how General Relativity corrections improve GPS accuracy and present how Einstein's theory impacts modern satellite navigation systems. • Provide opportunities to analyze authentic NASA, ESA, or James Webb Space Telescope data to evaluate evidence supporting stellar evolution, galaxy motion, or the Big Bang and compare scientific observations with classroom models. • Encourage students to work on advanced requirements or higher achievement levels, when applicable. • Offer choices of assignments to further content knowledge, once finished with a basic task, with personal interest being the key.

writes less, has simpler questions to answer, fewer spelling words, etc. • Provide models of completed homework assignments, projects, etc. • Assign a native language partner. • Provide extended time for written responses and reports.		• Use scaffolding for complex tasks See MLL, point 1.	
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Physics

Unit 3: Momentum and Impulse

Related Phenomena: Vehicle Safety Features

This investigation into vehicle collisions and safety features provides a concrete, high-stakes context in which students see why understanding momentum and impulse matters in their own lives. By analyzing collision timelines using simulation data, students explore how seat belts, airbags, and crumple zones extend the time over which a person's velocity changes, reducing the forces they experience during a crash. Using this phenomenon grounds the concepts of momentum conservation and impulse in a real-world scenario that directly connects physics to student safety and decision-making.

- Driving Question: What makes one car safer to drive than another?
- From OpenSciEd: [Video 1](#), [Video 2](#), [Video 3](#)

Pacing: 4 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-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

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Developing and Using Models • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.	PS2.A: Forces and Motion • Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) • Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2), (HS-PS2-3) PS2.B: Types of Interactions • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) • Attraction and repulsion between electric charges at the atomic scale explain the	Cause and Effect–Mechanism and Explanation: • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1), (HS-PS2-5) • Systems can be designed to cause a desired effect. (HS-PS2-3). Systems and System Models • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) Stability and Change: • Much of science deals with constructing explanations of how things change and how they remain stable. • Change and rates of change can be quantified and modeled over very short or very long periods of time.

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. 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. - Apply concepts of statistics and probability (including determining function fits to data, slope, and intercept) to scientific questions and problems. Constructing Explanations and Designing Solutions - Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, and theories). - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena. 6. Using Mathematics and Computational Thinking - Use mathematical representations of phenomena to describe explanations. (HS-PS2-2), (HS-PS2-4)	structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6), (secondary to HS-PS1-1), (secondary to HS-PS1-3) - ETS1.A: Defining and Delimiting Engineering Problems - Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3) - ETS1.C: Optimizing the Design Solution - Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS2-3)	Connections to Nature of Science Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena - Theories and laws provide explanations in science. (HS-PS2-1), (HS-PS2-4) - Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1), (HS-PS2-4)
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Interdisciplinary Connections	S.ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. SL.PE.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. RI.MF.11–12.6. Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept). W.IW.11–12.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.		
Career Readiness, Life Literacies, and Key Skills	9.1.12.PB.2: Prioritize financial decisions by considering alternatives and possible consequences. 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills. 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).		
Computer Science and Design Thinking	8.1.12.DA.5. Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. 8.2.12.ED.1. Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.		
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What is momentum, and how is it affected by forces and collisions? - How do safety features like seat belts, airbags, and crumple zones reduce the forces on passengers during a collision? - How do the interactions inside and outside of a system affect the system’s total momentum? - How can analyzing real and simulated collisions help us understand and apply the law of conservation of momentum? - How can we use physics to design safer vehicles?	Student will be able to: - Define momentum and describe how it depends on an object’s mass and velocity. - Explain the difference between momentum and impulse. - Describe how forces change the motion of an object during a collision. - Explain how increasing the time of a collision reduces the force experienced by an object. - Describe the purpose of seat belts, airbags, and crumple zones using the concepts of momentum and impulse. - Identify open and closed systems in everyday situations. - Explain the Law of Conservation of Momentum using words, diagrams, and real-world examples.	Modeling and Phenomena: #1 (Collisions–toys and/or videos) - Modeling #2 (Crumple Zone) Hands-On Activities: - Lab: Conservation of Momentum Lab - Demonstration: Water Balloon Toss with Impulse (force vs. time graphs) Class Practice: - Practice Momentum Station Activity - Practice with various representations (Card Sort) - Practice solving impulse problems Careers in Physics. Lesson 2	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting 2-3 Lab Reports (choose from suggested tasks/activities) (formative) - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking 1-2 quizzes (formative) and the Unit Test (Summative) - Assessment of Engineering Design Projects by building the project, including supporting documentation (formative) examples: Crumple zones in Egg Project - Linkit! Form B (Benchmark)

	• Use simple diagrams and momentum bar charts to describe collisions. Interpret force-time and velocity-time graphs related to collisions. • Calculate momentum using the appropriate equation. • Calculate impulse using force and time or change in momentum. • Solve simple conservation of momentum problems involving one-dimensional collisions. • Collect and analyze data from laboratory investigations involving momentum and collisions. • Use evidence from investigations to explain how momentum is conserved during collisions. • Compare elastic and inelastic collisions using observations, diagrams, and data. • Apply the concepts of momentum and impulse to everyday situations involving transportation, sports, and safety equipment. • Communicate scientific explanations about collisions using evidence collected during laboratory investigations. • Work collaboratively to investigate collisions, analyze data, and communicate scientific conclusions. • Design, test, and improve a simple engineering solution that reduces the effects of collisions using evidence collected during investigations.		
Modifications			
Multi-Lingual Learners	Students with Special Needs/504s	At-Risk	Gifted and Talented

● Provide illustrated vocabulary cards and bilingual reference sheets for momentum, impulse, conservation of momentum, elastic collision, inelastic collision, and system to reinforce academic language during investigations and problem solving. ● Allow students to demonstrate understanding of collision scenarios and momentum conservation through annotated diagrams, momentum bar charts, or brief oral explanations before completing extended written responses. ● Give multilingual learners with lower reading proficiency the option of focusing on the diagrams and animations, but encourage them to closely read a paragraph or two of the longer texts, so they practice and better comprehend the details shared by you and their classmates. ● Using classroom routines (such as <i>Domino Discover</i>) provides support for multilingual learners to provide different types of input, all from peers in the classroom, to students' language development. ● Allow student access to translation services such as Google Translate or PaperPal ● 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. ● Provide extended time for written responses and reports.	● Provide partially completed momentum bar charts, collision diagrams, and problem-solving templates so students can focus on interpreting momentum changes and conservation principles without becoming overwhelmed by multiple representations. ● Use color-coded diagrams and vectors to distinguish initial momentum, final momentum, impulse, and external forces when analyzing collisions and conservation of momentum. ● Use scaffolds, such as prompting ● 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 ● Print out larger versions of text and maps to ensure visibility is not a barrier. ● For students who do better with kinesthetic learning, it might be more effective to do demonstrations with the students instead of showing videos. ● Word bank	● Scaffold multistep momentum and impulse calculations by providing guided problem-solving organizers that prompt students to identify the system, determine known variables, apply the appropriate conservation principle, and evaluate whether their solution is physically reasonable. ● Provide structured collision analysis activities that progress from interpreting diagrams and momentum bar charts to solving conservation of momentum and impulse problems using mathematical representations. ● If students are struggling with starting models, use guiding questions. ● 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 ● Allow students many opportunities for practice and learning ● Use scaffolding for complex tasks See MLL, point 1.	● Challenge students to analyze authentic crash-test data or collision simulations to evaluate how impulse, momentum conservation, and vehicle safety systems influence passenger protection in modern automobiles. ● Provide opportunities to design, build, and optimize a collision-mitigation device (e.g., crumple zone, egg-drop system, or protective barrier) by comparing multiple design iterations using quantitative momentum and impulse data to justify engineering decisions. ● Encourage students to work on advanced requirements or higher achievement levels, when applicable. ● Offer choices of assignments to further content knowledge, once finished with a basic task, with personal interest being the key.
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Physics

Unit 4: Energy, Work, and Power

Related Phenomena: Rope Swing

Witnessing the sheer scale and thrill of the "World's Largest Rope Swing" immediately captures students' attention, providing a dynamic and high-energy context to explore fundamental concepts of energy. This phenomenon vividly demonstrates the continuous transformation between gravitational potential energy and kinetic energy, the work done against resistive forces like air drag, and the critical design considerations for safety and thrill. It allows students to analyze how engineers apply principles of energy conservation and work to create an exhilarating experience while ensuring the system can safely handle massive energy transfers.

- Driving Question: How can understanding energy transformations and work allow us to design exhilarating and safe experiences, like the world's largest rope swing or a thrilling roller coaster, and how do we harness or dissipate that energy effectively?
- Video: <https://www.youtube.com/watch?v=4B36Lr0Unp4>

OR

Related Phenomena: Newton's Cradle

The Mythbusters Giant Newton's Cradle provides a captivating and large-scale demonstration of energy transfer and the principles of conservation of energy and momentum. Watching massive wrecking balls transfer energy through a series of collisions vividly illustrates how kinetic energy and potential energy are exchanged between objects in a system. Students can observe the initial work done to lift the first wrecking ball, the subsequent conversion of its gravitational potential energy into kinetic energy, and how this energy is then transferred through the chain of balls. The eventual slowing down of the system highlights the role of non-conservative forces like air resistance and sound production, prompting discussions about energy dissipation and efficiency.

- Driving Question: How is energy transferred and conserved (or lost) in massive collisions, and what does this tell us about designing systems that manage large amounts of energy for both thrill and safety, or for efficient work?
- Video: <https://www.youtube.com/watch?v=d4QUgebCBUg> (long version)
- Video: <https://www.youtube.com/watch?v=OuA-znVMY3I> (short version)

Pacing: 5-6 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 tradeoffs 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. (HS-PS3-2), (HS-PS3-5)

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. (HS-PS3-4)

Using Mathematics and Computational Thinking

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)

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. (HS-PS3-3)

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.

Cause and Effect

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4)
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)

Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3)
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)

**Connections to Engineering, Technology, and Applications of Science
Influence of Science, Engineering, and Technology on Society and the Natural World**

- Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3)

Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems

	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. (<i>secondary</i>) 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.	Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)
Interdisciplinary Connections	RI.MF.11–12.6: Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept). W.IW.11–12.2: Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. SL.PE.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. 1.5.12prof.Cr1a: Use multiple approaches to begin creative endeavors. 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. N.Q.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.	
Career Readiness, Life Literacies, and Key Skills	9.1.12.PB.2: Prioritize financial decisions by considering alternatives and possible consequences. 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills. 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).	

Computer Science and Design Thinking	8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.		
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- Why is the first hill of a roller coaster always the biggest one? - What happens to energy when it is transferred from one form or storage mechanism to another? - How does the total energy inside a system remain constant unless work is done on it? - What is work, and how does it impact the energy of a system? - How can we design systems (bungee jump, wind turbine) to maximize safety, efficiency, and energy conservation? - How does power relate to the rate of energy transfer in real-world systems?	Student will be able to: - Define energy as the ability to cause change or do work. Identify different forms of energy, including kinetic, potential, and thermal energy. - Describe how energy can change from one form to another. - Explain the Law of Conservation of Energy using real-world examples. Identify situations in which energy is transferred between objects or systems. - Describe the relationship between work, force, and distance. - Calculate work using the appropriate equation. - Calculate kinetic and gravitational potential energy using the appropriate equations. - Describe how energy changes during the motion of objects such as roller coasters, rope swings, and falling objects. - Interpret energy bar charts, diagrams, and models to explain energy transformations. - Explain how friction and air resistance affect the transfer of energy. - Define power as the rate at which work is done or energy is transferred. - Calculate power using the appropriate equation. - Compare the efficiency of different machines or energy	Modeling and Phenomena: #1 (bungee jump) #2 (Spring/egg system) #3 (wind turbine) #4 (Popper Toy) Hands-On Activities: - Activity: Energy Skate Park Interactive - Activity: Energy formulas (KE and GPE) and activities. - Lab: LCE ($\sum E_i = \sum E_f$) - Lab: Work-ΔEnergy (U3-B2) - Lab: Work and Power Class Practice: - Practice KE and GPE Problems - Practice energy transfer in Roller Coasters Practice writing arguments and answering questions using reasoning about energy storage and transfers Careers in Physics, Lesson 3	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting 2-3 Lab Reports (choose from suggested tasks/activities) - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking 1-2 quizzes and the Unit Test. - Assessment of Engineering Design Projects by building the project, including supporting documentation, examples: - Wind-Powered Winch - Roller Coaster - Bungee drop - Rocket launch - Video project on example of conservation of energy Roller Coaster

	systems using observations and simple calculations. • Collect and analyze data from laboratory investigations involving work, energy, and power. • Use evidence from investigations to explain how energy is transferred and conserved in a system. • Apply concepts of work, energy, and power to everyday situations involving transportation, sports, amusement rides, and household devices. • Communicate scientific explanations about energy using evidence collected during laboratory investigations. • Work collaboratively to investigate energy transformations, analyze data, and communicate scientific conclusions. • Design, test, and improve a simple device that transfers or converts energy while considering efficiency, safety, and environmental impact.		
Modifications			
Multi-Lingual Learners	Students with Special Needs/504s	At-Risk	Gifted and Talented
• Provide illustrated vocabulary cards and bilingual reference sheets for key energy concepts (e.g., work, power, kinetic energy, potential energy, efficiency, conservation of energy) to reinforce academic language during investigations and engineering activities. • Allow students to demonstrate understanding of energy transformations and engineering designs through annotated diagrams, energy bar charts, or	• Provide partially completed energy bar charts, system diagrams, and problem-solving templates to help students organize energy conservation calculations and identify energy transfers within a system. • Use color-coded diagrams to distinguish kinetic energy, potential energy, work, power, and energy losses when analyzing energy transformations in laboratory	• Scaffold multistep energy conservation and work calculations by providing guided problem-solving organizers that prompt students to identify the system, determine energy changes, select appropriate equations, and evaluate whether their answers are physically reasonable. • Provide structured comparison activities that help students identify and explain energy transformations in real-world systems (e.g., roller	• Challenge students to compare the efficiency, environmental impact, and engineering tradeoffs of multiple renewable energy technologies (e.g., solar, wind, hydroelectric, and geothermal) using authentic energy production data to justify the most effective solution for a specific scenario. • Provide opportunities to design, build, and optimize an energy conversion device or engineering system by analyzing experimental efficiency, identifying sources of

brief oral explanations before completing extended written responses. • Give multilingual learners with lower reading proficiency the option of focusing on the diagrams and animations but encourage them to closely read a paragraph or two of the longer texts, so they practice and better comprehend the details shared by you and their classmates. • Using classroom routines (such as <i>Domino Discover</i>) provides support for multilingual learners to provide different types of input, all from peers in the classroom, to students' language development. • Allow student access to translation services such as Google Translate or PaperPal • 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. • Provide extended time for written responses and reports.	investigations and engineering designs. • Use scaffolds, such as prompting • 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 • Print out larger versions of text and maps to ensure visibility is not a barrier. • For students who do better with kinesthetic learning, it might be more effective to do demonstrations with the students instead of showing videos. • Word bank	coasters, rope swings, wind turbines, or renewable energy technologies) before solving quantitative problems. If students are struggling with starting models, use guiding questions. • 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 • Allow students many opportunities for practice and learning • Use scaffolding for complex tasks See MLL, point 1.	energy loss, and proposing data-driven improvements supported by quantitative evidence. • Encourage students to work on advanced requirements or higher achievement levels, when applicable. • Offer choices of assignments to further content knowledge, once finished with a basic task, with personal interest being the key.
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Physics

Unit 5: Mechanical Waves & Electromagnetic Radiation

Related Phenomena: Microwave Oven

This phenomenon allows students to connect their prior knowledge of cooking food in a microwave to the following concepts taught in this unit: superposition, standing waves, speed of light, heat transfer, wavelength, and radiation energy. Students can observe or research how microwaves are constructed and then explain how the microwave oven's properties directly lead to the creation of standing waves and the energy conversions necessary to cook your food.

- Driving Question: How does a microwave oven convert electrical energy into heat to cook food?
- Use a microwave in class to demo cooking food with and without the turntable (see lab demo below and at the following link)
- [Determining the Speed of Light with Chocolate](#) – YouTube Link “Physics High”

Pacing: 4 weeks

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-PS4-3: Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS-PS4-4: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set or the suitability of a design. Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. Engaging in Argument from Evidence • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	PS4.A: Wave Properties • The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. • 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. • Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two	Cause and Effect • Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Systems can be designed to cause a desired effect. Systems and System Models • Models (e.g., physical, mathematical, and computer models) can be used to simulate systems and interactions – including energy, matter, and information

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).
- Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible.

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Using Mathematics and Computational Thinking

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

----- Connections to Nature of Science -----**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment. The science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate,

different sounds can pass a location in different directions without getting mixed up.)

PS4.B: Electromagnetic Radiation

- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.
- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.
- Photoelectric materials emit electrons when they absorb light of a high-enough frequency.

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.

flows – within and between systems at different scales

Stability and Change

- Systems can be designed for greater or lesser stability

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Connections to Engineering, Technology, and Applications of Science****Influence of Engineering, Technology, and Science 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.

Interdependence of Science, Engineering, and Technology

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

the theory is generally modified in light of this new evidence. - Theories and laws provide explanations in science. - Laws are statements or descriptions of the relationships among observable phenomena.		
Interdisciplinary Connections	RI.CR.11–12.1: Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. W.AW.11–12.1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. W.WR.11–12.5: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. W.SE.11–12.6: 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 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 (MLA or APA Style Manuals). SL.II.11–12.2: Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. SL.PI.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. A.REI.A.1: Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. A.REI.B.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. F.IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. S.ID.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. S.ID.8: Compute (using technology) and interpret the correlation coefficient of a linear fit	
Career Readiness, Life Literacies, and Key Skills	9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision-making. 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth. 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.	
Computer Science and Design Thinking	8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints.	

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- How do waves transfer energy and information? - How do waves interact with matter? - How do waves interfere with each other, and what are the implications of interference? - How are waves used in technologies like communication and medical imaging? - How does motion affect the way wave frequencies are perceived? - How does light behave as both a wave and a particle? - What are the relationships between wavelength, frequency, and energy of electromagnetic waves? - How are electromagnetic waves produced and detected? - How does the speed of light relate to other properties of electromagnetic radiation? - What are the different types of electromagnetic radiation, and where do they fall on the spectrum? - What are the applications of different parts of the electromagnetic spectrum in science, technology, and everyday life	Students will be able to: - Define a mechanical wave and explain how waves transfer energy without transferring matter. - Distinguish between mechanical waves and electromagnetic waves. - Identify the parts of a wave, including wavelength, frequency, amplitude, and crest and trough. - Describe how wavelength, frequency, and wave speed are related. - Calculate wave speed using the appropriate equation. - Compare transverse and longitudinal waves using diagrams and real-world examples. - Describe how waves interact through reflection, refraction, diffraction, and interference. - Interpret wave diagrams, graphs, and models to explain wave behavior. - Describe how sound travels through different materials. - Explain how pitch and volume are related to the properties of sound waves. - Identify the regions of the electromagnetic spectrum and describe common uses for each. - Explain how electromagnetic waves are used in communication, medicine, astronomy, and everyday technology. - Collect and analyze data from laboratory investigations	Modeling/Phenomena - Transverse & Longitudinal waves demonstration using slinky - Wave frequency vs wavelength with slinky - Drill Demo for standing waves - Decibels headphones demo Hands On Activities Wave Intro Lab: Determine the speed of a wave using slinkies and springs. - Lab: Waves on a String PhET Lab – Superposition & Boundary reflection - Standing Wave Lab Part 1 and Part 2 Sound Wave Lab - Lab: Simulated Doppler Effect Gizmo Activity – explorelearning.com – paired with Redshift/Blueshift of Light Questions with CER Class Practice Wave Superposition problem set Parts of Wave covers frequencies, wavelengths, Velocity of a Wave - calculate the velocity of a sound wave in different mediums and velocity of standing wave Microwave Activity – covers parts of microwave, transfer of heat, standing wave patterns, how they cook food (interaction with water molecules) - Doppler Effect Canvas Quiz Standing Wave WKST - Climate Change Incorporation (heat transfer within the atmosphere due to radiation and convection currents) – Link to Lesson	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting 2-3 Lab Reports (choose from suggested tasks/activities) (formative) - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking 1-2 quizzes (formative) and the Unit Test (summative). - Assessment of Engineering Design Projects by building the RF transmitter project, including supporting documentation. (formative) Xylophone Project (Formative)

	involving waves and wave behavior. • Use evidence from investigations and models to explain how waves transfer energy. • Apply wave concepts to real-world situations involving sound, light, communication systems, and medical technologies. • Communicate scientific explanations about wave behavior using evidence collected during laboratory investigations. • Work collaboratively to investigate wave phenomena, analyze data, and communicate scientific conclusions. • Design, test, and evaluate a simple device or model that demonstrates wave behavior or the transfer of energy through waves.	• Project: Design and build a simple RF transmitter and receiver to light an LED • Careers in Physics – Lesson 5: Underrepresentation in Physics (Choose any 15 of the 30 slides)	
Modifications			
Multi-Lingual Learners	Students with Special Needs/504s	At-Risk	Gifted and Talented
• Provide illustrated vocabulary cards and bilingual reference sheets for key wave concepts (e.g., wavelength, frequency, amplitude, interference, reflection, refraction, diffraction, electromagnetic spectrum) to reinforce academic language during investigations and problem solving. • Allow students to demonstrate understanding of wave behavior and electromagnetic radiation through annotated diagrams, wave models, or brief oral explanations before completing extended written responses. • Give multilingual learners with lower reading proficiency the option of focusing on the	• Provide partially completed wave diagrams, ray diagrams, and graphic organizers to help students organize relationships among wavelength, frequency, energy, and wave speed before completing calculations. • Use color-coded diagrams and visual models to distinguish mechanical waves, electromagnetic waves, transverse waves, longitudinal waves, and the different regions of the electromagnetic spectrum. • Use scaffolds, such as prompting, activating prior knowledge, reducing	• Scaffold multistep wave calculations by providing guided problem-solving organizers that prompt students to identify known variables, select the appropriate wave equation, interpret graphical representations, and evaluate whether their answers are physically reasonable. • Provide structured comparison activities that help students identify similarities and differences among wave behaviors (reflection, refraction, diffraction, and interference) before applying these concepts to quantitative and real-world problems. If students are struggling with starting models, use guiding questions.	• Challenge students to investigate how electromagnetic radiation is used in modern technologies such as medical imaging, fiber-optic communications, remote sensing, or wireless communication and evaluate the advantages and limitations of each application. • Provide opportunities to analyze authentic NASA, NOAA, or satellite remote sensing data to investigate how different regions of the electromagnetic spectrum are used to study weather, climate change, Earth systems, or astronomical objects. • Encourage students to work on advanced requirements or

diagrams and animations, but encourage them to closely read a paragraph or two of the longer texts, so they practice and better comprehend the details shared by you and their classmates. • Using classroom routines (such as Domino Discover) provides support for multilingual learners to provide different types of input, all from peers in the classroom, to students' language development. • Allow student access to translation services such as Google Translate or PaperPal • 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. • Provide extended time for written responses and reports.	multiple-choice options, and think-alouds • Provide extended time for written responses, reports, and assessments • Use a graphic organizer to categorize concepts especially for written CERs • 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 • Preferential seating based on individual needs • Use a visual alarm to help with time management • Work with a partner or small group • Station rotations with various tasks and activities • Print out larger versions of text and maps to ensure visibility is not a barrier. • Include visual aids and images when necessary • Show demonstrations and videos for kinesthetic and auditory learners • Provide word bank	• 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 • Allow students many opportunities for practice and learning • Use scaffolding for complex tasks See MLL, point 1.	higher achievement levels, when applicable. • Offer choices of assignments to further content knowledge, once finished with a basic task, with personal interest being the key.
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Physics**Unit 6: Geophysics****Related Phenomena: Land Fissure**

The sudden appearance of a giant crack in Earth's crust in the Afar region in 2005, alongside the frequent occurrence of earthquakes, provides a concrete entry point for students to investigate how the movement of energy and matter deep within the Earth drives dramatic changes on its surface. By exploring maps of earthquake activity and considering the varying movements of continental plates, students can begin to piece together how Earth's interior processes, often too slow or large to observe directly, leave observable patterns and evidence on the surface. This phenomenon grounds the study of plate tectonics and Earth's systems in a real-world, ongoing geological event, prompting questions about the forces, energy transfers, and material cycling that shape our planet over vast spatial and temporal scales.

- Driving Question: What processes within Earth's dynamic systems cause dramatic changes to its surface, like the giant crack in the Afar region, and how can we use patterns of evidence to understand these large-scale, slow, or complex phenomena.
- From OpenSciEd, Physics Unit 2: [Lesson 1 teacher resources](#)

OR

Related Phenomena: Tsunami

In 2011, an earthquake and tsunami in Japan caused a nuclear disaster that we are still recovering from. In 1883, a volcanic eruption occurred at Krakatoa, Indonesia that was heard thousands of miles away, completely reshaping the island of Krakatoa, and a tsunami that followed led to disruption, destruction, and loss of life in the surrounding region. These are just two examples of many natural disasters caused by tectonic plate movement that have occurred during Earth's recent history. After learning about these events and others, how they occur, and the vulnerability of different populations, students develop and revise models related to the interior of the Earth, how energy travels in the Earth, and how different plate boundaries cause different patterns of tectonic events. These models support students in explaining risk levels around the world including where they live.

- Driving Question: Why do earthquakes, volcanic eruptions, and tsunamis occur in some places on Earth, how are they related, and what does this all mean for risk in different parts of the world?
- From New Visions Curriculum, ESS Unit 2: [teacher resources](#)

Pacing: 2-3 weeks**New Jersey Student Learning Standards (NJSLS)**

HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Developing and Using Models: • Develop a model based on evidence to illustrate the relationships between	ESS1.B: Earth and the Solar System: • Cyclical changes in the shape of Earth's orbit around the sun, together with	Cause and Effect: • Empirical evidence is required to differentiate between cause and

systems or between components of a system. (HS-ESS2-1), (HS-ESS2-3), (HS-ESS2-6) - Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) 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. (HS-ESS2-5) Analyzing and Interpreting Data: - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2) Engaging in Argument from Evidence: - Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)	changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4) ESS2.A: Earth Materials and Systems: - Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1), (HS-ESS2-2) - Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3) - The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4) ESS2.B: Plate Tectonics and Large-Scale System Interactions: - The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle,	correlation and make claims about specific causes and effects. (HS-ESS2-4) Energy and Matter: - The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) - Energy drives the cycling of matter within and between systems. (HS-ESS2-3) Structure and Function: - The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5) Stability and Change: - Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7) - Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1) - Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2) Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology: - Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS2-3) Influence of Engineering, Technology, and Science on Society and the Natural World:
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	providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3) • Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (ESS2.B Grade 8 GBE) (HS-ESS2-1) ESS2.C: The Roles of Water in Earth's Surface Processes: • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5) ESS2.D: Weather and Climate: • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space. (HS-ESS2-2), (HS-ESS2-4) • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6), (HS-ESS2-7) • Changes in the atmosphere due to human activity have increased carbon	• New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS2-2)
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	dioxide concentrations and thus affect climate. (HS-ESS2-6), (HS-ESS2-4) ESS2.E: Biogeology: - The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7) PS4.A: Wave Properties: - Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)	
Interdisciplinary Connections	RI.CR.11–12.1: Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. W.AW.11–12.1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. W.IW.11–12.2: Write informative/explanatory texts (including the narration of historical events, scientific procedures/experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. W.WR.11–12.5: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. SL.PE.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.PI.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. N.Q.2: Define appropriate quantities for the purpose of descriptive modeling. F.IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval; estimate the rate of change from a graph. F.IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. F.IF.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. S.ID.6a: Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data, emphasizing linear and exponential models.	
Career Readiness, Life Literacies, and Key Skills	9.1.12.PB.2: Prioritize financial decisions by considering alternatives and possible consequences. 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills. 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).	

Computer Science and Design Thinking	8.1.12.DA.5. Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. 8.2.12.ED.1. Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.		
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- Why is there such a distinct pattern in the locations of earthquakes, volcanic eruptions, and tsunamis, and what does this tell us about Earth's interior processes? - What processes inside Earth cause dramatic surface changes like the crack in the Afar region, and how can we detect and measure these changes? - How do energy and matter move within Earth's systems, and how do these movements drive the formation of mountains, trenches, volcanoes, and other surface features? - Why does Iceland experience so much volcanic activity, and what does this reveal about the interactions between Earth's surface and interior? - How can patterns in seismic wave behavior and earthquake data help us understand the structure and composition of Earth's interior?	Student will be able to: - Describe how Earth's surface changes over time as a result of natural processes. - Identify evidence that supports the theory of plate tectonics. - Describe the different types of plate boundaries and the landforms and natural events associated with each. - Explain how earthquakes, volcanoes, and tsunamis are related to plate movement. - Describe how energy from Earth's interior drives the movement of tectonic plates. - Explain how convection currents inside Earth contribute to plate motion. - Identify the major layers of Earth and describe their characteristics. - Interpret maps, diagrams, and models showing plate boundaries, earthquakes, volcanoes, and Earth's internal structure. - Describe how weathering, erosion, and deposition change Earth's surface over time. - Explain how water influences Earth's surface through weathering and erosion. - Describe how Earth's systems interact and how changes in one system can affect another. - Explain how human activities influence Earth's systems and contribute to climate change.	Phenomenon & Modeling - Phenomenon and Modeling #1: What caused the natural disasters in Iceland, Haiti, Jakarta and Japan? - Modeling #2: What is the structure of the Earth's interior? - Modeling #3: How do plate movements cause natural hazards and surface features? - Modeling #4: How does the energy inside the Earth drives the motion of tectonic plates on Earth's surface? Hands-On Activities: - Investigation: Seismic Waves - Investigation: Layering of Materials - Investigation: What causes the movement of Earth's magnetic poles? - Investigation: Modeling Earth's Interior Processes. - Investigation: Natural Disasters & Surface Features at Plate Boundaries - Investigation: Modeling Earth's Interior Processes. Class Practice: - Video guides and follow up questions from BB/MW Unit. - Class discussions and activities from New Visions ESS Unit 2 Careers in Physics, Lesson 4a Climate Change Lesson	- Assessment of lab skills (Experimental Design, Data Analysis, and Arguing a Scientific Claim) by submitting 2-3 Lab Reports (choose from suggested tasks/activities) (Formative) - Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking 1-2 quizzes (formative) and the Unit Test (Summative). - Research presentation on ESS Standards (Summative) - Assessment of Engineering Design Projects by building the project, including supporting documentation (Formative), examples: Project (BB-MW) Who's at Risk? Paper Towers EDP Earthquake-Resistant Structure EDP Build an Earthquake City EDP

	• Interpret graphs, maps, and scientific data related to earthquakes, climate, weather, and Earth's surface processes. • Collect and analyze data from laboratory investigations involving Earth's systems and geologic processes. • Use evidence from investigations, maps, and models to explain changes occurring within Earth's systems. • Apply Earth science concepts to real-world situations involving natural hazards, climate, and environmental change. • Communicate scientific explanations about Earth's dynamic systems using evidence collected during investigations. • Work collaboratively to investigate Earth processes, analyze scientific evidence, and communicate conclusions. • Design, test, and evaluate a simple engineering solution that helps reduce the impact of natural hazards or protects people and the environment from Earth system changes.		
Modifications			
Multi-Lingual Learners	Students with Special Needs/504s	At-Risk	Gifted and Talented
• Provide illustrated vocabulary cards and bilingual reference sheets for key geophysics and climate science terms (e.g., plate tectonics, convection, weathering, erosion, greenhouse gases, radiative transfer, seismic waves) to reinforce academic language during investigations and data analysis. • Allow students to demonstrate understanding of Earth systems and	• Provide partially completed graphic organizers, Earth system diagrams, and data analysis templates to help students organize information from multiple sources before drawing scientific conclusions. • Use color-coded maps, climate graphs, and plate boundary diagrams to help students distinguish between geological	• Scaffold analysis of climate and geophysical data by providing guided organizers that prompt students to identify observable patterns, interpret graphs and maps, connect evidence to scientific concepts, and support claims using evidence. • Provide structured comparison activities that help students connect plate tectonics,	• Challenge students to analyze authentic USGS, NOAA, NASA, or NJDEP datasets to investigate long-term trends in earthquake activity, sea-level rise, atmospheric carbon dioxide, or extreme weather events and communicate evidence-based conclusions. • Provide opportunities to design and evaluate an engineering solution that reduces the impacts of natural

climate processes through annotated diagrams, concept maps, or brief oral explanations before completing written products such as the news article or video/podcast. • Give multilingual learners with lower reading proficiency the option of focusing on the diagrams and animations, but encourage them to closely read a paragraph or two of the longer texts, so they practice and better comprehend the details shared by you and their classmates. • Using classroom routines (such as <i>Domino Discover</i>) provides support for multilingual learners to provide different types of input, all from peers in the classroom, to students' language development. • Allow student access to translation services such as Google Translate or PaperPal • 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. • Provide extended time for written responses and reports.	processes, atmospheric processes, and human impacts when interpreting complex Earth system interactions. • Use scaffolds, such as prompting • 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 • Print out larger versions of text and maps to ensure visibility is not a barrier. • For students who do better with kinesthetic learning, it might be more effective to do demonstrations with the students instead of showing videos. • Word bank	earthquakes, tsunamis, weathering, erosion, and climate change before synthesizing information in research projects or written explanations. • If students are struggling with starting models, use guiding questions. • 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 • Allow students many opportunities for practice and learning • Use scaffolding for complex tasks See MLL, point 1.	hazards or climate change (e.g., tsunami barriers, earthquake-resistant structures, coastal resilience systems, or flood mitigation strategies) while considering cost, sustainability, and environmental tradeoffs. • Encourage students to work on advanced requirements or higher achievement levels, when applicable. • Offer choices of assignments to further content knowledge, once finished with a basic task, with personal interest being the key.
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Physics

Unit 7: Electricity & Magnetism

Related Phenomena: Recycling Center Sorting Machine

This phenomenon connects the concepts of magnetic fields and forces with electric currents and provides students with a visual that reinforces that connection. Students can observe and analyze the properties of the sorting machine and identify what creates the magnetic field. Students will then be able to directly connect the properties of the sorting machine with the properties of their own electromagnets.

- Driving Question: How does a single electric current create a magnet strong enough to pick up, and hold, objects that weigh hundreds of pounds?
- [Scrap Yard Electromagnet in Action](#) – YouTube Link “Michael’s Scrap Yard”

Pacing: 5 weeks

New Jersey Student Learning Standards (NJSLs)

HS-PS2-4: Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.

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

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

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. • Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. Planning and Carrying Out Investigations • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how	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. 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.	Cause and Effect • Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. • 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.

much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. Using Mathematics and Computational Thinking - Use mathematical representations of phenomena to describe explanations. --- 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.			
Interdisciplinary Connections		A.REI.A.1: Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. A.REI.B.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. W.AW.11–12.1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. F.IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. S.ID.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. S.ID.8: Compute (using technology) and interpret the correlation coefficient of a linear fit.	
Career Readiness, Life Literacies, and Key Skills		9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision-making. 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth. 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.	
Computer Science and Design Thinking		8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.	
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
What creates a magnetic field?	Students will be able to:	Modeling/Phenomena	Assessment of lab skills (Experimental Design, Data

• How are magnetic fields used in technology we use everyday? • What is the relationship between electricity and magnetism? • Why do charged objects attract or repel each other? • 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 the requirements for a safe electrical circuit in your house? • What situations will cause a compass to fail to point to Earth's geographic north? • Why are common alternative energy sources considered viable options for powering residential homes?	• Describe the difference between electric forces and magnetic forces. • Identify positive and negative electric charges and explain how they interact. • Describe how electric charges produce electric fields. • Explain the relationship between voltage, current, and resistance in an electric circuit. • Calculate current, voltage, or resistance using Ohm's Law. • Identify the components of simple series and parallel circuits. • Construct and test simple electrical circuits using appropriate laboratory equipment. • Interpret circuit diagrams to explain how electricity flows through a circuit. • Describe the relationship between electricity and magnetism. • Explain how electric current creates a magnetic field. • Describe how electromagnets work and identify factors that affect their strength. • Explain how electromagnetic induction is used to generate electricity. • Identify everyday technologies that use electricity, magnetism, and electromagnetic induction. • Collect and analyze data from laboratory investigations involving electric circuits and magnetic fields. • Use evidence from investigations to explain the relationships among voltage, current, resistance, electricity, and magnetism.	• Determine the direction of a bar magnet's magnetic field. • Creating and interpreting magnetic field strength vs distance from a bar magnet graphs (graphical representations of magnetism) • Design and build simple series and parallel circuits in electron shuffle demo • Design and build a simple circuit that provides evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current Hands On Activities • Electricity Lab: Find the factors that create an electric circuit and relationship between current, voltage, and resistance • Series and Parallel Lab: Determine the factors that influence series vs parallel circuits • Lab: Ohm's Law graphical representation Class Practice • Coulomb's Law qualitative and quantitative problem set • Answering conceptual questions about magnetism (narrative representations of magnetism) • Solving quantitative problems involving electromagnets (mathematical representations of magnetism) • Ohm's Law problem set for series and parallel circuits • Load Limit Problems in commercial buildings • Project: Design and build a simple windmill and circuit that can	Analysis, and Arguing a Scientific Claim) by submitting 2-3 Lab Reports (choose from suggested tasks/activities) (Formative) • Assessment of test skills (Problem Solving, Creating and Interpreting Graphs, and Creating Scientific Explanations) by taking 1-2 quizzes (formative) and the Unit Test (Summative) • Assessment of Engineering Design Projects by building the project, including supporting documentation (formative), examples: ◦ Design Your Dorm Project • Linkit! Form C (Benchmark)
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	• Apply concepts of electricity and magnetism to real-world situations involving household electricity, transportation, communication, and medical technology. • Communicate scientific explanations about electricity and magnetism using evidence collected during laboratory investigations. • Work collaboratively to investigate electrical and magnetic phenomena, analyze data, and communicate scientific conclusions. • Design, test, and improve a simple electrical or electromagnetic device while considering efficiency, safety, and real-world applications.	demonstrate energy transfer and light an LED. Alternative project ideas: fan-powered maglev racer, recycling machine, build-a-toy... • Careers in Physics – Lesson 4b: Women in Physics	
Modifications			
Multi-Lingual Learners	Students with Special Needs/504s	At-Risk	Gifted and Talented
• Provide illustrated vocabulary cards and bilingual reference sheets for key electricity and magnetism terms (e.g., electric field, magnetic field, current, voltage, resistance, electromagnet, induction, Coulomb's Law) to reinforce academic language during investigations and engineering activities. • Allow students to demonstrate understanding of electric circuits, magnetic fields, and electromagnetic induction through annotated circuit diagrams, magnetic field sketches, or brief oral explanations before completing extended written responses. • Give multilingual learners with lower reading proficiency the option of focusing on the diagrams and animations, but	• Provide partially completed circuit diagrams, magnetic field models, and guided calculation templates to help students organize relationships among voltage, current, resistance, electric force, and magnetic fields before solving quantitative problems. • Use color-coded circuit diagrams and field line illustrations to distinguish electric current, magnetic field direction, conventional current flow, and force interactions during laboratory investigations. • Use scaffolds, such as prompting, activating prior knowledge, reducing multiple-choice options, and think-alouds	• Scaffold multistep circuit analysis and Coulomb's Law calculations by providing guided problem-solving organizers that prompt students to identify known variables, sketch circuits or field diagrams, select appropriate equations, and evaluate whether their solutions are physically reasonable. • Provide structured comparison activities that help students distinguish between electric fields and magnetic fields, permanent magnets and electromagnets, and static electricity versus electric current before applying these concepts to laboratory investigations and engineering challenges. • If students are struggling with starting models, use guiding questions.	• Challenge students to investigate how electromagnetism is applied in modern technologies such as MRI machines, electric vehicles, maglev trains, electric motors, generators, or power transmission systems and evaluate the underlying engineering tradeoffs. • Provide opportunities to design, build, and optimize an electromagnet or electromagnetic device by systematically investigating how variables such as current, coil turns, core material, and voltage affect performance, using quantitative data to justify design improvements. • Encourage students to work on advanced requirements or higher achievement levels, when applicable. • Offer choices of assignments to further content knowledge, once

encourage them to closely read a paragraph or two of the longer texts, so they practice and better comprehend the details shared by you and their classmates. • Using classroom routines (such as Domino Discover) provides support for multilingual learners to provide different types of input, all from peers in the classroom, to students' language development. • Allow student access to translation services such as Google Translate or PaperPal • 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. • Provide extended time for written responses and reports.	• Provide extended time for written responses, reports, and assessments • Use a graphic organizer to categorize concepts especially for written CERs • 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 • Preferential seating based on individual needs • Use a visual alarm to help with time management • Work with a partner or small group • Station rotations with various tasks and activities • Print out larger versions of text and maps to ensure visibility is not a barrier. • Include visual aids and images when necessary • Show demonstrations and videos for kinesthetic and auditory learners • Provide word bank	• 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 • Allow students many opportunities for practice and learning • Use scaffolding for complex tasks See MLL, point 1.	finished with a basic task, with personal interest being the key.
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Physics

Careers in Physics Lesson Details

Related Phenomena: Intro Activity

The card-sorting activity with famous scientists provides a concrete, high-stakes context in which students can examine their preconceptions about who becomes a scientist and what scientists actually do. It allows students to analyze patterns in recognition, demographics, and representation while questioning underlying biases about scientific identity. Using this phenomenon grounds the nature of science in real-world examples that connect directly to student identity formation and career decision-making, revealing how societal narratives shape perceptions of scientific careers.

- **Driving Question:** Who is a scientist (specifically, a physicist), and what do physicists actually do?
- **From STEP UP Physics:** [StepUp-LessonPlan-Careers2023.pdf](#)

Pacing: Integrated (one lesson per unit throughout the school year)

New Jersey Student Learning Standards (NJSLS)

Supporting Science Standards (Nature of Science and Science & Engineering Practices)

Science is a Human Endeavor

- Scientific knowledge is a result of human endeavor, imagination, and creativity.
- Individuals and teams from many nations and cultures have contributed to science and advances in engineering.
- Scientists' backgrounds, theoretical commitments, and fields of endeavor influence the nature of their findings.
- Science and engineering are influenced by society, and society is influenced by science and engineering.

Scientific Investigations Use a Variety of Methods

- Scientific inquiry is characterized by logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Science and engineering complement one another in the cycle known as research and development (R&D). Many research and development projects involve scientists, engineers, and other professionals with diverse areas of expertise.

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

- Science and engineering are influenced by societal needs, values, and priorities, and advances in science and engineering can have profound impacts on society and the natural world.
- Engineers continuously apply scientific knowledge and the engineering design process to develop technologies that improve quality of life while balancing societal, economic, and environmental considerations.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Engaging in Argument from Evidence • Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.	• Students will identify ways that a degree in physics can support a variety of careers, including careers that benefit humans, society, and the Earth. • Students will examine profiles of physicists and identify skills and traits	Patterns • Students will identify patterns in the demographics of recognized scientists, patterns in career pathways, and patterns in how different cultures and societies support or discourage participation in physics.

• Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions. • Construct, use, and/or present an oral and written argument or counter-argument based on data and evidence.	developed by earning a degree in physics. • Students will create a personal profile in which they identify how physics can help them meet their career goals or a persuasive display meant to encourage their peers to investigate a career in physics. • Students will compare the challenges faced by women in physics in the past (conscious bias) to the challenges faced today (more unconscious bias). • Students will give examples of gender inequalities with respect to science present in society today. • Students will define unconscious bias and give one example of the effect of unconscious bias. • Students will explain their own views on the current state of women in physics.	Cause and Effect-Mechanism and Explanation • Students will examine the causes behind underrepresentation in physics and the effects of bias on career choices. They will explore how societal factors cause certain groups to be excluded from or discouraged in physics careers. Stability and Change • Students will investigate how the field of physics has changed over time in terms of who participates, what problems are studied, and how scientific knowledge evolves through diverse perspectives and contributors. Understandings about the Nature of Science Science is a Human Endeavor • Scientific knowledge is a result of human endeavor, imagination, and creativity. • Individuals and teams from many nations and cultures have contributed to science and to advances in engineering. • Scientists' backgrounds, theoretical commitments, and fields of endeavor influence the nature of their findings. • Science and engineering are influenced by society and society is influenced by science and engineering. Scientific Investigations Use a Variety of Methods • Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.
Interdisciplinary Connections	• RI.MF.11–12.6: Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept).	

	● SL.PE.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. ● W.AW.11–12.1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. ● W.WR.11–12.5: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.		
Career Readiness, Life Literacies, and Key Skills	● 9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs. ● 9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment. ● 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills. ● 9.2.12.CAP.13: Analyze how the economic, social, and political conditions of a time period can affect the labor market. ● 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a). ● 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a). ● 9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).		
Computer Science and Design Thinking	● N/A		
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
● Who can be a physicist? ● What do physicists actually do in their daily work? ● How do societal perceptions influence who pursues physics? ● What discoveries and innovations have emerged from physicists with varied backgrounds and perspectives? ● What skills and ways of thinking do physicists develop? ● In what ways do physics careers benefit humanity and the natural world? ● Why are some groups underrepresented in physics, and how does this affect who we see as physicists? ● What careers are possible with a physics background?	Students will be able to: ● Describe what physicists do in their careers and research. ● Identify patterns in who is represented in physics and reflect on why these patterns exist. ● Evaluate the societal and personal impacts of pursuing physics careers. ● Analyze case studies of physicists with diverse backgrounds to understand the pathways into physics. ● Develop a personal reflection or plan on how physics connects to their interests, identities, and potential careers. ● Engage in discussions that critique the representation of	● Lesson 1: Introduction to "Careers in Physics" and "Who is a scientist?" [slideshow link] ● Lesson 2: Careers Profiles based on personal interests [slideshow link] ● Lesson 3: Career Prospects in Physics [slideshow link] ● Lesson 4a: Who have Physicists been, in the past? [slideshow link] ● Lesson 4b: Women in Physics [slideshow link] ● Lesson 5: Do presentation: Underrepresentation in Physics (continued) [Choose any 15 of the 30 slides on slideshow link] ● Lesson 6: Culminating MiniProject [slideshow link]	● Reflection/Questionnaires ● Writing a CER. ● Culminating MiniProject [slideshow link]

How can I see myself in physics, and what might pursuing physics look like for me?	- physicists in media and textbooks. - Explore the range of physics-related careers and align them with personal strengths and goals.		
Modifications			
Multi-Lingual Learners	Students with Special Needs/504s	At-Risk	Gifted and Talented
- Provide illustrated biographies and bilingual reference materials highlighting diverse physicists, engineers, and STEM professionals to reinforce academic language and career-specific vocabulary. - Pre-teach key vocabulary related to careers, scientific inquiry, engineering, bias, innovation, collaboration, and research using visuals, word walls, and sentence frames. - Allow students to demonstrate understanding through graphic organizers, concept maps, oral presentations, or multimedia products before completing extended written reflections. - Provide translated or simplified career profiles, articles, and research materials when appropriate to support comprehension of complex informational texts. - Pair multilingual learners with supportive peer partners during discussions, debates, and collaborative research activities to encourage language development through authentic scientific conversations. - Provide sentence starters and discussion stems to support participation in classroom conversations regarding scientific careers, diversity in	- Provide guided note-taking templates and graphic organizers to help students organize information from scientist biographies, career profiles, videos, and class discussions. - Break research projects and presentations into smaller tasks with clearly defined checkpoints and individual deadlines. - Provide models and exemplars of completed reflections, presentations, career profiles, and persuasive arguments before students begin independent work. - Allow students to demonstrate understanding through multiple formats such as oral presentations, interviews, digital presentations, videos, podcasts, or visual displays. - Provide extended time for research, writing assignments, presentations, and classroom discussions as appropriate. - Use structured discussion protocols and guided questions to help students analyze issues related to diversity, bias, ethics, and scientific careers. - Provide teacher-selected research resources to reduce cognitive load while maintaining opportunities for independent inquiry.	- Provide structured research organizers that guide students through identifying reliable sources, summarizing information, citing evidence, and developing conclusions. - Use sentence starters and CER (Claim-Evidence-Reasoning) templates to support written and verbal arguments related to careers, ethics, and diversity in STEM. - Connect classroom discussions to students' personal interests by exploring careers related to sports, medicine, technology, environmental science, aerospace, gaming, or automotive engineering. - Invite guest speakers, virtual career panels, or recorded interviews with practicing scientists and engineers to increase engagement and career awareness. - Break complex readings into manageable sections with guiding questions that help students identify key ideas before whole-class discussion. - Provide frequent teacher check-ins and conferencing during research projects to monitor progress and provide timely feedback. - Incorporate collaborative learning opportunities that allow students to share	- Challenge students to investigate emerging fields in physics such as quantum computing, fusion energy, nanotechnology, artificial intelligence, medical physics, astrophysics, climate science, or renewable energy engineering. - Encourage students to conduct independent research on the contributions of historically underrepresented scientists and engineers and evaluate how diverse perspectives have advanced scientific knowledge. - Provide opportunities to analyze ethical issues surrounding emerging technologies such as artificial intelligence, nuclear energy, autonomous systems, space exploration, or biotechnology and defend positions using scientific evidence. - Invite students to interview practicing scientists, engineers, university researchers, or STEM professionals and present how their educational pathways relate to current scientific challenges. - Encourage students to investigate global scientific collaborations and compare how different countries support innovation, research, and engineering careers.

STEM, and ethical issues in science. • Allow students to use translation tools, bilingual dictionaries, and speech-to-text technology when completing research and written assignments. • Encourage students to make connections between STEM careers in the United States and careers, innovations, or scientists from their own cultural backgrounds.	• Use visual schedules, checklists, and rubrics to clarify expectations and support task completion during long-term projects.	responsibilities during research, presentations, and discussions. • Recognize student growth through goal-setting activities, reflection journals, and opportunities to revise work based on feedback.	• Allow students to develop independent passion projects that explore the intersection of physics with fields such as medicine, environmental science, architecture, robotics, music, sports science, or entrepreneurship. • Challenge students to evaluate current scientific issues by analyzing multiple perspectives, identifying potential bias, and defending evidence-based conclusions through presentations or debates. • Encourage students to mentor classmates during collaborative investigations, facilitate classroom discussions, or assist with career exploration activities while continuing to pursue advanced independent learning opportunities.
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Physics

Climate Change Lesson Details

Related Phenomena:

N/A - Parts of Unit 5 and Unit 6.

Pacing: Integrated (Lessons will be included in Units 5 and 6)

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-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity

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. Engaging in Argument from Evidence: - Construct an oral and written argument or counter-arguments based on data and evidence.	ESS2.D: Weather and Climate: - Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. ESS2.E: Biogeology: - The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.	Stability and Change: - Much of science deals with constructing explanations of how things change and how they remain stable. - Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. - Feedback (negative or positive) can stabilize or destabilize a system. Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology: - Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

		Influence of Engineering, Technology, and Science on Society and the Natural World: New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	
Interdisciplinary Connections	W.WP.11–12.4: Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach; sustaining effort to complete complex writing tasks; tracking and reflecting on personal writing progress (e.g., using portfolios, journals, conferencing); or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience.		
Career Readiness, Life Literacies, and Key Skills	9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.		
Computer Science and Design Thinking	8.1.12.DA.5. Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.		
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
Waves Lesson - Why does an increase in atmospheric greenhouse gases lead to increased global temperatures? - How are climate patterns connected to the atmospheric temperature of Earth? Geophysics Lesson - What is the connection between historical atmospheric greenhouse gas concentration, rising global temperatures and extreme weather events? - How does the rise in extreme weather events impact the surface features of our planet?	Student will be able to: - Identify the external forces that impact our planet's surface - Analyze primary sources, data tables, and graphs - Connect the provided source material to the concepts behind erosion, weathering, and planetary surface forces - Summarize those connections via a novel, journalistic approach to story-telling - Explain how solar radiation is absorbed and then re-emitted by Earth - Explain how greenhouse gases trap the outgoing radiation to warm the atmosphere. - Explain how the atmosphere is warmed through convection and how those convection currents help distribute the heat around the planet and cause climate/weather patterns.	Waves Lesson - Explain the concept of radiative transfer - absorption, reflection, and re-emittance of solar radiation - Identify the properties of greenhouse gases that allow them to trap heat in our atmosphere - Model our planet's atmosphere and how the transfer/trapping on energy in it leads to climate/weather patterns - Create a video/podcast that explains how the greenhouse gases, along with the electromagnetic radiation, impact the natural energy cycles on Earth and what could happen if the concentration of greenhouse gases continues to increase at its current rate. Geophysics Lesson	- Formative - questions asked when students were analyzing data - Summative Waves Lesson: video/podcast project (based on scientific connections made between climate change, heat and energy transfer and the future impact on our planet) Geophysics Lesson: News article project (based on scientific connections made between climate change, systems, and external forces concepts)

	Model the behavior of greenhouse gases in our atmosphere and how convection currents and other atmospheric heating lead to climate patterns	- Discuss how naturally occurring external forces shape our planet's surface - Identify naturally occurring materials/conditions that provide those external forces - Analyze the data provided in primary sources, data tables, and graphs - Create a news article connecting the climate change effects to the "destruction" of our planet's surface features	
Modifications			
Multi-Lingual Learners	Students with Special Needs/504s	At-Risk	Gifted and Talented
Links for translation websites are provided	- Provide resources that have the data tables and graphs organized so that they are chunked together. - Spaces are provided to make connections between only two sources of data at a time rather than all at once. - Provide resources that have the notes organized so that they can follow easier in class. - Annotated diagrams and readings will be provided to aid in research.	- Provide an outline for research and design tasks. - Provide extended time for written responses and reports. - Incorporate student choice - Assure students they can be successful - Allow students many opportunities for practice and learning	- In addition to writing the news article, research is done to identify a current landmark on Earth's surface that may have been created through naturally occurring forces. - Connect your understanding of greenhouse gases from chemistry with what is taught in this course to further enhance the video/podcast.

Professional Learning Course Resources

- [New York's Open Science Curriculum](#). NGSS-aligned, phenomenon based units for Physics
 - Physics Unit 1, Big Ideas 1–6.
- OpenSciEd Instructional Materials
 - Physics [Unit 3: Collisions and Momentum](#) (Lesson Set 1: #1–7)
- <https://www.positivephysics.org/>
- The Physics Classroom [tutorials](#), [concept builders](#), and [interactives](#)
- [Bozeman Science](#)
- [PhET](#)
- [Khan Academy](#)
- <https://thephysicsaviary.com/index.html>
- Careers in Physics Lesson Resources
 - Scientist cards to purchase: needed for Activity in Lesson 1 (alternatively, can create your own)
 - [Deck 1](#): Scientists
 - [Deck 2](#): Scientists
 - [Deck 3](#): Women in Science (postcard size, more artistic than representative)
 - STEP UP [Lesson Plans for Careers in Physics](#)
 - STEP UP [Lesson Plans for Women in Physics](#)
 - <https://careereexplorer.americangeosciences.org/>
 - American Physical Society Careers Site: [org/careers](#)
 - Compadre: [org/facts.cfm](#)
 - Society of Physics Students Careers Toolbox: [org/careerstoobox](#)
 - American Association of Physics Teachers HerStories: [org/resources/Herstories.cfm](#)
 - Institute of Physics Careers Site: [physics.org/careers.asp?contentid=381](#)
 - S. Department of Labor Explore Careers: [careeronestop.org/ExploreCareers/explore-careers.aspx](#)
 - National Career Development Association Resources: [org/aws/NCDA/pt/sp/resources](#)
 - lgbt+physicists: [org](#)
 - 500 Women Scientists - Women in STEM database: [org/request-a-scientist](#)
 - Adopt-a-Physicist: [org](#)
 - I am a Scientist Project: [iamascientist.info](#)
 - Positive Physics: [www.positivephysics.com](#)
 - <https://www.classtools.net/>
 - [polleverywhere.com](#)
 - <https://wordcloud.app/edit>
 - <https://www.classtools.net/FB/home-page>
- Climate Change Lessons Resources
 - [Summary of Climate Change in New Jersey for Teachers \(As of 9/23\)](#)
 - [NASA: Climate Change Resources](#)
 - [NJDEP Climate Change Education Resources](#)
 - [NASA: Radiative Transfer](#)

Careers in Physics

Standard(s) Alignment:

These lessons address **NGSS [Appendix F – Science and Engineering Practices](#)** in the NGSS

• Engaging in Argument from Evidence

- Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.
- Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
- Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.
- Construct, use, and/or present an oral and written argument or counter-argument based on data and evidence.

These lessons address **NGSS [Appendix H – Understandings about the Nature of Science](#)**

• Science is a Human Endeavor

- **Science is a Human Endeavor**
 - Scientific knowledge is a result of human endeavor, imagination, and creativity.
 - Individuals and teams from many nations and cultures have contributed to science and to advances in engineering.
 - Scientists' backgrounds, theoretical commitments, and fields of endeavor influence the nature of their findings.
 - Science and engineering are influenced by society and society is influenced by science and engineering.
- **Scientific Investigations Use a Variety of Methods**
 - Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.

Performance Objectives

- *Critical learning objective:* Students will identify ways that a degree in physics can support a variety of careers, including careers that benefit humans, society, and the Earth.
- Students will examine profiles of physicists and identify skills and traits developed by earning a degree in physics.
- Students will create a personal profile in which they identify how physics can help them meet their career goals or a persuasive display meant to encourage their peers to investigate a career in physics.
- Students will compare the challenges faced by women in physics in the past (conscious bias) to the challenges faced today (more unconscious bias).
- Students will give examples of gender inequalities with respect to science present in society today.
- Students will define unconscious bias and give one example of the effect of unconscious bias.
- Students will explain their own views on the current state of women in physics.

Choose one per unit, from the following 18 available short periods or use a lab period.

Delayed openings: 9/15, 11/10, 12/8, 2/9, 3/2, 4/13, 5/4

Early dismissals: 10/13, 11/26, 12/23,

Testing days: 3/10-3/13, 5/18-5/21

Physics Plan:

Unit 1: Aug 28-Oct 10 (D.O. 9/15)

Unit 2: Oct 13-Nov14 (D.O. 11/10, E.D. 10/13)

Unit 3: Nov 17-Dec23 (D.O. 12/8, E.D. 11/26, 12/8, 12/23)

Unit 4: Jan 5-Jan30 (none, use a lab period instead)

Unit 5: Feb 2-Mar 6 (5) (D.O. 3/2)

Unit 6: (4-5) Mar 9-April17 (spring break is 3/30-4/6) (5) (D.O. 4/13, testing dates 3/10-3/13)

Unit 7: (7-8) April 20-June 5 (7, but also includes AP and state testing) (D.O. 5/4, testing dates 5/18-5/21)

Final exam week 6/8-6/12

7 mini-lessons each take approximately 30 minutes.

- Below is the suggested order, but could also do Lesson 4 right after Lesson 1 or Lesson 2.
- All slideshow links will force you to make a copy for yourself so you can edit as you like.
- All have PearDeck interactives to engage student responses, but you could also use whiteboards, post-its, or chart paper.
- There are some notes for teacher use.
- There are embedded links for surveys and questionnaires.

Lesson 1: Introduction to "Careers in Physics" and "Who is a scientist?" [[slideshow link](#)]

- The pre-survey is embedded, but you could assign it for homework the day before.
- There are 3 parts. Each should take about 10 minutes to complete. If you want to take longer, feel free to break them up over 3 days.

Lesson 2: Careers Profiles based on personal interests [[slideshow link](#)]

Lesson 3: Career Prospects in Physics [[slideshow link](#)]

Lesson 4a: Carousel: Who have Physicists been, in the past? do the reading/questions as assigned to groups [[slideshow link](#)] *Can assign this in class or for homework—great assignment for when you are absent.*

- Group A: Read [H. Ayrton, M. Curie, and Lise Meitner](#) and answer [questions 1–4](#).
- Group B: Read [J. Bell Burnell, C. Alexander, and D. Berebichez](#) and answer [questions 1–4](#).
- Group C: Read [S. Jackson, E. Ochoa, and M. Goepfert-Mayer](#) and answer [questions 1–4](#).
- Group D: [Gender Gap](#) and [Huh?](#) and answer [questions 1, 5–7](#).
- Group E: Read [Naming Theories](#) and answer [questions 1, 5,6,8](#).
- Group F: Read [So few women in science](#) and answer [questions 1,5,6,8](#).
- Submit your responses to the questions on gF "Reflections".

Lesson 4b: Women in Physics—Carousel groups to make sure you understand what you read and peer review responses to questions, then back to the whole group to share findings. Write CER. [[slideshow link](#)]

- There are 2 parts. Each should take about 15 minutes to complete. If you want to take longer, feel free to break them up over 2 days.

Lesson 5: Do presentation: Underrepresentation in Physics (continued) [\[slideshow link\]](#)

- Choose any 15 of the 30 slides, depending on your interest and comfort level.

Lesson 6: Culminating MiniProject [\[slideshow link\]](#)

Option A: Create a personal career profile for yourself.

1. Re-read the norms.
2. Identify a career that you have an interest in.
3. Challenge: incorporate a physics degree into the pathway to your chosen career.
 - What would your profile look like?
 - Creatively imagine your future with a physics degree: What schooling would you need? How much money would you make? What job(s) might you have? Where might you live and work?
4. Complete this [Personal Career Profile](#).
 - Page 1 is a planning page.
 - Page 2 shows the mandatory information.
 - You may make it on Slides, Canva, [Fakebook](#), or any other app you want to use to make it convincing and fun. It should be professional and presentable.
5. When done, add yours to [this slideshow presentation](#). If you are at a loss, there are 3 examples...one is mine.

Option B: Create a persuasive display.

1. Work individually or in pairs.
2. Convince the audience that studying physics (in high school or college or as a career) is a good idea.
3. Use paper, Canva, slides, or any other medium.
4. When done, add it to [this slideshow presentation](#).

Physics - Climate Change Lesson #1

Section	Description / Instructions	Sample
Lesson Title	Give your lesson a clear and descriptive title.	<i>Climate Change & External Forces Impacting Earth</i>
Course	Identify the course (e.g., Biology CP, World History, Environmental Science).	<i>Physics</i>
Unit	Specify the unit within the course where this lesson fits.	<i>Geophysical Science</i>
Grade Level(s)	List all applicable grade levels.	<i>Grade 11</i>

Lesson Duration	Indicate how many days or periods the lesson spans.	2-3 class periods (41 minutes each)
NJSLS Standards	List all relevant content standards (e.g., Science, Social Studies, ELA, etc.).	<i>HS-ESS2-1 Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.</i> <i>HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems</i> <i>HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.</i> <i>HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity</i> <i>W.WP.11–12.4. Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach; sustaining effort to complete complex writing tasks; tracking and reflecting on personal writing progress (e.g., using portfolios, journals, conferencing); or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience.</i>
Climate Change Education Connection	Briefly explain how this lesson addresses the NJ Climate Change Mandate.	<i>This lesson helps students track the connection between increased greenhouse gases, rising global temperatures, extreme weather, and external forces acting on and changing the surfaces of our planet.</i>

Lesson Overview	Summarize what students will do, learn, and create.	<i>Students will analyze primary sources and data presented in table and graphical form to identify the connection between historical atmospheric greenhouse gas concentration, rising global temperatures and extreme weather events. They will then explain how the rise in extreme weather events impacts the surface features of our planet. Students will work in partners to create a news article describing the “destruction” of a modern day naturally occurring feature on our planet, explaining how it was impacted by the extreme weather caused by climate change.</i>
Instructional Approach	Describe how the lesson is student-centered, project-based, or inquiry-driven.	<i>Student-centered and project based. Students engage in data analysis, group discussion, and creative processing to design the news article.</i>
Learning Objectives	State 2–4 clear, measurable objectives.	• <i>Identify the external forces that impact our planet's surface</i> • <i>Analyze primary sources, data tables, and graphs</i> • <i>Connect the provided source material to the concepts behind erosion, weathering, and planetary surface forces</i> • <i>Summarize those connections via a novel, journalistic approach to story-telling</i>
Lesson Activities	Outline the major activities and instructional sequence.	<i>1. Discuss how naturally occurring external forces shape our planet's surface (Day 1)</i> <i>2. Identify naturally occurring materials/conditions that provide those external forces (Day 1)</i> <i>3. Analyze the data provided in primary sources, data tables, and graphs (Day 1-2)</i> <i>4. Create a news article connecting the climate change effects to the “destruction” of our planet's surface features (Day 2–3)</i>
Assessment Methods	Describe formative or summative assessments used. <i>(Include links to rubrics or assessments)</i>	• <i>Formative: questions asked when students were analyzing data</i> • <i>Summative: News article project rubric (based on scientific connections made between climate change, systems, and external forces concepts)</i>

Differentiation & Modifications	Explain how the lesson will be adapted for: • Special Education • Multilingual Learners • Gifted & Talented	• <i>Special Ed: Provide resources that have the data tables and graphs organized so that they are chunked together. Spaces are provided to make connections between only two sources of data at a time rather than all at once.</i> • <i>MLs: Provide links for translation websites</i> • <i>G&T: In addition to writing the news article, research is done to identify a current landmark on Earth's surface that may have been created through naturally occurring forces.</i>
Resources & References	Include links or citations to articles, videos, primary sources, or websites.	• <i>Sep 2023: Summary of Climate Change in New Jersey for Teachers</i> • <i>NASA: Climate Change Resources</i> • <i>NJDEP Climate Change Education Resources</i>
Materials Needed	List any special materials or supplies required.	<i>Primary Sources, Graphs, Data Tables - Provided from websites and articles via Canvas Course Website</i>
Teacher Notes	Include any additional notes, tips, or reflections.	<i>None</i>

Physics - Climate Change Lesson #2

Section	Description / Instructions	Sample
Lesson Title	Give your lesson a clear and descriptive title.	<i>How Greenhouse Gases Heat the Atmosphere</i>
Course	Identify the course (e.g., Biology CP, World History, Environmental Science).	<i>Physics</i>
Unit	Specify the unit within the course where this lesson fits.	<i>Waves & Electromagnetic Radiation</i>
Grade Level(s)	List all applicable grade levels.	<i>Grade 11</i>

Lesson Duration	Indicate how many days or periods the lesson spans.	<i>2-3 class periods (41 minutes each)</i>
NJSLS Standards	List all relevant content standards (e.g., Science, Social Studies, ELA, etc.).	<i>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).</i> <i>HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.</i>
Climate Change Education Connection	Briefly explain how this lesson addresses the NJ Climate Change Mandate.	<i>This lesson helps students understand the science behind why increased atmospheric greenhouse gases lead to increased global temperatures. It will also cover radiative transfer, convection currents, and climate patterns.</i>
Lesson Overview	Summarize what students will do, learn, and create.	<i>Students will learn about how solar radiation is absorbed and then re-emitted by Earth and how greenhouse gases trap the outgoing radiation to warm the atmosphere. They will also learn how the atmosphere is warmed through convection and how those convection currents help distribute the heat around the planet and cause climate/weather patterns. Students will then create a model depicting how these concepts are all connected. Finally students will create a video/podcast describing how the increase in greenhouse gases has impacted the natural energy cycles of the planet and what would happen if the concentration continues to increase at the rate it is currently going.</i>

Instructional Approach	Describe how the lesson is student-centered, project-based, or inquiry-driven.	<i>Teacher-driven, Student-centered, and project based. Teachers will deliver key concepts at the start of the lesson. Students engage in modeling and designing the video/podcast.</i>
Learning Objectives	State 2–4 clear, measurable objectives.	• <i>Explain how the Earth absorbs, reflects, and re-emits electromagnetic radiation from the sun</i> • <i>Connect prior learning to explain how convection cycles and greenhouse gases heat up our atmosphere</i> • <i>Model the behavior of greenhouse gases in our atmosphere and how convection currents and other atmospheric heating lead to climate patterns</i>
Lesson Activities	Outline the major activities and instructional sequence.	1. <i>Explain the concept of radiative transfer - absorption, reflection, and re-emittance of solar radiation (Day 1)</i> 2. <i>Identify the properties of greenhouse gases that allow them to trap heat in our atmosphere (Day 1)</i> 3. <i>Model our planet's atmosphere and how the transfer/trapping on energy in it leads to climate/weather patterns (Day 2)</i> 4. <i>Create a video/podcast that explains how the greenhouse gases, along with the electromagnetic radiation, impact the natural energy cycles on Earth and what could happen if the concentration of greenhouse gases continues to increase at its current rate. (Day 2–3)</i>
Assessment Methods	Describe formative or summative assessments used. <i>(Include links to rubrics or assessments)</i>	• <i>Formative: questions asked when students were analyzing data</i> • <i>Formative: questions asked when students were analyzing data</i> • <i>Summative: News article project rubric (based on scientific connections made between climate change, systems, and external forces concepts)</i>

Differentiation & Modifications	Explain how the lesson will be adapted for: • Special Education • Multilingual Learners • Gifted & Talented	• <i>Special Ed: Provide resources that have the notes organized so that they can follow easier in class. Annotated diagrams and readings will be provided to aid in research.</i> • <i>MLs: Provide links for translation websites</i> • <i>G&T: Connect your understanding of greenhouse gases from chemistry with what is taught in this course to further enhance the video/podcast.</i>
Resources & References	Include links or citations to articles, videos, primary sources, or websites.	• <i>Sep 2023: Summary of Climate Change in New Jersey for Teachers</i> • <i>NASA: Radiative Transfer</i> • <i>NJDEP Climate Change Education Resources</i>
Materials Needed	List any special materials or supplies required.	• <i>Primary Sources, Graphs, Data Tables - Provided from websites and articles via Canvas Course Website</i> • <i>Large Whiteboard or Large Pad of Paper for modeling</i>
Teacher Notes	Include any additional notes, tips, or reflections.	<i>None</i>