Lakewood School DIstrict Curriculum Guide

Grade: High School	**Content Area: Science - Physics**

Original Adoption: 2023 NJSLS English Language Arts and English as a Second Language (8-21-24); Math NJSLS Mathematics (8-21-24); 2020 NJSLS Science, Social Studies, Career Readiness, Life Literacies & Key Skills, Computer Design & Thinking, Visual & Performing Arts, World Language, Comprehensive Health and Physical Education (5-11-22)
Created By:

Recommended Pacing Guide	
Unit 1: Mechanics	40 days
Unit 2: Dynamics	20 days
Unit 3: Energy	25 days
Unit 4: Circular and Rotational Dynamics	25 days
Unit 5: Waves	20 days
Unit 6: Optics	25 days
Unit 7: Electricity and Magnetism	40 days

Alignment with State Mandates

The following colors are used throughout this document to indicate areas in which the curriculum is aligned with the following NJSA requirements:

- Holocaust and genocides (N.J.S.A. 18A:35-28)
- History and contributions of African-Americans (Amistad Law) (N.J.S.A. 18A:35-4.43)
- Highlight and promote diversity and inclusion (Diversity & Inclusion Law) (N.J.S.A. 18A:35-4.36a)
- History of disabled and LGBT persons included in middle and high school curriculum (Section 18A:35-4.35)
- Climate Change - to prepare students to understand how and why climate change happens, the impact it has on our local and global communities and to act in informed and sustainable ways. Please click here for specific examples (by subject).

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Unit 1: Mechanics	40 days

New Jersey Learning Standards-Science	
HS-PS2-1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS2-2	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
HS-PS2-3	Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science and Engineering Practices	Discipline Core Ideas/Unit Enduring Understandings	Crosscutting Concepts
Analyzing and Interpreting Data • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS2-1) **Using Mathematics and Computational Thinking** • Use mathematical representations of phenomena to describe explanations. (HS-PS2-2) **Constructing Explanations and Designing Solutions** • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HSPS2-3) • Design a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria,	**PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) • Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2) • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2) **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS23)	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS21) • Systems can be designed to cause a desired effect. (HS-PS2-3) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) **Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-3)

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and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	**ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to (HS-PS2-3) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	**Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-1) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1)

Social and Emotional Learning Standards	
Self-Awareness	• Recognize one's personal traits, strengths, and limitations • Recognize the importance of self-confidence in handling daily tasks and challenges
Self-Management	• Recognize the skills needed to establish and achieve personal and educational goals • Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals
Social Awareness	• Demonstrate an understanding of the need for mutual respect when viewpoints differ
Responsible Decision-Making	• Develop, implement and model effective problem solving and critical thinking skills

Interdisciplinary Connections	
	ELA Standards
• **RL.CR.11–12.1**	Accurately cite strong and thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what a literary text says explicitly and inferentially, as well as interpretations of the text; this may include determining where the text leaves matters uncertain
• **L.SS.11–12.1**	Demonstrate command of the system and structure of the English language when writing or speaking.
• **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.

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• **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.
• **RI.CT.11–12.8**	Analyze and reflect on (e.g., practical knowledge, historical/cultural context, and background knowledge) documents of historical and scientific significance for their purposes, including primary source documents relevant to U.S. and/or global history and texts proposing scientific or technical advancements.
• **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.
	Math Standards
• **MP.2**	Reason abstractly and quantitatively.
• **HSA.SSE.A.1**	Interpret expressions that represent a quantity in terms of its context.

Computer Science & Design Thinking

8.1 Computer Science

- 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects

8.2 Design Thinking

- 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 (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
- 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.
- 8.2.12.NT.2: Redesign an existing product to improve form or function.

Career Readiness, Life Literacies & Key Skills

9.1 Personal Financial Literacy

- 9.1.12.EG.3: Explain how individuals and businesses influence government policies

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9.2 Career Readiness, Life Literacies, and Key Skills

- 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
- 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills.

9.3 Career & Technical Education (CTE)

- 9.3.12.AG-PST.1: Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.
- 9.3.12.AC.2: Use architecture and construction skills to create and manage a project.
- 9.3.12.AC-DES.1: Justify design solutions through the use of research documentation and analysis of data.
- 9.3.12.AC-DES.8: Apply standards, applications and restrictions pertaining to the selection and use of
- construction materials, components and assemblies in the project design.
- 9.3.ST-ET.1: Use STEM concepts and processes to solve problems involving design and/or production.
- 9.3.ST-ET.4: Apply the elements of the design process.
- 9.3.ST-SM.2: Apply science and mathematics concepts to the development of plans, processes and projects
- that address real world problems.

9.4 Life Literacies & Key Skills

- 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.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.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)

Evidence of Student Learning	
Formative Tasks: ● Oral Questioning ● Student Conference ● Self-Assessment ● Hand Signals ● Communicators ● Graphic Organizers ● Teacher Observation ● DOL ● Quiz Classwork ● NJSLA Released questions ● Problem of the Day	**Alternative Assessments:** ● Teacher-Created Projects ● https://www.khanacademy.org/ ● Completion of webquests ● On-Line Laboratory activities ● Online assessment activities example: ○ Kahoot ○ Quizizz
Summative Assessments: ● Unit Tests ● Midterm Exam ● Final Exam	**Benchmark Assessments:** ● Quarterly Benchmarks ● Beginning/End of Year Assessment ● Unit Common Assessment

Knowledge & Skills

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Enduring Understandings:

- Motion changes only when a net force acts on an object, and this change can be described mathematically.
- Newton's second law explains the relationship among force, mass, and acceleration in macroscopic systems.
- Momentum is a conserved quantity in closed systems and provides a powerful way to analyze interactions between objects.
  Collisions involve transfers of momentum, and the forces experienced depend on how quickly that transfer occurs.
- Engineering solutions can reduce the forces experienced during collisions by changing system design and interaction time.
  Complex physical problems can be solved by breaking systems into smaller, manageable components.
- Mathematical models and data analysis strengthen claims about motion, force, and system behavior.
- Evaluating engineering solutions requires balancing performance with constraints such as safety, cost, reliability, and societal impact.

Essential Questions:

- How do force, mass, and acceleration interact to determine an object's motion?
- Why does an object's motion change only when a net force is applied?
- How can momentum be used to explain interactions in a closed system?
- What factors influence the forces experienced during a collision?
- How can engineering design reduce the impact forces on objects during collisions?
- How can complex real-world motion problems be broken into simpler parts for analysis and design?
- How do mathematical representations support claims about motion and momentum?
- How do trade-offs among safety, cost, and performance influence engineering solutions in mechanical systems?

Content

Students will know…

- Motion is described relative to a frame of reference using displacement, time, velocity, and acceleration.
- Displacement and velocity are vector quantities, while distance and speed are scalars.
- The relationships among position, velocity, acceleration, and time can be represented graphically and mathematically.
- Position–time and velocity–time graphs reveal the type of motion through their slopes and shapes.
- Constant acceleration, including free fall, can be analyzed using kinematic equations.
- Objects in free fall experience the same constant acceleration due to gravity, regardless of mass.
- Vectors can be represented, added, and resolved into components using coordinate systems and trigonometric relationships.
- Projectile motion results in a parabolic path and can be analyzed by applying kinematics separately to

Skills

Students will be able to …

- Describe motion in terms of frame of reference, displacement, time, and velocity.
- Calculate the displacement of an object traveling at a known velocity for a specific time interval.
- Construct and interpret graphs of position versus time.
- Describe motion in terms of changing velocity.
- Compare graphical representations of accelerated and non-accelerated motions.
- Apply kinematic equations to calculate distance, time, or velocity under conditions of constant acceleration.
- Relate the motion of a freely falling body to motion with constant acceleration.
- Calculate displacement, velocity, and time at various points in the motion of a freely falling object.
- Compare the motions of different objects in free fall.
- Describe situations in terms of frame of reference.
- Distinguish between a scalar and a vector.

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horizontal and vertical components	• Add and subtract vectors by using the graphical method. • Multiply and divide vectors by scalars. • Identify appropriate coordinate systems for solving problems with vectors. • Apply the Pythagorean theorem and tangent function to calculate the magnitude and direction of a resultant vector. • Resolve vectors into components using the sine and cosine functions. • Add vectors that are not perpendicular. • Recognize examples of projectile motion. • Describe the path of a projectile as a parabola. • Resolve vectors into their components and apply the kinematic equations to solve problems involving projectile motion.

Core Instructional & Supplemental Materials

Suggested Activities/Resources:

- Holt Physics [2009] – Chapter 2 & 3
- Forces and Motion
- Force and Acceleration Lab
- Terminal Velocity
- Skills-Friction Handout

Supplemental resources:

- Lakewood Physics [notes online] https://desopophysics.webs.com/
- The Physics Classroom https://www.physicsclassroom.com/
- Study Physics http://www.studyphysics.ca/page03.html
- A+ physics Videos http://aplusphysics.com/courses/ap-1/AP1_Physics.html
- Khan Academy for Physics https://www.khanacademy.org/science/physics
- Race & Social Justice Teacher Resources

Suggested Accommodations

English Language Learners:

- Multi-Sensory Instruction
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives/Concrete Models
- Build Background/Vocabulary
- Math Word Wall/Word Bank

- Gradual Release Model
- Visual Cues
- Visual Models
- Technology Integration
- Hands-On/Experiential Activities
- Native language support when possible
- Sheltered English Instructional Strategies
- Provide additional time

Special Education/Students with Disabilities:

- Extra help opportunities provided
- Credit Recovery
- Allow use of a calculator, when appropriate
- Modified length and time frame of assignments
- Alternate assessments with extended time
- Provide guided notes and study guides as needed
- Preferential Seating
- Extra Practice
- Directions repeated, clarified, and reworded
- Breakdown task into manageable units
- Differentiated instruction
- Use of manipulatives
- Math tool paper available
- Cooperative learning groups
- Supplemental books
- Repeat, reword or clarify directions
- Small group instruction as needed
- Instructional technology as needed/required
- Effective teacher questioning; ranging from fact recall to higher order critical thinking questions

504 Plans:

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Gifted and Talented:

- Cooperative Learning Groups
- Enriched Assignments
- Tiered Assignments
- Word Problems
- NJSLA questions
- Model Curriculum Questions
- Inquiry Based Project
- Interest Based/Choice Activities

Students at Risk of Failure:

- Extended Time
- Multi-Sensory Instruction
- Flexible Grouping
- Small Group Instruction
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- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Tiered Activities
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- Modified Assignments
- Gradual Release Model
- Preferential Seating
- Brain Breaks
- Visual Cues
- Visual Models
- Technology Integration
- Assistive Technology
- Credit Recovery

Economically Disadvantaged:

- Pre-teach vocabulary using visuals and gestures
- Chunk texts
- Summarize as you go
- Preview lessons
- Graphic organizers
- Highlight key words
- Sentence starters
- Prompting and cueing
- Activate schema

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- Build background knowledge

Culturally Diverse:

- Create pictures, posters, art, books, maps, flags, etc to hang in the classroom.
- Create an emotionally positive classroom climate.
- Bring in guest speakers
- Create effective communication
- Model and teach cultural respect
- Build relationships with students by interviewing students to understand their background

Unit 2: Dynamics	20 days

New Jersey Learning Standards-Science

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.

Social and Emotional Learning Standards	
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	Math Standards
• **HSN.Q.A.3**	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
• **HSN.Q.A.2**	Define appropriate quantities for the purpose of descriptive modeling.

Science and Engineering Practices	Discipline Core Ideas/Unit Enduring Understandings	Crosscutting Concepts
Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (HS-PS2-4)	**PS2.B: Types of Interactions** • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4)	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4) **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-4) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)

Computer Science & Design Thinking

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8.1 Computer Science

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Summative Assessments: ● Unit Tests ● Midterm Exam ● Final Exam	**Benchmark Assessments:** ● Quarterly Benchmarks ● Beginning/End of Year Assessment ● Unit Common Assessment

Knowledge & Skills	
Enduring Understandings: ● Gravitational and electrostatic forces are fundamental interactions that act at a distance and govern how objects influence one another. ● Mathematical models such as Newton's Law of Gravitation and Coulomb's Law allow scientists to describe, compare, and predict force interactions. ● The strength of gravitational and electrostatic forces depends predictably on object properties and distance, following inverse-square relationships. ● Using mathematical representations helps explain real-world phenomena ranging from planetary motion to electric interactions at the atomic scale.	**Essential Questions:** ● How do objects exert forces on one another without direct contact? ● How can mathematical models be used to predict the strength of gravitational and electrostatic forces? ● Why does distance play such a significant role in determining force magnitude? ● How are gravitational and electrostatic forces similar and different in their behavior and effects? ● How do these force laws help explain observable phenomena in the natural world?
Content *Students will know…* ● A force is an interaction that can change an object's motion by affecting its speed or direction. ● Free-body diagrams represent all external forces	**Skills** *Students will be able to …* ● Describe how force affects the motion of an object. ● Interpret and construct free-body diagrams.

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acting on an object and are used to analyze motion. ● An object's motion is determined by the net external force, not by individual forces acting alone. ● Equilibrium occurs when the net external force on an object is zero, resulting in no acceleration. ● An object's acceleration depends on both the net force acting on it and its mass. ● Action–reaction force pairs act on different objects and are equal in magnitude and opposite in direction. ● Mass and weight are distinct quantities, with weight depending on the gravitational field strength. ● Frictional forces, including air resistance, oppose motion and can be calculated using coefficients of friction and normal force.	● Explain the relationship between the motion of an object and the net external force acting on the object. ● Determine the net external force on an object. ● Calculate the force required to bring an object into equilibrium. ● Describe an object's acceleration in terms of its mass and the net force acting on it. ● Predict the direction and magnitude of the acceleration caused by a known net force. ● Identify action-reaction pairs. ● Explain the difference between mass and weight. ● Find the direction and magnitude of normal forces. ● Describe air resistance as a form of friction. ● Use coefficients of friction to calculate frictional force.

Core Instructional & Supplemental Materials

Suggested Activities/Resources:	Supplemental resources:
● Holt Physics [2009] – Chapter 4 ● Gravity Force Lab ● Electrical Fields ● Electrostatistics	● Lakewood Physics [notes online] https://desopophysics.webs.com/ ● The Physics Classroom https://www.physicsclassroom.com/ ● Study Physics http://www.studyphysics.ca/page03.html ● A+ physics Videos http://aplusphysics.com/courses/ap-1/AP1_Physics.html ● Khan Academy for Physics https://www.khanacademy.org/science/physics ● Race & Social Justice Teacher Resources ● Matter & Mass

Suggested Accommodations

English Language Learners:

- Multi-Sensory Instruction
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning

- Manipulatives/Concrete Models
- Build Background/Vocabulary
- Math Word Wall/Word Bank
- Gradual Release Model
- Visual Cues
- Visual Models
- Technology Integration
- Hands-On/Experiential Activities
- Native language support when possible
- Sheltered English Instructional Strategies
- Provide additional time

Special Education/Students with Disabilities:

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- Cooperative learning groups

- Supplemental books
- Repeat, reword or clarify directions
- Small group instruction as needed
- Instructional technology as needed/required
- Effective teacher questioning; ranging from fact recall to higher order critical thinking questions

Gifted and Talented:

- Cooperative Learning Groups
- Enriched Assignments
- Tiered Assignments
- Word Problems
- NJSLA questions
- Model Curriculum Questions
- Inquiry Based Project
- Interest Based/Choice Activities

Students at Risk of Failure:

- Extended Time
- Multi-Sensory Instruction
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Tiered Activities
- Manipulatives/Concrete Models
- Build Background/Vocabulary
- Math Word Wall/Word Bank
- Modified Assignments
- Gradual Release Model
- Preferential Seating
- Brain Breaks
- Visual Cues
- Visual Models
- Technology Integration
- Assistive Technology
- Credit Recovery

Economically Disadvantaged:

- Pre-teach vocabulary using visuals and gestures
- Chunk texts
- Summarize as you go
- Preview lessons
- Graphic organizers
- Highlight key words
- Sentence starters

Grade: High School	Content Area: Science - Physics

- Prompting and cueing
- Activate schema
- Build background knowledge

Culturally Diverse:

- Create pictures, posters, art, books, maps, flags, etc to hang in the classroom.
- Create an emotionally positive classroom climate.
- Bring in guest speakers
- Create effective communication
- Model and teach cultural respect
- Build relationships with students by interviewing students to understand their background

Unit 3: Energy	25 days

New Jersey Learning Standards-Science

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-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practices	Discipline Core Ideas/Unit Enduring Understandings	Crosscutting Concepts
Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships between systems or between components	**PS3.A: Definitions of Energy** • Energy is a quantitative property of a system that depends on the motion and interactions of matter	**Systems and System Models** • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent

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of a system. (HS-PS3-2) **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1) • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3)	and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-2) • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) • These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) **PS3.B: Conservation of Energy and Energy Transfer** • Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1) • Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles,	in models. (HSPS3-1) • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-ETS1-4) **Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HSPS3-3) • 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) • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3) **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes the universe is a vast single system in which basic laws are consistent. (HSPS3-1)

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	compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) • The availability of energy limits what can occur in any system. (HS-PS3-1) **PS3.D: Energy in Chemical Processes** • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3) **ETS1.A: Defining and Delimiting an Engineering Problem** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS3-3) • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HSETS1-1) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social,	

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	cultural, and environmental impacts. (HS-ETS1-3) • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	

Social and Emotional Learning Standards	
Self-Awareness	• Recognize one's personal traits, strengths, and limitations • Recognize the importance of self-confidence in handling daily tasks and challenges
Self-Management	• Recognize the skills needed to establish and achieve personal and educational goals • Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals
Social Awareness	• Demonstrate an understanding of the need for mutual respect when viewpoints differ
Responsible Decision-Making	• Develop, implement and model effective problem solving and critical thinking skills

Interdisciplinary Connections	
	ELA Standards
• **RL.CR.11–12.1**	Accurately cite strong and thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what a literary text says explicitly and inferentially, as well as interpretations of the text; this may include determining where the text leaves matters uncertain
• **L.SS.11–12.1**	Demonstrate command of the system and structure of the English language when writing or speaking.
• **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

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	appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
• **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.
• **RI.CT.11–12.8**	Analyze and reflect on (e.g., practical knowledge, historical/cultural context, and background knowledge) documents of historical and scientific significance for their purposes, including primary source documents relevant to U.S. and/or global history and texts proposing scientific or technical advancements.
• **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.
	Math Standards
• **MP.4**	Model with mathematics.
• **HSN-Q.A.1**	Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Computer Science & Design Thinking

8.1 Computer Science

- 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects

8.2 Design Thinking

- 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 (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
- 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.
- 8.2.12.NT.2: Redesign an existing product to improve form or function.

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Career Readiness, Life Literacies & Key Skills

9.1 Personal Financial Literacy

- 9.1.12.EG.3: Explain how individuals and businesses influence government policies

9.2 Career Readiness, Life Literacies, and Key Skills

- 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
- 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills.

9.3 Career & Technical Education (CTE)

- 9.3.12.AG-PST.1: Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.
- 9.3.12.AC.2: Use architecture and construction skills to create and manage a project.
- 9.3.12.AC-DES.1: Justify design solutions through the use of research documentation and analysis of data.
- 9.3.12.AC-DES.8: Apply standards, applications and restrictions pertaining to the selection and use of
- construction materials, components and assemblies in the project design.
- 9.3.ST-ET.1: Use STEM concepts and processes to solve problems involving design and/or production.
- 9.3.ST-ET.4: Apply the elements of the design process.
- 9.3.ST-SM.2: Apply science and mathematics concepts to the development of plans, processes and projects
- that address real world problems.

9.4 Life Literacies & Key Skills

- 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.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.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)

Evidence of Student Learning

Formative Tasks:

- Oral Questioning
- Student Conference
- Self-Assessment
- Hand Signals
- Communicators
- Graphic Organizers
- Teacher Observation
- DOL
- Quiz Classwork
- NJSLA Released questions
- Problem of the Day

Alternative Assessments:

- Teacher-Created Projects
- https://www.khanacademy.org/
- Completion of webquests
- On-Line Laboratory activities
- Online assessment activities example:
  - Kahoot
  - Quizizz

Summative Assessments:

- Unit Tests

Benchmark Assessments:

- Quarterly Benchmarks

Lakewood School DIstrict Curriculum Guide

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● Midterm Exam ● Final Exam	● Beginning/End of Year Assessment ● Unit Common Assessment

Knowledge & Skills

Enduring Understandings:

- Energy is a conserved quantity that can be transferred, transformed, and redistributed within and between systems.
- Changes in a system's energy can be calculated and predicted using mathematical and computational models.
- At the macroscopic level, energy can be understood as a combination of energy of motion and energy of position.
- Energy transformations are central to the design and function of engineered systems.
- Effective energy solutions require balancing constraints and trade-offs, including efficiency, cost, safety, and environmental impact.
- Complex global challenges related to energy can be addressed by breaking problems into manageable components and evaluating solutions systematically.
- Computational tools and simulations allow scientists and engineers to test, refine, and predict the outcomes of energy-related designs before implementation.

Essential Questions:

- How does energy move into, out of, and within a system?
- How can mathematical and computational models be used to track and predict energy changes?
- In what ways can energy be classified and accounted for at the macroscopic scale?
- How is energy transformed from one form to another in natural and engineered systems?
- What constraints and criteria must be considered when designing devices that convert energy?
- How can complex, real-world energy problems be broken down and solved through engineering design?
- How do trade-offs influence decisions about energy solutions in terms of efficiency, cost, and societal impact?
- How can simulations help evaluate the effectiveness and consequences of proposed energy solutions?

Content

Students will know…

- In physics, work occurs only when a force causes displacement in the direction of the force, which differs from everyday usage of the term.
- Net work depends on the sum of all forces acting on an object and determines changes in the object's motion.

Energy exists in multiple forms, including kinetic energy and various forms of potential energy, and can be transferred between objects.

- Kinetic energy depends on an object's mass and velocity, and changes in kinetic energy can be explained using the work–energy theorem.

Skills

Students will be able to …

- Recognize the difference between the scientific and ordinary definitions of work.
- Define work by relating it to force and displacement.
- Identify where work is being performed in a variety of situations.
- Calculate the net work done when many forces are applied to an object.
- Identify several forms of energy.
- Calculate kinetic energy for an object.
- Apply the work-kinetic energy theorem to solve problems.
- Distinguish between kinetic and potential energy.
- Classify different types of potential energy.

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• Potential energy is associated with an object's position or configuration and can be classified into distinct types. • Mechanical energy is conserved in systems where only conservative forces act. • Power describes the rate at which work is done or energy is transferred and can be calculated using work or energy over time. • Machines do not reduce the total work required but can change the magnitude of force and distance over which it is applied. • Momentum depends on an object's mass and velocity and changes when forces act over time. • In interactions and collisions, total momentum is conserved, though kinetic energy may or may not be conserved depending on the type of collision. • Elastic and inelastic collisions differ in how kinetic energy is conserved, but both obey the law of conservation of momentum. • Mathematical models can be used to predict final velocities of objects involved in collisions.	• Calculate the potential energy associated with an object's position. • Identify situations in which conservation of mechanical energy is valid. • Recognize the forms that conserved energy can take. • Solve problems using conservation of mechanical energy. • Relate the concepts of energy, time, and power. • Calculate power in two different ways. • Explain the effect of machines on work and power. • Compare the momentum of different moving objects. • Compare the momentum of the same object moving with different velocities. • Identify examples of change in the momentum of an object. • Describe changes in momentum in terms of force and time. • Describe the interaction between two objects in terms of the change in momentum of each object. • Compare the total momentum of two objects before and after they interact. • State the law of conservation of momentum. • Predict the final velocities of objects after collisions, given the initial velocities. • Identify different types of collisions. • Determine the changes in kinetic energy during perfectly inelastic collisions. • Compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. • Find the final velocity of an object in perfectly inelastic and elastic collisions.

Core Instructional & Supplemental Materials	
Suggested Activities/Resources: • Holt Physics [2009] – Chapter 5 & 6 • Energy Skate Park • Work and Energy • Build a Solar House	**Supplemental resources:** • Lakewood Physics [notes online] https://desopophysics.webs.com/ • The Physics Classroom https://www.physicsclassroom.com/ • Study Physics http://www.studyphysics.ca/page03.html • A+ physics Videos http://aplusphysics.com/courses/ap-1/AP1_Physic

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	s.html • Khan Academy for Physics https://www.khanacademy.org/science/physics • Race & Social Justice Teacher Resources • Energy Transfer

Suggested Accommodations

English Language Learners:

- Multi-Sensory Instruction
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives/Concrete Models
- Build Background/Vocabulary
- Math Word Wall/Word Bank
- Gradual Release Model
- Visual Cues
- Visual Models
- Technology Integration
- Hands-On/Experiential Activities
- Native language support when possible
- Sheltered English Instructional Strategies
- Provide additional time

Special Education/Students with Disabilities:

- Extra help opportunities provided
- Credit Recovery
- Allow use of a calculator, when appropriate
- Modified length and time frame of assignments
- Alternate assessments with extended time
- Provide guided notes and study guides as needed
- Preferential Seating
- Extra Practice
- Directions repeated, clarified, and reworded
- Breakdown task into manageable units
- Differentiated instruction
- Use of manipulatives
- Math tool paper available
- Cooperative learning groups
- Supplemental books
- Repeat, reword or clarify directions
- Small group instruction as needed

- Instructional technology as needed/required
- Effective teacher questioning; ranging from fact recall to higher order critical thinking questions

504 Plans:

- Extra help opportunities provided
- Credit Recovery
- Allow use of a calculator, when appropriate
- Modified length and time frame of assignments
- Alternate assessments with extended time
- Provide guided notes and study guides as needed
- Preferential Seating
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- Modified Assignments

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- Gradual Release Model
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- Pre-teach vocabulary using visuals and gestures
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- Build relationships with students by interviewing students to understand their background

Unit 4: Circular and Rotational Dynamics	25 days

New Jersey Learning Standards-Science	
HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
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.

Science and Engineering Practices	Discipline Core Ideas/Unit Enduring Understandings	Crosscutting Concepts

Grade: High School	Content Area: Science - Physics

Using Mathematical and Computational Thinking • Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)	**ESS1.B: Earth and the Solar System** • Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1- 4)	**Scale, Proportion, and Quantity** • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4) **Connection to Engineering, Technology, and Applications of Science Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-4)

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Grade: High School	Content Area: Science - Physics

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	Math Standards
• **MP.2**	Reason abstractly and quantitatively.
• **HSA-CED.A.2**	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Computer Science & Design Thinking

8.1 Computer Science

- 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
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Career Readiness, Life Literacies & Key Skills

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- 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.

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- 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)

Evidence of Student Learning	
Formative Tasks: ● Oral Questioning ● Student Conference ● Self-Assessment ● Hand Signals ● Communicators ● Graphic Organizers ● Teacher Observation ● DOL ● Quiz Classwork ● NJSLA Released questions ● Problem of the Day	**Alternative Assessments:** ● Teacher-Created Projects ● https://www.khanacademy.org/ ● Completion of webquests ● On-Line Laboratory activities ● Online assessment activities example: ○ Kahoot ○ Quizizz
Summative Assessments: ● Unit Tests ● Midterm Exam ● Final Exam	**Benchmark Assessments:** ● Quarterly Benchmarks ● Beginning/End of Year Assessment ● Unit Common Assessment

Knowledge & Skills

Lakewood School DIstrict Curriculum Guide

Grade: High School	Content Area: Science - Physics

Enduring Understandings:

- Circular motion requires a net inward force that continuously changes an object's direction of motion.
- Apparent outward forces in circular motion result from inertia, not from an actual force acting on the object.
- Gravitational force governs the motion of orbiting bodies and explains planetary, satellite, and tidal phenomena.
- Kepler's laws describe planetary motion and are supported by Newton's mathematical analysis of gravitation.
- Mathematical models can be used to predict orbital speed, period, and motion of objects in gravitational systems.
- Rotational motion depends on torque, which is influenced by force magnitude, lever arm distance, and angle.
- Simple machines apply principles of rotational dynamics to change force and distance while conserving work.

Essential Questions:

- Why does an object moving in a circle require a continuous inward force?
- How does inertia explain the sensation of an outward force during circular motion?
- How does Newton's Law of Universal Gravitation explain orbital motion in the solar system?
- In what ways do Kepler's laws describe and predict planetary motion?
- How can mathematical and computational models be used to predict orbital behavior?
- How is torque different from force, and why is it important in rotational motion?
- How do simple machines use rotational principles to provide mechanical advantage?

Content

Students will know…

- Objects moving in a circle experience centripetal acceleration directed toward the center of the circular path.
- Centripetal force is the net inward force required to maintain circular motion and can arise from gravity, tension, friction, or normal force.
- The apparent outward force in circular motion is explained by inertia, not by an actual outward force.
- Newton's Law of Universal Gravitation explains satellite motion, planetary orbits, falling objects, and tidal effects.
- Kepler's laws of planetary motion describe elliptical orbits, equal areas in equal times, and the relationship between orbital period and distance.
- Newton's mathematical analysis of gravitation provides the theoretical basis for Kepler's empirical laws.
- Orbital speed and period depend on

Skills

Students will be able to …

- Solve problems involving centripetal acceleration.
- Solve problems involving centripetal force.
- Explain how the apparent existence of an outward force in circular motion can be explained as inertia resisting the centripetal force.
- Explain how Newton's law of universal gravitation accounts for various phenomena, including satellite and planetary orbits, falling objects, and the tides.
- Apply Newton's law of universal gravitation to solve problems.
- Describe Kepler's laws of planetary motion.
- Relate Newton's mathematical analysis of gravitational force to the elliptical planetary orbits proposed by Kepler.
- Solve problems involving orbital speed and period.
- Distinguish between torque and force.
- Calculate the magnitude of a torque on an object.
- Identify the six types of simple machines.
- Calculate the mechanical advantage of a simple machine.

Grade: High School	Content Area: Science - Physics

gravitational force, mass, and distance between objects. ● Torque measures the tendency of a force to cause rotation and differs from linear force. ● The magnitude of torque depends on force, lever arm distance, and angle of application. Simple machines modify force and distance to provide mechanical advantage without reducing total work. ● Mechanical advantage quantifies how effectively a machine multiplies force.	

Core Instructional & Supplemental Materials

Suggested Activities/Resources:

- Holt Physics [2009] – Chapter 5
- Orbital Labs
- Gravity Labs
- Jupiter Moons
- Kepler Activity

Supplemental resources:

- Lakewood Physics [notes online] https://desopophysics.webs.com/
- The Physics Classroom https://www.physicsclassroom.com/
- Study Physics http://www.studyphysics.ca/page03.html
- A+ physics Videos http://aplusphysics.com/courses/ap-1/AP1_Physics.html
- Khan Academy for Physics https://www.khanacademy.org/science/physics
- Race & Social Justice Teacher Resources

Suggested Accommodations

English Language Learners:

- Multi-Sensory Instruction
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives/Concrete Models
- Build Background/Vocabulary
- Math Word Wall/Word Bank
- Gradual Release Model
- Visual Cues
- Visual Models
- Technology Integration

- Hands-On/Experiential Activities
- Native language support when possible
- Sheltered English Instructional Strategies
- Provide additional time

Special Education/Students with Disabilities:

- Extra help opportunities provided
- Credit Recovery
- Allow use of a calculator, when appropriate
- Modified length and time frame of assignments
- Alternate assessments with extended time
- Provide guided notes and study guides as needed
- Preferential Seating
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- Supplemental books
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Gifted and Talented:

- Cooperative Learning Groups
- Enriched Assignments
- Tiered Assignments
- Word Problems
- NJSLA questions
- Model Curriculum Questions
- Inquiry Based Project
- Interest Based/Choice Activities

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- Highlight key words
- Sentence starters
- Prompting and cueing
- Activate schema
- Build background knowledge

Culturally Diverse:

- Create pictures, posters, art, books, maps, flags, etc to hang in the classroom.
- Create an emotionally positive classroom climate.
- Bring in guest speakers

Grade: High School	Content Area: Science - Physics

- Create effective communication
- Model and teach cultural respect
- Build relationships with students by interviewing students to understand their background

Unit 5: Waves	20 days

New Jersey Learning Standards-Science

HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

Science and Engineering Practices	Discipline Core Ideas/Unit Enduring Understandings	Crosscutting Concepts
Using Mathematics and Computational Thinking • Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1)	**PS4.A: Wave Properties** • The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1)

Social and Emotional Learning Standards	
Self-Awareness	• Recognize one's personal traits, strengths, and limitations • Recognize the importance of self-confidence in handling daily tasks and challenges
Self-Management	• Recognize the skills needed to establish and achieve personal and educational goals • Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals
Social Awareness	• Demonstrate an understanding of the need for mutual respect when viewpoints differ
Responsible Decision-Making	• Develop, implement and model effective problem solving and critical thinking skills

Interdisciplinary Connections	
	ELA Standards
• **RL.CR.11–12.1**	Accurately cite strong and thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what a literary text says explicitly and inferentially, as well as interpretations of the text; this may include determining where the text leaves matters uncertain
• **L.SS.11–12.1**	Demonstrate command of the system and structure of the English language when writing or

	speaking.
• **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.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.
• **RI.CT.11–12.8**	Analyze and reflect on (e.g., practical knowledge, historical/cultural context, and background knowledge) documents of historical and scientific significance for their purposes, including primary source documents relevant to U.S. and/or global history and texts proposing scientific or technical advancements.
• **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.
	Math Standards
• **HAS.SSE.B.3**	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
• **HSA.CED.A.4**	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Computer Science & Design Thinking

8.1 Computer Science

- 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects

8.2 Design Thinking

- 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 (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
- 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.
- 8.2.12.NT.2: Redesign an existing product to improve form or function.

Grade: High School	Content Area: Science - Physics

Career Readiness, Life Literacies & Key Skills

9.1 Personal Financial Literacy

- 9.1.12.EG.3: Explain how individuals and businesses influence government policies

9.2 Career Readiness, Life Literacies, and Key Skills

- 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
- 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills.

9.3 Career & Technical Education (CTE)

- 9.3.12.AG-PST.1: Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.
- 9.3.12.AC.2: Use architecture and construction skills to create and manage a project.
- 9.3.12.AC-DES.1: Justify design solutions through the use of research documentation and analysis of data.
- 9.3.12.AC-DES.8: Apply standards, applications and restrictions pertaining to the selection and use of
- construction materials, components and assemblies in the project design.
- 9.3.ST-ET.1: Use STEM concepts and processes to solve problems involving design and/or production.
- 9.3.ST-ET.4: Apply the elements of the design process.
- 9.3.ST-SM.2: Apply science and mathematics concepts to the development of plans, processes and projects
- that address real world problems.

9.4 Life Literacies & Key Skills

- 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.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.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)

Evidence of Student Learning

Formative Tasks:

- Oral Questioning
- Student Conference
- Self-Assessment
- Hand Signals
- Communicators
- Graphic Organizers
- Teacher Observation
- DOL
- Quiz Classwork
- NJSLA Released questions
- Problem of the Day

Alternative Assessments:

- Teacher-Created Projects
- https://www.khanacademy.org/
- Completion of webquests
- On-Line Laboratory activities
- Online assessment activities example:
  - Kahoot
  - Quizizz

Lakewood School DIstrict Curriculum Guide

Grade: High School	Content Area: Science - Physics

Summative Assessments:	Benchmark Assessments:
● Unit Tests ● Midterm Exam ● Final Exam	● Quarterly Benchmarks ● Beginning/End of Year Assessment ● Unit Common Assessment

Knowledge & Skills	
Enduring Understandings: ● Waves transfer energy and information without permanently transferring matter. ● The speed of a wave depends on the properties of the medium through which it travels. ● Frequency, wavelength, and wave speed are mathematically related and can be used to describe and predict wave behavior. ● Changing one wave property affects the others in predictable ways within a given medium. Mathematical representations provide evidence to support claims about wave relationships. Different types of waves share common properties but behave differently depending on the medium. ● Understanding wave relationships helps explain real-world phenomena such as sound, light, and communication technologies.	**Essential Questions:** ● How do waves transfer energy without transferring matter? ● What factors determine the speed of a wave in a given medium? ● How are frequency, wavelength, and wave speed mathematically related? ● How does changing frequency or wavelength affect wave behavior? ● Why does wave speed remain constant in a medium even when frequency changes? ● How can mathematical representations be used to support claims about wave motion? ● How do wave properties explain everyday and technological phenomena?
Content *Students will know…* ● Simple harmonic motion occurs when a restoring force is proportional to displacement, causing predictable changes in force, velocity, and acceleration. ● Hooke's Law describes the spring force in vibrating systems, and vibration amplitude measures maximum displacement from equilibrium. ● Period and frequency describe oscillatory motion and are inversely related. ● Waves transfer energy through a medium via local particle vibrations, not bulk motion of matter. ● Transverse and longitudinal waves, as well as pulse and periodic waves, differ in particle motion and waveform representation. ● Wave speed, frequency, and wavelength are mathematically related, and wave energy increases with amplitude.	**Skills** *Students will be able to …* ● Identify the conditions of simple harmonic motion. ● Explain how force, velocity, and acceleration change as an object vibrates with simple harmonic motion. ● Calculate the spring force using Hooke's law. ● Identify the amplitude of vibration. ● Recognize the relationship between period and frequency. ● Calculate the period and frequency of an object vibrating with simple harmonic motion. ● Distinguish local particle vibrations from overall wave motion. ● Differentiate between pulse waves and periodic waves. ● Interpret waveforms of transverse and longitudinal waves. ● Apply the relationship among wave speed, frequency, and wavelength to solve problems. Relate

Grade: High School	Content Area: Science - Physics

• Superposition explains wave interference, including constructive and destructive interference, reflection behavior, and standing waves with nodes and antinodes. • Sound waves are longitudinal pressure waves whose speed depends on the medium and whose frequency determines pitch. Sound intensity, decibel level, and perceived loudness are related but distinct measures of wave energy. • Resonance, harmonics, beats, and the Doppler effect result from interactions between wave frequency, boundary conditions, and relative motion.	energy and amplitude. • Apply the superposition principle. • Differentiate between constructive and destructive interference. • Predict when a reflected wave will be inverted. • Predict whether specific traveling waves will produce a standing wave. Identify nodes and antinodes of a standing wave. • Explain how sound waves are produced. • Relate frequency to pitch. • Compare the speed of sound in various media. • Relate plane waves to spherical waves. • Recognize the Doppler effect, and determine the direction of a frequency shift when there is relative motion between a source and an observer. • Calculate the intensity of sound waves. • Relate intensity, decibel level, and perceived loudness. • Explain why resonance occurs. • Differentiate between the harmonic series of open and closed pipes. • Calculate the harmonics of a vibrating string and of open and closed pipes. • Relate harmonics and timbre. • Relate the frequency difference between two waves to the number of beats heard per second.

Core Instructional & Supplemental Materials	
Suggested Activities/Resources: • Holt Physics [2009] – Chapter 11 & 12 • Wave on a String • Slinky Lab • Ripple Tank • Resonance Tube • Sound Waves • Doppler Radar	**Supplemental resources:** • Lakewood Physics [notes online] https://desopophysics.webs.com/ • The Physics Classroom https://www.physicsclassroom.com/ • Study Physics http://www.studyphysics.ca/page03.html • A+ physics Videos http://aplusphysics.com/courses/ap-1/AP1_Physics.html • Khan Academy for Physics https://www.khanacademy.org/science/physics • Race & Social Justice Teacher Resources

Grade: High School	Content Area: Science - Physics

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Grade: High School	Content Area: Science - Physics

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- Technology Integration
- Assistive Technology
- Credit Recovery

Grade: High School	Content Area: Science - Physics

Economically Disadvantaged:

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Unit 6: Optics	25 days

New Jersey Learning Standards-Science

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-PS4-3	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.

Science and Engineering Practices	Discipline Core Ideas/Unit Enduring Understandings	Crosscutting Concepts
Using Mathematics and Computational Thinking • Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1)	**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	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1)

Grade: High School	Content Area: Science - Physics

Engaging in Argument from Evidence
• Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3)

Obtaining, Evaluating, and Communicating Information
• Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)
• Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS4-5)

Asking Questions and Defining Problems
• Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)
• Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS-PS4-2)

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

medium through which it is passing. (HS-PS4-1)

PS4.A: Wave Properties
• 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 different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)
• Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-5)
• Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2)

Electromagnetic Radiation
• Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)
• When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength

Systems and System Models
• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-3)
Cause and Effect
• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS- PS4-4)
• Systems can be designed to cause a desired effect. (HS-PS4-5)

Stability and Change
• Systems can be designed for greater or lesser stability. (HS-PS4-2)

Interdependence of Science, Engineering, and Technology
• Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5)
Influence of Engineering, Technology, and Science on Society and the Natural World
• Modern civilization depends on major technological systems. (HS-PS4-5, HS-PS4-2)
• New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-3)
• Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HSPS4-2)

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
• A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment. The science community validates each theory before it is accepted. If new evidence is discovered that the theory does not

Grade: High School	Content Area: Science - Physics

	electromagnetic radiation (ultraviolet, Xrays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4) • Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS45) **PS3.D: Energy in Chemical Processes** • Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (secondary to HS-PS4-5) **PS4.C: Information Technologies & Instrumentation** • Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5) **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)	accommodate, the theory is generally modified in light of this new evidence. (HS-PS4-3)

Grade: High School	Content Area: Science - Physics

	• Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	

Social and Emotional Learning Standards	
Self-Awareness	● Recognize one's personal traits, strengths, and limitations ● Recognize the importance of self-confidence in handling daily tasks and challenges
Self-Management	● Recognize the skills needed to establish and achieve personal and educational goals ● Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals
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Grade: High School	Content Area: Science - Physics

• **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.
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Computer Science & Design Thinking

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Career Readiness, Life Literacies & Key Skills

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Grade: High School	Content Area: Science - Physics

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- 9.3.12.AC-DES.8: Apply standards, applications and restrictions pertaining to the selection and use of
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- 9.3.ST-ET.1: Use STEM concepts and processes to solve problems involving design and/or production.
- 9.3.ST-ET.4: Apply the elements of the design process.
- 9.3.ST-SM.2: Apply science and mathematics concepts to the development of plans, processes and projects
- that address real world problems.

9.4 Life Literacies & Key Skills

- 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.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.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)

Evidence of Student Learning	
Formative Tasks: ● Oral Questioning ● Student Conference ● Self-Assessment ● Hand Signals ● Communicators ● Graphic Organizers ● Teacher Observation ● DOL ● Quiz Classwork ● NJSLA Released questions ● Problem of the Day	**Alternative Assessments:** ● Teacher-Created Projects ● https://www.khanacademy.org/ ● Completion of webquests ● On-Line Laboratory activities ● Online assessment activities example: ○ Kahoot ○ Quizizz
Summative Assessments: ● Unit Tests ● Midterm Exam ● Final Exam	**Benchmark Assessments:** ● Quarterly Benchmarks ● Beginning/End of Year Assessment ● Unit Common Assessment

Lakewood School DIstrict Curriculum Guide

Grade: High School	Content Area: Science - Physics

Knowledge & Skills

Enduring Understandings:

- Light is a form of electromagnetic radiation that transfers energy through space and matter.
- The behavior of light can be described using mathematical relationships among frequency, wavelength, and speed.
  Different models of light, wave and particle, are useful for explaining different phenomena.
- The electromagnetic spectrum consists of a range of frequencies and wavelengths with distinct properties and effects.
- When electromagnetic radiation is absorbed by matter, it can produce observable physical, chemical, or biological effects.
- Scientific claims about electromagnetic radiation must be evaluated based on the quality of evidence and reasoning.
  Understanding optics supports informed decisions about technology, health, and safety.

Essential Questions:

- How are wavelength, frequency, and speed related for electromagnetic waves?
- Why is light sometimes better explained as a wave and other times as a particle?
- How does the electromagnetic spectrum differ across frequencies and wavelengths?
- What happens when electromagnetic radiation interacts with matter?
- How do different frequencies of radiation affect living and nonliving systems?
  How can we evaluate the validity and reliability of claims about the effects of electromagnetic radiation?
- How does scientific modeling help explain and predict the behavior of light?

Content

Students will know…

- Light is electromagnetic radiation that travels at a finite speed and exists across a spectrum of wavelengths and frequencies.
- Frequency, wavelength, and speed of electromagnetic waves are mathematically related and can be used to describe and predict light behavior.
- The brightness of a light source decreases with distance as light energy spreads over a larger area.
- Light reflects from surfaces as specular or diffuse reflection, and flat mirrors form images with predictable location, orientation, and size.
- Spherical and parabolic mirrors differ in geometry and image formation, and their behavior can be predicted using ray diagrams and mirror equations.
- Images formed by mirrors and lenses may be real or virtual, depending on how light rays converge or diverge.
- Refraction occurs when light changes speed between media, causing bending that can be described

Skills

Students will be able to …

- Identify the components of the electromagnetic spectrum.
- Calculate the frequency or wavelength of electromagnetic radiation. Recognize that light has a finite speed.
- Describe how the brightness of a light source is affected by distance.
- Distinguish between specular and diffuse reflection of light.
- Apply the law of reflection for flat mirrors.
- Describe the nature of images formed by flat mirrors.
- Calculate distances and focal lengths using the mirror equation for concave and convex spherical mirrors.
- Draw ray diagrams to find the image distance and magnification for concave and convex spherical mirrors.
- Distinguish between real and virtual images.
- Describe how parabolic mirrors differ from spherical mirrors.
- Recognize how additive colors affect the color of light.
- Recognize how pigments affect the color of reflected light.

Grade: High School	Content Area: Science - Physics

mathematically using Snell's Law. ● Converging and diverging lenses form images whose position, magnification, and nature can be predicted using ray diagrams and thin-lens equations. Optical devices such as microscopes and telescopes use specific lens arrangements to magnify images. ● Color, polarization, dispersion, and total internal reflection arise from interactions between light and matter and depend on wavelength, index of refraction, and medium properties.	● Explain how linearly polarized light is formed and detected. ● Recognize situations in which refraction will occur. ● Identify which direction light will bend when it passes from one medium to another. ● Solve problems using Snell's law. ● Use ray diagrams to find the position of an image produced by a converging or diverging lens, and identify the image as real or virtual. ● Solve problems using the thin-lens equation. ● Calculate the magnification of lenses. ● Describe the positioning of lenses in compound microscopes and refracting telescopes. ● Predict whether light will be refracted or undergo total internal reflection. ● Recognize atmospheric conditions that cause refraction. ● Explain dispersion and phenomena such as rainbows in terms of the relationship between the index of refraction and the wavelength.

Core Instructional & Supplemental Materials

Suggested Activities/Resources:

- Holt Physics [2009] – Chapter 13 & 14
- Electromagnetic Structure
- Imaging the Universe
- NASA Launchpad
- Radio Waves & Electromagnetic Fields
- Refraction
- Wave Interference
- Photoelectric
- Molecules & Light
- Quantum Waves

Supplemental resources:

- Lakewood Physics [notes online] https://desopophysics.webs.com/
- The Physics Classroom https://www.physicsclassroom.com/
- Study Physics http://www.studyphysics.ca/page03.html
- A+ physics Videos http://aplusphysics.com/courses/ap-1/AP1_Physics.html
- Khan Academy for Physics https://www.khanacademy.org/science/physics
- Race & Social Justice Teacher Resources

Suggested Accommodations

English Language Learners:

- Multi-Sensory Instruction
- Flexible Grouping

- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives/Concrete Models
- Build Background/Vocabulary
- Math Word Wall/Word Bank
- Gradual Release Model
- Visual Cues
- Visual Models
- Technology Integration
- Hands-On/Experiential Activities
- Native language support when possible
- Sheltered English Instructional Strategies
- Provide additional time

Special Education/Students with Disabilities:

- Extra help opportunities provided
- Credit Recovery
- Allow use of a calculator, when appropriate
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- Provide guided notes and study guides as needed
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- Math tool paper available
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- Enriched Assignments
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- Credit Recovery

Economically Disadvantaged:

- Pre-teach vocabulary using visuals and gestures
- Chunk texts
- Summarize as you go
- Preview lessons

Grade: High School	Content Area: Science - Physics

- Graphic organizers
- Highlight key words
- Sentence starters
- Prompting and cueing
- Activate schema
- Build background knowledge

Culturally Diverse:

- Create pictures, posters, art, books, maps, flags, etc to hang in the classroom.
- Create an emotionally positive classroom climate.
- Bring in guest speakers
- Create effective communication
- Model and teach cultural respect
- Build relationships with students by interviewing students to understand their background

Unit 7: Electricity and Magnetism	40 days

New Jersey Learning Standards-Science	
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.

Social and Emotional Learning Standards	
Self-Awareness	• Recognize one's personal traits, strengths, and limitations • Recognize the importance of self-confidence in handling daily tasks and challenges
Self-Management	• Recognize the skills needed to establish and achieve personal and educational goals • Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals
Social Awareness	• Demonstrate an understanding of the need for mutual respect when viewpoints differ
Responsible Decision-Making	• Develop, implement and model effective problem solving and critical thinking skills

Interdisciplinary Connections	
	ELA Standards
• **RL.CR.11–12.1**	Accurately cite strong and thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what a literary text says explicitly and inferentially, as well as interpretations of the text; this may include

	determining where the text leaves matters uncertain
• **L.SS.11–12.1**	Demonstrate command of the system and structure of the English language when writing or speaking.
• **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.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.
• **RI.CT.11–12.8**	Analyze and reflect on (e.g., practical knowledge, historical/cultural context, and background knowledge) documents of historical and scientific significance for their purposes, including primary source documents relevant to U.S. and/or global history and texts proposing scientific or technical advancements.
• **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.
	Math Standards
• **HSN.Q.A.1**	Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
• **HSN.Q.A.2**	Define appropriate quantities for the purpose of descriptive modeling.

Science and Engineering Practices	Discipline Core Ideas/Unit Enduring Understandings	Crosscutting Concepts
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	**Types of Interactions** • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-5) **Relationship between Energy and Forces**	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5) • 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)

data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5) **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)	• When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)	

Computer Science & Design Thinking

8.1 Computer Science

- 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects

8.2 Design Thinking

- 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 (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
- 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.
- 8.2.12.NT.2: Redesign an existing product to improve form or function.

Career Readiness, Life Literacies & Key Skills

9.1 Personal Financial Literacy

- 9.1.12.EG.3: Explain how individuals and businesses influence government policies

9.2 Career Readiness, Life Literacies, and Key Skills

- 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
- 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills.

9.3 Career & Technical Education (CTE)

- 9.3.12.AG-PST.1: Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.
- 9.3.12.AC.2: Use architecture and construction skills to create and manage a project.

Grade: High School	**Content Area: Science - Physics**

- 9.3.12.AC-DES.1: Justify design solutions through the use of research documentation and analysis of data.
- 9.3.12.AC-DES.8: Apply standards, applications and restrictions pertaining to the selection and use of
- construction materials, components and assemblies in the project design.
- 9.3.ST-ET.1: Use STEM concepts and processes to solve problems involving design and/or production.
- 9.3.ST-ET.4: Apply the elements of the design process.
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- that address real world problems.

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Evidence of Student Learning

Formative Tasks:

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- Student Conference
- Self-Assessment
- Hand Signals
- Communicators
- Graphic Organizers
- Teacher Observation
- DOL
- Quiz Classwork
- NJSLA Released questions
- Problem of the Day

Alternative Assessments:

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Summative Assessments:

- Unit Tests
- Midterm Exam
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Benchmark Assessments:

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Knowledge & Skills

Enduring Understandings:

- Electric and magnetic forces arise from fields that influence objects without direct contact.
- Electric charges interact according to predictable mathematical relationships that govern force and energy.

Essential Questions:

- How do electric and magnetic fields allow objects to interact at a distance?
  How can mathematical models be used to predict electric forces and energy changes?
- Why does a moving charge create a magnetic field, and how can a magnetic field produce an electric current?

Grade: High School	**Content Area: Science - Physics**

● Moving electric charges produce magnetic fields, and changing magnetic fields can induce electric currents. ● Electrical energy can be stored, transferred, and transformed within systems such as batteries, capacitors, and circuits. ● Circuit behavior depends on the arrangement of components and the properties of materials. Models and representations help explain complex interactions among charges, fields, and energy. ● Electricity and magnetism underpin many technological systems and have practical implications for energy use and efficiency.	● How is electrical energy stored and transferred in circuits and devices? ● How do material properties influence current, resistance, and energy conversion? ● How does circuit design affect current, potential difference, and power? ● How do models help us understand and optimize electrical and magnetic systems?
Content *Students will know…* ● Electric charge is a fundamental property of matter, and interactions between charges depend on charge type, magnitude, and distance. ● Materials behave as conductors or insulators based on the mobility of charge carriers, and objects can be charged by contact, induction, or polarization. ● Coulomb's Law describes electric force mathematically and reveals similarities and differences between electric and gravitational forces. ● The superposition principle explains how multiple electric forces combine to determine the net force on a charge. ● Electric fields represent the influence of charges in space and can be visualized and analyzed using field lines. ● Electrical interactions involve energy relationships, including electric potential energy, electric potential, and potential difference. ● Batteries and capacitors store and transform electrical energy by separating charges, and capacitance measures a system's ability to store electric energy. ● Electric current results from the motion of charges, and current, charge, resistance, and potential difference are related through well-defined mathematical models. ● Ohmic and non-ohmic materials, direct current and alternating current, and power relationships	**Skills** *Students will be able to …* ● Understand the basic properties of electric charge. ● Differentiate between conductors and insulators. ● Distinguish between charging by contact, charging by induction, and charging by polarization. ● Calculate electric force using Coulomb's law. ● Compare electric force with gravitational force. ● Apply the superposition principle to find the resultant force on a charge and to find the position at which the net force on a charge is zero. ● Calculate electric field strength. ● Draw and interpret electric field lines. ● Identify the four properties associated with a conductor in electrostatic equilibrium. ● Distinguish between electrical potential energy, electric potential, and potential difference. ● Solve problems involving electrical energy and potential difference. ● Describe the energy conversions that occur in a battery. ● Relate capacitance to the storage of electrical potential energy in the form of separated charges. ● Calculate the capacitance of various devices. ● Calculate the energy stored in a capacitor. ● Describe the basic properties of electric current, and solve problems relating current, charge, and time. ● Distinguish between the drift speed of a charge carrier and the average speed of the charge carrier between collisions. ● Calculate resistance, current, and potential difference by using the definition of resistance. ● Distinguish between ohmic and non-ohmic

Grade: High School	Content Area: Science - Physics

determine how electrical energy is converted in circuits. Complex circuits can be analyzed using series and parallel resistance models to determine current and potential difference throughout the system.	materials, and learn what factors affect resistance. ● Differentiate between direct current and alternating current. ● Relate electric power to the rate at which electrical energy is converted to other forms of energy. ● Calculate electric power and the cost of running electrical appliances ● Interpret and construct circuit diagrams. ● Identify circuits as open or closed. ● Deduce the potential difference across the circuit load, given the potential difference across the battery's terminals. ● Calculate the equivalent resistance for a circuit of resistors in series, and find the current in and potential difference across each resistor in the ● circuit. ● Calculate the equivalent resistance for a circuit of resistors in parallel, and find the current in and potential difference across each resistor in the circuit. ● Calculate the equivalent resistance for a complex circuit involving both series and parallel portions. ● Calculate the current in and potential difference across individual elements within a complex circuit. ● For given situations, predict whether magnets will repel or attract each other. ● Describe the magnetic field around a permanent magnet. ● Describe the orientation of Earth's magnetic field. ● Describe the magnetic field produced by current in a straight conductor and in a solenoid. ● Use the right-hand rule to determine the direction of the magnetic field in a current-carrying wire. ● Given the force on a charge in a magnetic field, determine the strength of the magnetic field. ● Use the right-hand rule to find the direction of the force on a charge moving through a magnetic field. ● Determine the magnitude and direction of the force on a wire carrying current in a magnetic field.

Core Instructional & Supplemental Materials	
Suggested Activities/Resources: ● Holt Physics [2009] – Chapter 16, 17, 18, 19 ● Magnets & Electromagnetics ● Charges & Fields	**Supplemental resources:** ● Lakewood Physics [notes online] https://desopophysics.webs.com/ ● The Physics Classroom

Grade: High School	Content Area: Science - Physics

• Faraday's Law	https://www.physicsclassroom.com/ • Study Physics http://www.studyphysics.ca/page03.html • A+ physics Videos http://aplusphysics.com/courses/ap-1/AP1_Physics.html • Khan Academy for Physics https://www.khanacademy.org/science/physics • Race & Social Justice Teacher Resources • Industrial Systems

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Grade: High School	Content Area: Science - Physics

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