Physics

Grades 11-12

Prepared by:

DEBORAH MARKS

Superintendent of Schools:

Marie C. Cirasella, Ed.D.

Approved by the Midland Park Board of Education on

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Born on Date: **June 20, 2022**

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Physics

Course Description:

High School Physics is taught in six units throughout the school year. The curriculum is hands-on, open-ended and a sequential process of investigating the world around us. High School Physics is a laboratory science course in which students investigate the study of matter and its motion through the universe and time. The laws of physics affect everything in the universe from matter, energy, velocity, accelerations, forces, momentum, charge and waves. Students use science process skills to study the fundamental structure of physics laws. Students will investigate kinematics & dynamics, momentum, circular motion, work, energy & power, static electricity & electricity, magnets, and waves. Aspects of physical science; chemistry; earth & space science; engineering, technology and applications of science are taught throughout the year. A guided inquiry program, problem-based learning and engineering projects will give students the opportunity to explore topics and concepts through investigations. Participating in this hands-on program helps students:

1. To observe science in the world around them.
2. To be prepared for College/Career by emphasizing key skills and practices (NJSLS & STEAM).
3. Become lifelong learners and engaged citizens.
4. To meet the science standards for New Jersey Public Schools.

Course Sequence:

Unit 1: Kinematics (45 days)

Unit 2: Dynamics, Newton's Laws (45 days)

Unit 3: Momentum and Its Conservation (20 days)

Unit 4: Work, Energy, and Power (20 days)

Unit 5: Electrostatics and Electricity (20 days)

Unit 6: Vibrations and Waves (20 days)

Pre-requisite: Biology, Chemistry, Algebra 1, Geometry

*The number of instructional days is an estimate based on the information available at this time. 1 day equals approximately 48 minutes of seat time. Teachers are strongly encouraged to review the entire unit of study carefully and collaboratively to determine whether adjustments to this estimate need to be made.

Unit 1	
Overview	
Content Area: Physics	
Unit Title: Kinematics	
Grade Level: 11-12	
Core Ideas: The motion of objects in one-dimension and two-dimensions are described using words, diagrams, numbers, graphs, and equations. The unit will cover the understanding and application of important terms such as scalars, vectors, distance, displacement, speed, velocity and acceleration and how they are used with regularity to describe the motion of objects	
Standards (Content and Technology)	
CPI#:	**Statement:**
Performance Expectations (NJSLS)	
HS-PS2-1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
Scientific & Engineering Practices	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.
Scientific & Engineering Practices	-Use mathematical representations of phenomena to describe explanations. -Theories and laws provide explanations in science -Laws are statements or descriptions of the relationships among observable phenomena.
Disciplinary Core Ideas PS2.A	Newton's Second Law accurately predicts changed in the motion of macroscopic objects.
Crosscutting Concepts	-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. -Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects
Career Readiness, Life Literacies, and Key Skills	
9.1.12.EG.3	Explain how individuals and businesses influence government policies.
9.1.12. FP.3	Relate the concept of delayed gratification (i.e., psychological distance) to meeting financial goals, investing and building wealth over time.
9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
9.4.12.CI.1	Demonstrate the ability to reflect, analyze and use creative skills and ideas.
9.4.12.CI.2	Identify career pathways that highlight personal talents, skills and abilities
Computer Science and Design Thinking	
8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
8.1.12.IC.2	Test and refine computational artifacts to reduce bias and equity deficits.
8.1.12.IC.3	Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.
8.2.12.ITH.3	Analyze the impact that globalization, social media, and access to open source technologies have had on innovation and on a society's economy, politics, and culture.
8.2.12.ETW.4	Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.
Interdisciplinary Connection	
NJSLS.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
NJSLS.A-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression
NJSLS.A-CED.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
Companion Standards ELA/L	
NJSLSA.R1.	Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
NJSLSA.R2.	Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

NJSLSA.R3	Analyze how and why individuals, events, and ideas develop and interact over the course of a text.
NJSLSA.R4	Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem

Cross-cultural Statements/Mandates (Amistad, Holocaust, LGBT, etc...)

Reflect on the influence that Hispanic Americans; Blind, Deaf & Hard of Hearing Americans; members of the AAPI, the LGBTQ and handicapped community has had on our knowledge and understanding of kinematics

Recognize the importance of self-confidence in handling daily tasks and challenges (CASEL)

Develop, implement and model effective problem solving and critical thinking skills (CASEL)

7.1.AL.IPRET.1	Identify main ideas and significant details in a range of oral, viewed, and written texts.
7.1.AL. IPRET.9	Differentiate facts from opinions by accurately answering most questions that require inferring implied meanings.

Unit Essential Question(s):

- How do scalar measurements differ from vector measurements?
- Which aspects of an object's motion can be described using a motion diagram?
- Which aspects of an object's motion can be described using a position-time graph?
- Which aspects of an object's motion can be described using a velocity-time graph?
- How are the kinematic equations applied to the study of motion?

Unit Enduring Understandings:

- Describing Motion with Words
- Describing Motion with Diagrams
- Describing Motion with Position vs. Time Graphs
- Describing Motion with Velocity vs. Time Graphs
- Describing Motion with Equations
- Free Fall and the Acceleration of Gravity

Evidence of Learning

Formative Assessments:
Quizzes
Worksheets
Q&A
Exit Slips
Internet Activities
Homework

Summative/Benchmark Assessment(s):
Tests
Lab

Alternative Assessments:
Projects
Posters

Resources/Materials:
Physics Principles & Problems by Zitzewitz, Haase, Harper

Key Vocabulary:

acceleration	motion diagram	trajectory
distance	parabola	vector
displacement	projectile	velocity
graph	scalar	
kinematics	speed	

Suggested Pacing Guide

Lesson Name/Topic	Student Learning Objective(s)	Suggested Tasks/Activities:	Day(s) to Complete
Kinematics - words	Determine whether a mathematically described quantity is scalar or vector Determine the difference between distance traveled and displacement of an object	Physics Classroom - Distance vs Displacement Representing Motion in 1 Dimension with practice problems	5
Kinematics - diagrams	Determine the average velocity of a moving object for a given time interval Construct a diagram to accurately depict motion Use a motion diagram to describe how an object is moving (direction, type, and relative size)	Battery Operated Car Lab Investigation and Lab Report Practice Problems Worksheets	10

	Use a vector diagram to determine the direction of an object's acceleration		
Kinematics - P-T graphs	Determine the direction of an object's motion from a position-time graph Determine whether an object is at rest, constant velocity, or accelerating from a position-time graph Calculate the velocity of a moving object from a position-time graph	Ed puzzle Position-time graphs Battery Operated Car Lab extension (Google sheet and graph) Concept Builders	5
Kinematics - V-T graphs and calculations	Determine the direction of an object's motion from a velocity-time graph Determine whether an object is at rest, constant velocity, or accelerating from a velocity-time graph Calculate the acceleration of a moving object from a velocity-time graph Determine the displacement of a moving object from a velocity-time graph	2 Stage Rocket Virtual Activity Pullback Cars Lab	8
Free-fall study	Describe the characteristics of a true free-falling object Describe the acceleration due to gravity Describe the effects of air resistance on free-falling objects	Student Exploration: Free-Fall Laboratory - GIZMOS	7
Kinematic Equations and projectile Motion	Apply the first kinematics equation to objects in free fall Apply the kinematic equations to determine variables in an object's accelerated motion	PhET - Exploring vectors and Projectile Motion Rocket Activity	10

Teacher Notes:

Additional Resources:
http://www.physicsclassroom.com
Https://phet.colorado.edu

Differentiation/Modification Strategies

Students with Disabilities	English Language Learners	Gifted and Talented Students	Students at Risk	504 Students
● Consult student IEP ● Allow errors ● Rephrase questions, directions, and explanations ● Allow extended time to answer questions, and permit drawing, as an explanation	● Consult ELL student Plan ● Assign a buddy, same language or English speaking ● Allow errors in speaking ● Rephrase questions, directions, and explanations ● Allow extended time to answer questions	● Consult G and T teacher ● Provide extension activities ● Build on students' intrinsic motivations ● Higher Level mathematical computations	● Consult with IR&S as needed ● Provide extended time to complete tasks ● Consult with Guidance	● Consult 504 Plan ● Allow errors ● Rephrase questions, directions, and explanations ● Allow extended time to answer questions, and permit drawing, as an explanation

Unit 2	
Overview	
Content Area: Physics	
Unit Title: Dynamics, Newton's Laws	
Grade Level: 11-12	
Core Ideas: Newton's three laws of motion are explained and their application to the analysis of the motion of objects is discussed. Learning how Newton's laws apply in everyday situations and devices enables students to be able to describe how objects move and prepares them for the study of more complex physics concepts.	
Standards (Content and Technology)	
CPI#:	**Statement:**
Performance Expectations (NJSLS)	
HS-PS2-1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
Disciplinary Core Ideas PS2.A	Newton's Second Law accurately predicts changed in the motion of macroscopic objects.
Scientific & Engineering Practices	-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. -Use mathematical representations of phenomena to describe explanations. -Theories and laws provide explanations in science -Laws are statements or descriptions of the relationships among observable phenomena
Crosscutting Concepts	-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. -Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
Career Readiness, Life Literacies, and Key Skills	
9.1.12.EG.3	Explain how individuals and businesses influence government policies.
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9.4.12.CI.1	Demonstrate the ability to reflect, analyze and use creative skills and ideas.
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Computer Science and Design Thinking	
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8.2.12.ITH.3	Analyze the impact that globalization, social media, and access to open source technologies have had on innovation and on a society's economy, politics, and culture.
8.2.12.ETW.4	Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.
Interdisciplinary Connection	
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Companion Standards ELA/L	
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RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem

Cross-cultural Statements/Mandates (Amistad, Holocaust, LGBT, etc...)

Reflect on the influence that Hispanic Americans; Blind, Deaf & Hard of Hearing Americans; members of the AAPI, the LGBTQ and handicapped community has had on our knowledge and understanding of dynamics

Recognize the importance of self-confidence in handling daily tasks and challenges (CASEL)

Develop, implement and model effective problem solving and critical thinking skills (CASEL)

7.1.AL.IPRET.1	Identify main ideas and significant details in a range of oral, viewed, and written texts.
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Unit Essential Question(s):

- How do scientists communicate their
- measurements and observations?
- What is the relationship between force and
- acceleration?
- What are Newton's Three Laws?
- What is terminal velocity?

Unit Enduring Understandings:

- Scientific Measurement
- Acceleration
- Newton's Laws
- Terminal Velocity
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
- Engineers continuously modify design solutions to increase benefits while decreasing costs and risks.

Evidence of Learning

Formative Assessments:
Quizzes
Worksheets
Q&A
Exit SLips
Internet Activities
Homework

Summative/Benchmark Assessment(s):
Tests
Lab

Alternative Assessments:
Projects
Posters

Resources/Materials:
Physics Principles & Problems by Zitzewitz, Haase, Harper

Key Vocabulary:

Force	Mass	Weight
Friction	Net Force	
Gravity	Newton	
Inertia	Sir Issac Newton	

Suggested Pacing Guide

Lesson Name/Topic	Student Learning Objective(s)	Suggested Tasks/Activities:	Day(s) to Complete
Force in Action	Determine ideal variables for the application of forces	Domino Lab	2
Mass and Weight	Identify weight as a force Compare weight and mass	Mini Lab (Spring Scale)	2
Free Body Diagrams	Use free body diagrams to correctly represent forces is a given scenario	Practice worksheets Physics classroom concept builders Rocket Sled Lab Launch Lab	8
Types of Forces	Identify and describe types of forces	Complete chart	2

F=ma	Explain and calculate how unbalanced forces affect motion	Practice Problems Concept builder	6
Apparent Weight	relate Newton's 2nd law and free body diagrams to the motion of slowing down, speeding up and moving at constant speed	Elevator Ride Lab	3
Friction	Understand the characteristics of friction as a force and its effects on motion	Friction simulation Coefficient of Friction Lab	8
Real Life Applications of Forces	How are forces used in engineering? Label and recognize the forces on engineering builds	Bridge Design Bridge Research	8
Motion in two dimensions	Vectors, Friction & Forces in Two Dimensions	PhET Ramp Lab	3
Gravity	Newton's Law of Universal Gravitation	Calculation Practice Problems PhET Sim Lab	3

Teacher Notes:

Additional Resources:

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Unit 3	
Overview	
Content Area: Physics	
Unit Title: Momentum and Its Conservation	
Grade Level: 11-12	
Core Ideas: The impulse-momentum change theorem and the law of conservation of momentum are introduced, explained and applied to the analysis of explosions and the collisions of objects.	
Standards (Content and Technology)	
CPI#:	**Statement:**
Performance Expectations (NJSLS)	
HS-PS2-2	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
HS-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.
Disciplinary Core Ideas PS2.A	-Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. -If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
Scientific & Engineering Practices	-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. -Use mathematical representations of phenomena to describe explanations. -Theories and laws provide explanations in science -Laws are statements or descriptions of the relationships among observable phenomena.
Crosscutting Concepts	-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. -Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
Career Readiness, Life Literacies, and Key Skills	
9.1.12.EG.3	Explain how individuals and businesses influence government policies.
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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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Interdisciplinary Connection	
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Cross-cultural Statements/Mandates (Amistad, Holocaust, LGBT, etc...)

Reflect on the influence that Hispanic Americans; Blind, Deaf & Hard of Hearing Americans; members of the AAPI, the LGBTQ and handicapped community has had on our knowledge and understanding of momentum and collisions
Recognize the importance of self-confidence in handling daily tasks and challenges (CASEL)
Develop, implement and model effective problem solving and critical thinking skills (CASEL)

7.1.AL.IPRET.1	Identify main ideas and significant details in a range of oral, viewed, and written texts.
7.1.AL. IPRET.9	Differentiate facts from opinions by accurately answering most questions that require inferring implied meanings.

Unit Essential Question(s):	**Unit Enduring Understandings:**
● What is momentum? ● What is the law of conservation of momentum?	● How momentum depends on mass and velocity ● Relate momentum to car collisions

Evidence of Learning

Formative Assessments:
Quizzes
Worksheets
Q&A
Exit Slips
Internet Activities
Homework
Summative/Benchmark Assessment(s):
Tests
Lab
Alternative Assessments:
Projects
Posters

Resources/Materials:	**Key Vocabulary:**
Physics Principles & Problems by Zitzewitz, Haase, Harper	Collisions Elastic Impulse Inelastic Kinetic Energy Momentum

Suggested Pacing Guide

Lesson Name/Topic	Student Learning Objective(s)	Suggested Tasks/Activities:	Day(s) to Complete
Momentum	Define momentum	notes	1
Angular Momentum	Discuss Angular Momentum	phet lab demo video explanation (pbs)	3
Newtons' Laws	Relate Newton's Third Law to conservation of momentum	physics classroom collision lab	2
Impulse	Learn what an impulse is and relate the concept to changes in momentum	Practice problems Momentum-impulse theorem simulation models	4
Collisions	Study the types of collisions Predict the mass and velocity based on given situations	edpuzzle chart completion	3
Conservation of Momentum	Explain how the law of conservation of momentum relates to the motion of objects	concept builders	4

Egg Car	Apply understanding of momentum, collisions, and impulse	Design and Engineer an Race Egg Car	3

Teacher Notes:

Additional Resources:

Paper Car Crash: https://www.youtube.com/watch?v=jFuTwNVjfzc

https://www.teachengineering.org/activities/view/safety_sue

https://classroom.iihs.org/wp-content/uploads/2019/03/Egg-Crash_Student.pdf

https://www.khanacademy.org/science/ap-physics-1/ap-linear-momentum/introduction-to linear-momentum-and-impulse-ap/v/introduction-to-momentum

https://phet.colorado.edu/en/simulation

Differentiation/Modification Strategies

Students with Disabilities	English Language Learners	Gifted and Talented Students	Students at Risk	506 Students
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Unit 4	
Overview	
Content Area: Physics	
Unit Title: Work, Energy, and Power	
Grade Level: 11-12	
Core Ideas: Concepts of work, kinetic energy and potential energy are discussed; these concepts are combined with the work-energy theorem to provide a convenient means of analyzing an object or system of objects moving between an initial and final state.	
Standards (Content and Technology)	
CPI#:	**Statement:**
Performance Expectations (NJSLS)	
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy
HS-PS3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems
Science & Engineering Practices	-Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. -Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data and refine the design accordingly.
Disciplinary Core Ideas PS3.A	-Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. -At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
Disciplinary Core Ideas PS3.B	-Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. -Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. -The availability of energy limits what can occur in any system.
Disciplinary Core Ideas ETS1.A	-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.
Crosscutting Concepts	-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. -Energy cannot be created or destroyed, but it can move between one place to another place, between objects and/or fields, or between systems. -When investigating or describing a system, the boundaries and

		initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
Disciplinary Core Ideas PS2.B		-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. -Attraction & repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
Disciplinary Core Ideas PS3.A		"Electrical Energy "may mean energy stored in a battery or energy transmitted by electric currents
Disciplinary Core Ideas ETS1.A		-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.
Disciplinary Core Ideas ETS1.C		-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) nay be needed.
Career Readiness, Life Literacies, and Key Skills		
9.1.12.EG.3		Explain how individuals and businesses influence government policies.
9.1.12. FP.3		Relate the concept of delayed gratification (i.e., psychological distance) to meeting financial goals, investing and building wealth over time.
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Companion Standards ELA/L		
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NJSLSA.R2.		Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
NJSLSA.R3		Analyze how and why individuals, events, and ideas develop and interact over the course of a text.
NJSLSA.R4		Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
RST.9-10.8		Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem
Cross-cultural Statements/Mandates (Amistad, Holocaust, LGBT, etc...)		
Reflect on the influence that Hispanic Americans; Blind, Deaf & Hard of Hearing Americans; members of the AAPI, the LGBTQ and handicapped community has had on our knowledge and understanding of Physics		
Recognize the importance of self-confidence in handling daily tasks and challenges (CASEL)		
Develop, implement and model effective problem solving and critical thinking skills (CASEL)		
7.1.AL.IPRET.1		Identify main ideas and significant details in a range of oral, viewed, and written texts.
7.1.AL. IPRET.9		Differentiate facts from opinions by accurately answering most questions that require inferring implied meanings.

Unit Essential Question(s):	**Unit Enduring Understandings:**
● How does energy change from one form to another? ● What is work and power? ● What is mechanical energy? ● How are work & kinetic energy of a moving object related?	● Change of energy from one form to another. ● Calculating work and power. ● Law of Conservation of Energy

Evidence of Learning

Formative Assessments:
Quizzes
Worksheets
Q&A
Exit SLips
Internet Activities
Homework

Summative/Benchmark Assessment(s):
Tests
Lab

Alternative Assessments:
Projects
Posters

Resources/Materials:	**Key Vocabulary:**
Physics Principles & Problems by Zitzewitz, Haase, Harper	Gravitational Potential Energy Joule Kinetic Energy Mechanical Energy Work

Suggested Pacing Guide

Lesson Name/Topic	Student Learning Objective(s)	Suggested Tasks/Activities:	Day(s) to Complete
Work Physics Definition	Determine when work is done on an object	Teacher Presentation and practice Problems	2
Work and Power	Create a computational model to calculate work and power in a system.	The Power - Energy - Work Connection Analysis	2
Energy in Physics	Forms of mechanical energy	Roller Coaster Introduction	1
Gravitational Energy	Relate energy associated with the relative position of an object	Extension of Momentum lesson - Collision Phet Lab	2
Potential Energy	Explore examples of potential energy such as elastic potential energy	Hooke's law lab (phet and in class)	2
Work and Energy Theorem	Relate work and kinetic energy.	What is a Joule?	2
Conservation of Energy	Apply the law of conservation of energy	Energy Skate Park	2
Energy Transformation	Design, build and refine a device that changes one form of energy to another	Foam Coasters Lab	2
Energy Forms and Applications	Analyze the variety of energy forms and how they are relevant to our lives	Energy Forms Research (thermal, nuclear, sound etc)	4
Energy and Work as a vector	Recognize the importance of direction in the application of energy in a scenario and how it affects the work done.	It's All Up Hill	2

Teacher Notes:

Additional Resources:
http://www.physicsclassroom.com
Https://phet.colorado.edu

Differentiation/Modification Strategies

Students with Disabilities	English Language Learners	Gifted and Talented Students	Students at Risk	507 Students
● Consult student IEP ● Allow errors ● Rephrase questions, directions, and explanations ● Allow extended time to answer questions, and permit drawing, as an explanation	● Consult ELL student Plan ● Assign a buddy, same language or English speaking ● Allow errors in speaking ● Rephrase questions, directions, and explanations ● Allow extended time to answer questions	● Consult G and T teacher ● Provide extension activities ● Build on students' intrinsic motivations ● Higher Level mathematical computations	● Consult with IR&S as needed ● Provide extended time to complete tasks ● Consult with Guidance	● Consult 504 Plan ● Allow errors ● Rephrase questions, directions, and explanations ● Allow extended time to answer questions, and permit drawing, as an explanation

Unit 5	
Overview	
Content Area: Physics	
Unit Title: Electrostatics and Electricity	
Grade Level: 11-12	
Core Ideas: This unit covers electrostatic forces and electric fields. Positive and negative charges exert forces on one another. Electric charge is neither created nor destroyed, it is conserved. Objects can be charged by the transfer of electric charges from one object to another. The forces between charged particles are mathematically related to charge and distance. Coulomb's Law states that the force between two charged particles can be calculated.	
Standards (Content and Technology)	
CPI#:	**Statement:**
Performance Expectations (NJSLS)	
HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-5	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
HS-PS3-5	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials
HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios
Scientific & Engineering Practices	-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. -Use mathematical representations of phenomena to describe explanations. -Theories and laws provide explanations in science -Laws are statements or descriptions of the relationships among observable phenomena.
Crosscutting Concepts	-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. -Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
Disciplinary Core Ideas PS2.B	-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. -Attraction & repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
Disciplinary Core Ideas PS3.A	"Electrical Energy "may mean energy stored in a battery or energy transmitted by electric currents.
Disciplinary Core Ideas ETS1.A	-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
Disciplinary Core Ideas ETS1.C	-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) nay be needed.
Career Readiness, Life Literacies, and Key Skills	
9.1.12.EG.3	Explain how individuals and businesses influence government policies.
9.1.12. FP.3	Relate the concept of delayed gratification (i.e., psychological distance) to meeting financial goals, investing and building wealth over time.
9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
9.4.12.CI.1	Demonstrate the ability to reflect, analyze and use creative skills and ideas.
9.4.12.CI.2	Identify career pathways that highlight personal talents, skills and abilities
Computer Science and Design Thinking	
8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and

	cultural practices.
8.1.12.IC.2	Test and refine computational artifacts to reduce bias and equity deficits.
8.1.12.IC.3	Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.
8.2.12.ITH.3	Analyze the impact that globalization, social media, and access to open source technologies have had on innovation and on a society's economy, politics, and culture.
8.2.12.ETW.4	Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.
Interdisciplinary Connection	
NJSLS.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
NJSLS.A-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression
NJSLS.A-CED.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
Companion Standards ELA/L	
NJSLSA.R1.	Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
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RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem
Cross-cultural Statements/Mandates (Amistad, Holocaust, LGBT, etc...)	
Reflect on the influence that Hispanic Americans; Blind, Deaf & Hard of Hearing Americans; members of the AAPI, the LGBTQ and handicapped community has had on our knowledge and understanding of electrostatics and electricity	
Recognize the importance of self-confidence in handling daily tasks and challenges (CASEL)	
Develop, implement and model effective problem solving and critical thinking skills (CASEL)	
7.1.AL.IPRET.1	Identify main ideas and significant details in a range of oral, viewed, and written texts.
7.1.AL.IPRET.9	Differentiate facts from opinions by accurately answering most questions that require inferring implied meanings.

Unit Essential Question(s):	**Unit Enduring Understandings:**
● How do things become charged? ● What are the differences between conductors and insulators? ● How can we make environmentally conscientious decision for choosing materials in the use of electricity? ● How can you charge objects? ● How do you measure an electric field? ● What is electric current?	● How objects become charged. ● Objects that are conductors or insulators. ● Electric Fields ● Electric Circuits ● Ohm's Law

Evidence of Learning

Formative Assessments:
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Exit SLips
Internet Activities
Homework

Summative/Benchmark Assessment(s):
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Alternative Assessments:
Projects
Posters

Resources/Materials:	**Key Vocabulary:**	
Physics Principles & Problems by Zitzewitz, Haase, Harper	Amp	Ohm's Law
	Charging	Parallel Circuit
	Coulomb's Law	Polarization

	Conduction Series Circuit Current Voltage Electric field Electrostatics Induction

Suggested Pacing Guide

Lesson Name/Topic	Student Learning Objective(s)	Suggested Tasks/Activities:	Day(s) to Complete
Electric Charge	Learn that electric forces are both attractive & repulsive	Compare and contrast Newton's Law of Universal Gravitation and Coulomb's Law	1
Conductors and Insulators	Discuss the difference between conductors & insulators	Conductors vs Insulators in electrostatics lab	1
Coulomb's Law	Relate electrostatic force to the distance between charges	Practice problems calculating force using Coulomb's Law	2
Charging Methods	Compare & contrast charging by conduction vs. induction	Charging by conduction, induction, and polarization activity	2
Electric Fields	Define an electric field and Relate charge, electric field to forces	PhET Electrostatic Hockey Lab	2
Voltage	Define Voltage and study Ohm's Law Relate power, current, potential difference and resistance mathematically	Phet Ohm's Law Model Practice Problems	4
Circuits	Differentiate between series and parallel circuits	Phet Circuit Lab	1
Circuits	Explain how currents, potential differences and resistances are related in a series circuit and parallel circuit	Producing Electric Current and Electric Circuits Diagramming Circuits Lamp Lab	4
Calculations	Calculate a combined circuit	Practice Problems	2
Electric current and magnets	Relate magnetic fields & electric currents	Modeling Electromagnets	1
Generators and Transformers	Analyze magnetic field on a current carrying wire Describe the force on a charged particle in a magnetic field	Changing Magnetic Fields Electric Generators/Transformers concept builder	2
Energy Transformation	Solar energy into Electrical energy into thermal energy. Choosing and using earth's resources conscientiously	Solar Cars lab	2

Teacher Notes:

Additional Resources:

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Unit 6	
Overview	
Content Area: Physics	
Unit Title: Vibrations and Waves	
Grade Level: 11-12	
Core Ideas: The nature, properties and behaviors of waves are discussed and illustrated. The nature of sound as a longitudinal, mechanical pressure wave is explained and the properties of sound are discussed. The behavior of light waves is introduced and discussed; polarization, color, diffraction and interference are introduced as supporting evidence of the wave nature of light. The behaviors of reflection and refractions are also covered in this unit.	
Standards (Content and Technology)	
CPI#:	**Statement:**
Performance Expectations (NJSLS)	
HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
Science & Engineering Practices	-Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. -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)
Disciplinary Core Ideas PS4.A	-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. -Waves can add or cancel one another as they cross, depending on their relative phase, but they emerge unaffected by each other.
Disciplinary Core Ideas PS4.B	-Electromagnetic ration can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining may features of electromagnetic radiation, and the particle model explains other features. -When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy. Shorter wavelength electromagnetic radiation can ionize atoms and cause damage to living cells.
Disciplinary Core Ideas PS4.C	-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.
Crosscutting Concepts	-Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. -Systems can be designed to cause a desired effect. --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.
Connections to Engineering, Technology, and Applications of Science	-Science and engineering complement each other in the cycle know as research and development. -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.
Career Readiness, Life Literacies, and Key Skills	
9.1.12.EG.3	Explain how individuals and businesses influence government policies.

9.1.12.FP.3	Relate the concept of delayed gratification (i.e., psychological distance) to meeting financial goals, investing and building wealth over time.
9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
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8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
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RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem
RI.11-12.7	Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem
RST.11-12.1	Write arguments focused on discipline-specific content
Cross-cultural Statements/Mandates (Amistad, Holocaust, LGBT, etc...)	
Reflect on the influence that Hispanic Americans; Blind, Deaf & Hard of Hearing Americans; members of the AAPI, the LGBTQ and handicapped community has had on our knowledge and understanding of the physics of waves	
Recognize the importance of self-confidence in handling daily tasks and challenges (CASEL)	
Develop, implement and model effective problem solving and critical thinking skills (CASEL)	
7.1.AL.IPRET.1	Identify main ideas and significant details in a range of oral, viewed, and written texts.
7.1.AL.IPRET.9	Differentiate facts from opinions by accurately answering most questions that require inferring implied meanings.

Unit Essential Question(s):	**Unit Enduring Understandings:**
● What are waves? ● What Type of Waves exist? ● Differences between the types of waves? ● How are waves reflected and refracted between mediums? ● How do we hear sound? ● What is the ray model of light and how are objects illuminated? ● What is diffraction of light? ● How do polarized sunglasses work? ● What is the Law of Reflection ● How are images formed in mirrors?	● Characteristics of waves ● Waves in different mediums ● How sound is made ● How objects are illuminated ● Wave characteristics of light ● How images are formed ● Law of reflection ● Wave Behaviors

Evidence of Learning

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Projects
Posters

Resources/Materials:
Physics Principles & Problems by Zitzewitz, Haase, Harper

Key Vocabulary:
amplitude
boundary
crest
compression
diffraction
frequency
harmonics
hertz
lenses (convex and concave)
longitudinal wave
nodes and antinodes
period
periodic motion
rarefraction
reflection
refraction
restoring force
standing wave
transverse wave
trough
vibration
wavelength

Suggested Pacing Guide

Lesson Name/Topic	Student Learning Objective(s)	Suggested Tasks/Activities:	Day(s) to Complete
Properties	Identify and evaluate wave properties and the effects of matter on them	Labs: Slinky lab and waves on a string Practice Problems, solving for frequency, wavelength and velocity	3
Technology And Communication	Explain how some devices use the principles of waves to capture and transfer information	A study of Communication Devices	3
Doppler Effect	Define and recognize the Doppler Effect	Doppler Effect Demo	1
Behaviors	Understand how wave behaviors can those behaviors can be useful in modern technology	Reflection, Diffraction and Refraction experiments and virtual sim	5
Light and Sound	Explain how everyday objects use waves to function	Mirrors, radios, cameras, telescopes, instruments, headphones… How physics is involved.	4
EM Spectrum	Predict cause and effect relationships for electromagnetic radiation systems when matter absorbs different frequencies	Electromagnetic Radiation Model and Application study	4

Teacher Notes:

Additional Resources:
http://www.physicsclassroom.com
Https://phet.colorado.edu
https://nasa3d.arc.nasa.gov/visualizations/networking

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● Rephrase questions, directions, and explanations ● Allow extended time to answer questions, and permit drawing, as an explanation	● Assign a buddy, same language or English speaking ● Allow errors in speaking ● Rephrase questions, directions, and explanations ● Allow extended time to answer questions	● Build on students' intrinsic motivations ● Higher Level mathematical computations	● Provide extended time to complete tasks ● Consult with Guidance	directions, and explanations ● Allow extended time to answer questions, and permit drawing, as an explanation