PUBLIC SCHOOLS OF EDISON TOWNSHIP

OFFICE OF CURRICULUM AND INSTRUCTION



Physics 1-2

Length of Course:	Term
Elective/Required:	Required
Schools:	High School
Eligibility:	Grade 11-12
Credit Value:	5 Credits
Date Approved:	August 23, 2022

Physics 1-2

TABLE OF CONTENTS

Statement of Purpose	3
Course objectives	4
Timeline and Pacing Guide	7
Unit 1: Measurement	10
Unit 2: Kinematics	15
Unit 3: Dynamics	21
Unit 4: Circular Motion	27
Unit 5: Momentum	32
Unit 6: Work and Energy	37
Unit 7: Waves	44
Unit 8: Electrostatics	50
Unit 9: DC Circuits	56
Unit 10: Magnetism	62

Modifications will be made to accommodate IEP mandates for classified students.

STATEMENT OF PURPOSE

The Physics 1-2 curriculum is a comprehensive survey of physics that meets local objectives and contributes to the accomplishment of the state and national standards. The program was chosen to complement the flow and sequence of scientific studies from Chemistry and is an elective course for Grade 11 or Grade 12 science. All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science. An overarching goal for learning in physics is to help students see that there are mechanisms of cause and effect in all systems and processes that can be understood through a common set of physical quantities and principles. The focus of the Physics 1-2 course is to develop and nurture the skills necessary to problem solve, design experiments, analyze assumptions, and evaluate the validity of scientific claims. The final goal is to combine these skills to provide students with a strong ability to collaborate with each other in determining and solving societal issues, such as energy production/usage.

The curriculum guide was revised/updated by: Kruti Singh (EHS) Christopher McKnight (EHS)

Coordinated by: Laurie Maier (Science Supervisor)

COURSE OBJECTIVES

By the end of the Physics 1-2 course, students will be able to:

Motion and Stability: Forces and Interactions

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

Energy

- (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.
- (NJSLS/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).
- (NJSLS/HS-PS3-3) Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- **(NJSLS/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.

Waves And Their Applications In Technologies For Information Transfer

- (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.
- (NJSLS/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.
- (NJSLS/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.

Engineering Design

(NJSLS/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.

Earth's Place In The Universe

(NJSLS/HS-ESS1-4) Use mathematical or computational representations to predict the motion of
orbiting objects in the solar system

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1) RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems;

choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4) HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2- 4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2- 1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)

HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them

CRP11. Use technology to enhance productivity.

TIMELINE AND PACING GUIDE

Marking Period 1:

Measurement SI units dimensional analysis significant digits and scientific notation scientific method precision and accuracy graphical analysis

Kinematics

reference frames vectors, scalars position, displacement average velocity uniform acceleration free fall projectile motion relative velocity

Quarterly Exam 1

Marking Period 2:

Dynamics

force, mass four fundamental forces Newton's Laws of Motion particular forces (weight, normal, tension, drag, friction) gravitational force

Circular Motion

kinematics dynamics horizontal circular motion

Momentum

momentum impulse momentum conservation

Quarterly Exam 2

Marking Period 3:

Work and Energy work (constant force) mechanical energy energy conversions energy conservation power

Mechanical Waves

wave motion mechanical waves wave characteristics amplitude wavelength frequency period wave speed

Sound vs. Light Waves

sound is a longitudinal wave light is an electromagnetic wave amplitude is loudness for sound amplitude is brightness/intensity for light frequency is pitch for sound frequency is color for light

Quarterly Exam 3

Marking Period 4:

Electrostatics electrostatic charge nature of materials Coulomb's Law

DC Circuits

simple circuits series circuits parallel circuits

Electromagnetism magnetism magnetic force

- magnetic field
- magnetic force on...
 - ... charged particle
 - ... current carrying wire

Quarterly Exam 4

TARGETED STATE STANDARDS:

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2- 4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them

CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

Identify and define SI units

Complete dimensional analysis

Write scientific notation

Identify aspects of the scientific method

Differentiate between precision and accuracy

Analyze graphs by identifying independent and dependent variables and demonstrating understanding of linear relationships

ESSENTIAL QUESTIONS: How do we represent patterns mathematically?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?) Quarterly Exam Tests and quizzes Laboratory activities and reports

Concepts	Skills	Progress Indicators	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
PS2.B: Types of Interactions Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. (HS- PS2- 4),(HS-PS2-5)	Investigations Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5) Analyzing and Interpreting Data Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS2-1) Using Mathematics and	scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4)	Use appropriate classroom materials, online and textbook resources (i.e. simulations, measurement tools/instruments/software) for presentation	Formative Assessments: Exit tickets Laboratory activities Classwork Homework Summative Assessments: Tests Quizzes Laboratory reports Project Quarterly exam

mathematical representations of	interactions including	
	energy, matter, and	
-	information flows—	
	within and between	
,	systems at different	
	scales. (HS-ETS1-4)	
and Designing Solutions	$500003. (110^{-1} - 101^{-1})$	
Apply scientific ideas to solve a		
design problem, taking into		
account possible unanticipated		
effects. (HS-PS2-3)		
enects. (113-F 32-3)		
Obtaining, Evaluating, and		
Communicating Information		
Communicate scientific and		
technical information (e.g. about		
the process of development and		
the design and performance of		
a proposed process or system)		
in multiple formats (including		
orally, graphically, textually, and		
mathematically). (HS-PS2-6)		
(113-F 32-0)		
Science Models, Laws,		
Mechanisms, and Theories		
Explain Natural Phenomena		
Theories and laws provide		
explanations in science. (HS-		
PS2- 1),(HS-PS2-4)		
Laws are statements or		
descriptions of the relationships		
among observable phenomena.		
(HS-PS2-1),(HS-PS2-4)		
<u> </u>		

Resources: Essential Materials, Supplementary Materials, Links to Best Practices	Instructional Adjustments:
Textbook: Conceptual Physics Custom Edition (Hewitt) Phet online simulations (https://phet.colorado.edu/en/simulations/category/physics) Gizmos (https://gizmos.explorelearning.com/) PAER Rutgers (http://www.plysics.aet/pt3/) The Physics Classroom (http://www.physicsclassroom.com/) Pivot Interactives (https://www.pivotinteractives.com/) Physics textbooks Experimental equipment pertinent to lab activities	Modifications will be made to accommodate IEP mandates for classified students

TARGETED STATE STANDARDS:

NGSS

NJSLS/HS-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

[Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to macroscopic objects moving at non-relativistic speeds.]

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-4),(HS-PS2-5)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)

HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them

CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

Motion is relative to a reference frame

An observer in a particular reference frame can describe the linear motion of an object's center of mass using such quantities as position, displacement, distance, velocity, speed, and acceleration

Displacement, velocity and acceleration are all vector quantities

Displacement is a change in position.

Velocity is the rate of change of position as a function of time.

Acceleration is the rate of change of velocity as a function time.

Changes in each property are expressed by subtracting initial values from final values

A choice of reference frame determines the direction and the magnitude of each of these quantities.

The kinematic equations only apply to constant acceleration situations.

The three kinematic equations describing linear motion with constant acceleration in one and two dimensions are

 $\Box = \Box_0 + \Box \Box \qquad \Box = \Box_0 + \Box_0 \Box + \frac{1}{2} \Box \Box = 2 \qquad \Box = 2 = \Box_0^2 + 2 \Box \Box$

Vectors can be broken into their components and added

Perpendicular vectors are independent of each other

ESSENTIAL QUESTIONS:

How do we define motion? Why is motion relative? How do we model the motion of objects? How do we describe objects in free fall?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

Quarterly Exam Tests and quizzes Laboratory activities and reports

Concepts	Skills	Progress Indicators	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
PS2.B: Types of Interactions Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. (HS-PS2- 4),(HS-PS2-5)	Planning and Carrying Out Investigations Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5) Analyzing and Interpreting Data Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable	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)	textbook resources (i.e. simulations, measurement tools/instruments/software) for presentation, demonstration, classroom and laboratory activities, and problem solving: Express the motion of an object in one dimension using multiple	Assessments: Exit tickets Laboratory activities
	scientific claims or determine an optimal	models) can be used to simulate systems and	based on the fact that acceleration is equal to the	

design solution. (HS-PS2-	interactions— including	change in velocity per unit	
1)	energy, matter, and	time, and velocity is equal	
	information flows—	to the change in position	
-	within and between	per unit time.	
Computational Thinking	systems at different		
	scales. (HS-ETS1-4)		
representations of			
phenomena to describe			
explanations. (HS-PS2-			
2),(HS-PS2-4)			
Constructing			
Explanations and			
Designing Solutions			
Apply scientific ideas to			
solve a design problem,			
taking into account possible			
unanticipated effects. (HS-			
PS2-3)			
Obtaining, Evaluating,			
and Communicating			
Information			
Communicate scientific and			
technical information (e.g.			
about the process of			
development and the			
design and performance of			
a proposed process or			
system) in multiple formats			
(including orally,			
graphically, textually, and			
mathematically). (HS-PS2-			
6)			

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4) Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4) Resources: Essential Materials, Supplementary Materials, Links to Best Practices Textbook: Conceptual Physics Custom Edition (Hewitt) Phet online simulations (https://phet.colorado.edu/en/simulations/category/physics) Gizmos (https://gizmos.explorelearning.com/) PAER Rutgers (http://www.islephysics.net/pt3/) The Physics Classroom (http://www.pivotinteractives.com/) Pivot Interactives (https://www.pivotinteractives.com/) Physics textbooks Experimental equipment pertinent to lab activities	Instructional Adjustments: Modifications will be made to accommodate IEP mandates for classified students
---	---

Unit 3: Dynamics

TARGETED STATE STANDARDS:

NGSS

NJSLS/HS-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

[Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to macroscopic objects moving at non-relativistic speeds.]

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2- 4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2- 1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason CRP8. Utilize critical thinking to make sense of problems and persevere in solving them CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

A system is an object or a collection of objects. Objects are treated as having no internal structure.

Forces are described by vectors

Force diagrams are useful tools for visualizing forces being exerted on a single object and writing the equations that represent a physical situation

A force exerted on an object is always due to the interaction of that object with another object

Newton's First Law and Second Law of Motion: The acceleration of an object interacting with other objects can be predicted by:

 $a = \frac{\Sigma F}{m}$

If an object of interest interacts with several other objects, the net force is the vector sum of the individual forces

Force and acceleration are both vectors, with acceleration in the same direction as the net force.

Newton's Third Law of Motion: If one object exerts a force on a second object, the second object always exerts a force of equal magnitude on the first object in the opposite direction

 $F_{2 \text{ on } 1} = -F_{1 \text{ on } 2}$

Objects and systems have properties of inertial mass and gravitational mass that are experimentally verified to be the same and that satisfy conservation principles.

Inertial mass is the property of an object or a system that determines how its motion changes when it interacts with other objects or systems. Gravitational mass is the property of an object or a system that determines the strength of the gravitational interaction with other objects or

systems.

There are fundamental forces in nature

Gravitational forces are exerted at all scales and dominate at the largest distance and mass scale Electromagnetic forces are exerted at all scales and can dominate at the human scale The strong force is exerted at nuclear scales and dominates the interactions of nucleons

Field forces result from interaction of one field on another

Gravitational force describes the interaction of one object that has mass with another object that has mass

A gravitational field g at the location of an object with mass m causes a gravitational force of magnitude mg to be exerted on the object in the direction of the field.

On Earth, this gravitational force is called weight

Contact forces result from interaction of one object touching another object, and they arise from interatomic electric forces.

These forces include normal, tension, drag force, and friction

$$|F_{f_s}| \le |\mu_s F_N|$$
$$|F_{f_k}| = |\mu_k F_N|$$

Normal force and friction force are the perpendicular forces of the surface on an object

ESSENTIAL QUESTIONS:

How can we change the motion of an object? How do we describe and predict changes in the motion of an object?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?) Quarterly Exam Tests and quizzes Laboratory activities and reports

Concepts	Skills	Progress Indicators	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
PS2.A: Forces and Motion	Planning and Carrying	Patterns	Use appropriate classroom	Formative Assessments:
	5 7 5			Exit tickets
	-		-	Laboratory activities
objects. (HS-PS2-1)	investigation individually	the scales at which a	simulations, measurement	Classwork
	C 1	system is studied and	tools/instruments/software)	Homework
PS2.B: Types of Interactions	produce data to serve as	can provide evidence for	for presentation,	
	the basis for evidence, and	causality in explanations	demonstration, classroom	<u>Summative</u>
fields (gravitational, electric, and magnetic)	in the design: decide on	of phenomena. (HS-	and laboratory activities,	Assessments:
permeating space that can transfer energy	types, how much, and	PS2-4)	and problem solving:	Tests
through space. (HS-PS2- 4),(HS-PS2-5)	accuracy of data needed to			Quizzes
	produce reliable	Cause and Effect	Represent forces in	Laboratory reports
	measurements and	Empirical evidence is		Project
	consider limitations on the	required to differentiate	mathematically using	Quarterly exam
	precision of the data (e.g.,	between cause and	appropriately labeled	
	number of trials, cost, risk,		vectors with magnitude,	
	time), and refine the design	claims about specific	direction and units during	
	•••	causes and effects. (HS- PS2- 1),(HS-PS2-5)	the analysis of a situation.	
	Analyzing and		Re-express a force	
	Interpreting Data	Systems can be	diagram into a	
	Analyze data using tools,	designed to cause a	mathematical	
	technologies, and/or	desired effect. (HS-PS2-	representation, and solve	
	models (e.g.,	3)	the mathematical	
	computational,		representation for the	
	mathematical) in order to	Systems and System	acceleration of the object.	
	make valid and reliable	Models		
	scientific claims or	When investigating or	Describe a force as an	
	determine an optimal	describing a system, the	interaction between two	

0		objects, and identify both	
1)	conditions of the system	objects for any force.	
	need to be defined. (HS-		
Using Mathematics and	PS2-2)	Calculate the gravitational	
Computational Thinking		force on an object with	
Use mathematical	Systems and System	mass <i>m</i> in a gravitational	
representations of	Models	field of strength <i>g</i> in the	
phenomena to describe	Models (e.g., physical,	context of the effects of a	
explanations. (HS-PS2-	mathematical, computer	net force on objects and	
2),(HS-PS2-4)	models) can be used to	systems.	
	simulate systems and		
Constructing	interactions— including	Predict the motion of an	
Explanations and	energy, matter, and	object subject ot forces	
Designing Solutions	information flows—	exerted by several objects	
Apply scientific ideas to	within and between	using an application of	
solve a design problem,	systems at different	Newton's Second Law of	
taking into account possible	scales. (HS-ETS1-4)	Motion in a variety of	
unanticipated effects. (HS-		physical situations	
PS2-3)			
		Express the motion of an	
Obtaining, Evaluating,		object in one dimension	
and Communicating		using multiple	
Information		representations (i.e.	
Communicate scientific and		narrative, dot diagram,	
technical information (e.g.		video analysis, data table,	
about the process of		graphical and	
development and the		mathematical	
design and performance of		representations).	
a proposed process or			
system) in multiple formats			
(including orally,			
graphically, textually, and			
mathematically). (HS-PS2-			
6)			

Resources: Essential Materials, Suppler Textbook: Conceptual Physics Custon Phet online simulations (https://phet.co Gizmos (https://gizmos.explorelearning PAER Rutgers (http://www.islephysics The Physics Classroom (http://www.ph	n Edition (Hewitt) blorado.edu/en/simulations/categ g.com/) .net/pt3/)	Instructional Adjustment Modifications will be made mandates for classified stu	to accommodate IEP
Pivot Interactives (<u>https://www.pivotint</u> Physics textbooks Experimental equipment pertinent to la			

Unit 4: Circular Motion

TARGETED STATE STANDARDS:

NGSS

NJSLS/HS-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

[Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to macroscopic objects moving at non-relativistic speeds.]

ELA/Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-4),(HS-PS2-5) HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2- 4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason CRP8. Utilize critical thinking to make sense of problems and persevere in solving them CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

For curved and circular motion such as projectiles and orbitals, a system must have a net centripetal force exerted on it perpendicular to the direction of a velocity component toward the center of curvature.

Force and acceleration are both vectors with acceleration in the same direction as the net force

$$a_c = \frac{F_c}{m}$$

Force diagrams are useful tools for visualizing forces being exerted on a single object and writing the equations that represent a physical situation

For uniform circular motion where the velocity is entirely perpendicular to the net centripetal force:

$$a_c = \frac{v^2}{r}$$
 $v = 2\pi r f$ $f = \frac{1}{T}$

ESSENTIAL QUESTIONS:

What causes an object to move in uniform circular motion? Why doesn't Earth "fall into" the Sun?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?) Quarterly Exam Tests and quizzes Laboratory activities and reports

Concepts	Skills	Progress Indicators	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) PS2.B: Types of Interactions Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. (HS-PS2- 4),(HS-PS2-5)	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	required to differentiate between cause and correlation and make claims about specific causes and effects. (HS- PS2- 1),(HS-PS2-5)	textbook resources (i.e. simulations, measurement tools/instruments/software) for presentation, demonstration, classroom and laboratory activities, and problem solving: Create and use force	Exit tickets Laboratory activities Classwork
	determine an optimal		out an analysis to	

design solution. (HS-PS2-	determine the relationship	
1)	between the net force and	
	the vector sum of the	
Using Mathematics and	individual forces.	
Computational Thinking		
Use mathematical		
representations of		
phenomena to describe		
explanations. (HS-PS2-		
2),(HS-PS2-4)		
Constructing		
Explanations and		
Designing Solutions		
Apply scientific ideas to		
solve a design problem,		
taking into account possible		
unanticipated effects. (HS-		
PS2-3)		
Obtaining, Evaluating,		
and Communicating		
Information		
Communicate scientific and		
technical information (e.g.		
about the process of		
development and the		
design and performance of		
a proposed process or		
system) in multiple formats		
(including orally,		
graphically, textually, and		
mathematically). (HS-PS2-		
6)		

	Science Models, Laws, Mechanisms, and			
	Theories Explain Natural Phenomena			
	Theories and laws provide			
	explanations in science.			
	(HS-PS2- 1),(HS-PS2-4)			
	Laws are statements or			
	descriptions of the			
	relationships among			
	observable phenomena.			
Resources: Essential Materials, S	(HS-PS2-1),(HS-PS2-4)	inks to Best Practices	Instructional Adjustments	•
	appieniental y materialo, E			-
Textbook: Conceptual Physics Cust			Modifications will be made to accommodate IEP mandates	
Phet online simulations (<u>https://phet</u>		s/category/physics)	for classified students	
Gizmos (<u>https://gizmos.explorelearning.com/</u>) PAER Rutgers (<u>http://www.islephysics.net/pt3/</u>)				
The Physics Classroom (<u>http://www.physicsclassroom.com/</u>)				
Pivot Interactives (<u>https://www.pivot</u>	interactives.com/)			
Physics textbooks Experimental equipment pertinent to	a lab activities			

Unit 5: Momentum

TARGETED STATE STANDARDS: NGSS

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.

[Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.]

NJSLS/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.

[Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.]

[Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]

ELA/Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-4),(HS-PS2-5) - 5)

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them

CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

Momentum is a conserved vector. A net force on a system yields a change in momentum (impulse) over time

 $\Sigma F = \frac{\Delta p}{\Delta t} = \frac{m\Delta V}{\Delta t} = ma$ p = mV $\Sigma p_i + \Delta p = \Sigma p_f$

The momentum of a closed, isolated system is constant.

ESSENTIAL QUESTIONS:

How do we quantify motion? How do airbags help save lives?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

Quarterly Exam

Tests and quizzes

Laboratory activities and reports

Concepts	Skills	Progress Indicators	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
PS2.A: Forces and Motion	Planning and Carrying Out	Cause and Effect	Use appropriate classroom	Formative
Momentum is defined for a particular	Investigations	Empirical evidence is	materials, online and	Assessments:
frame of reference; it is the mass times	Plan and conduct an	required to	textbook resources (i.e.	Exit tickets
the velocity of the object. (HS-PS2-2)	investigation individually and	differentiate between	simulations, measurement	Laboratory activities
	collaboratively to produce	cause and correlation	tools/instruments/software)	Classwork
,		and make claims	· · · · · · · · · · · · · · · · · · ·	Homework
		about specific causes	demonstration, classroom	
	decide on types, how much,	and effects. (HS-PS2-	•	<u>Summative</u>
		1),(HS-PS2-5)	, 0	Assessments:
-	to produce reliable		Predict the change in	Tests
		Systems can be	,	Quizzes
	limitations on the precision of	designed to cause a	from the average force	Laboratory reports
		desired effect. (HS-	exerted on the object and	Project
	trials, cost, risk, time), and	PS2-3)	-	Quarterly exam
Criteria and constraints also include	refine the design accordingly.		which the force is exerted.	
satisfying any requirements set by	(HS-PS2-5)	Systems and System		
society, such as taking issues of risk		Models		
	Analyzing and Interpreting	When investigating or	Define open and closed	
		describing a system,	systems for everyday	
stated in such a way that one can tell if a		the boundaries and	situations and apply	
	/ · · · ·	initial conditions of the	conservation concepts for	
HS-PS2-3)		system need to be	linear momentum.	
		defined. (HS-PS2-2)	Apply mothematical	
	make valid and reliable scientific claims or determine		Apply mathematical	
Criteria may need to be broken down into			routines appropriately to problems involving elastic	
simpler ones that can be approached	(HS-PS2-1)		collisions in one dimension	
systematically, and decisions about the			and justify the selection of	
systematically, and decisions about the				

priority of certain criteria over others	Using Mathematics and	those mathematical	
(trade-offs) may be needed. (secondary	Computational Thinking	routines based on	
to HS-PS2-3)	Use mathematical	conservation of momentum	
	representations of	and restoration of kinetic	
	phenomena to describe	energy.	
	explanations. (HS-PS2-		
	2),(HS-PS2-4)	Apply the conservation of	
		linear momentum to a	
	Constructing Explanations	closed system of objects	
	and Designing Solutions	involved in an inelastic	
	Apply scientific ideas to solve	collision to predict the	
	a design problem, taking into	change in kinetic energy.	
	account possible		
	unanticipated effects. (HS-	Design an experimental	
	PS2-3)	test of an application of the	
		principle of the	
	Obtaining, Evaluating, and	conservation of linear	
	Communicating Information	momentum, predict an	
	Communicate scientific and	outcome of the experiment	
	technical information (e.g.	using the principle, analyze	
	about the process of	data generated by that	
	development and the design	experiment whose	
	and performance of a	uncertainties are	
	proposed process or system)	expressed numerically, and	
	in multiple formats (including	evaluate the match	
	orally, graphically, textually,	between the prediction and	
	and mathematically). (HS-	the outcome.	
	PS2-6)		

Resources: Essential Materials, Supplementary Materials, Links to Best	Instructional Adjustments:
Practices	
	Modifications will be made to accommodate IEP mandates for
Franklander Organization (und Dhursian Organization (Harville)	classified students
Textbook: Conceptual Physics Custom Edition (Hewitt)	
Phet online simulations (<u>https://phet.colorado.edu/en/simulations/category/physics</u>)	
Gizmos (https://gizmos.explorelearning.com/)	
PAER Rutgers (<u>http://www.islephysics.net/pt3/</u>)	
The Physics Classroom (http://www.physicsclassroom.com/)	
Pivot Interactives (https://www.pivotinteractives.com/)	
Physics textbooks	
Experimental equipment pertinent to lab activities	
	1

Unit 6: Energy

TARGETED STATE STANDARDS: NGSS

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.

[Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.]

[Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]

NJSLS/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). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]

NJSLS/HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-4),(HS-PS2-5) HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2- 4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason CRP8. Utilize critical thinking to make sense of problems and persevere in solving them CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

A system is an object or a collection of objects. The objects are treated as having no internal structure.

An interaction can be either a force exerted by objects outside the system or the transfer of some quantity with objects outside the system.

The placement of a boundary between a system and its environment is a decision made by the person considering the situation in order to simplify or otherwise assist in analysis.

Work changes the energy of a system, and both are conserved scalar quantities.

The change in kinetic energy of an object depends on the force exerted on the object and on the displacement of the object during the interval that the force is exerted.

Only the component of the net force exerted on an object parallel or antiparallel to the displacement of the object will increase or decrease the

kinetic energy of the object

* A single object can only have kinetic energy

For work done by a constant force: the magnitude of the change in the kinetic energy is the product of the magnitude of the displacement and of the magnitude of the component of force parallel or antiparallel to the displacement

Work = $F_{\parallel} \cdot \Delta x$ = $F \Delta x \cos \theta = \Delta E$

The component of the net force exerted on an object perpendicular to the direction of the displacement of the object can change the direction of the motion of the object without changing the kinetic energy of the object. This should include uniform circular motion and projectile motion.

Mechanical Power is the time rate at which work is done or energy is transferred.

$$Power = \frac{\Delta E}{\Delta t} = \frac{work}{\Delta tt} = \Sigma F \cdot v$$

Mechanical energy of a rigid system consists of the sum of kinetic energy and potential energies (gravitational, elastic). Energy of a rigid system consists of the sum of kinetic energy, potential energies and microscopic internal energy. For a rigid system:

Translational kinetic energy:

 $KE = \frac{1}{2}mv^{2}$

Gravitational potential energy:

GPE = mgh

For all systems under all circumstances, energy is conserved. For an isolated or closed system, conserved quantities are constant. An open system is one that exchanges any conserved quantity with its surroundings.

ESSENTIAL QUESTIONS:

How can we change the energy of a system? How can we analyze motion in terms of energy? Why is the first hill of a roller coaster always the tallest?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

Quarterly Exam

Tests and quizzes

Laboratory activities and reports

			Activities/Strategies	
Concepts	Skills	Progress Indicators	Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
PS3.A: Definitions of Energy	Planning and Carrying	Systems and System	Use appropriate classroom	Formative Assessments:
Energy is a quantitative property	Out Investigations	Models	materials, online and	Exit tickets
of a system that depends on the	Plan and conduct an	Models can be used to	textbook resources (i.e.	Laboratory activities
motion and interactions of matter	investigation individually	predict the behavior of a	simulations, measurement	Classwork
and radiation within that system.	and collaboratively to	system, but these	tools/instruments/software)	Homework
That there is a single quantity	produce data to serve as	predictions have limited	for presentation,	
called energy is due to the fact	the basis for evidence, and	precision and reliability	demonstration, classroom	Summative Assessments:
that a system's total energy is	in the design: decide on	due to the assumptions	and laboratory activities, and	Tests
conserved, even as, within the	types, how much, and	and approximations	problem solving:	Quizzes
system, energy is continually	accuracy of data needed to	inherent in models.		Laboratory reports
transferred from one object to	produce reliable	(HSPS3-1)	Define open and closed	Project
another and between its various	measurements and		systems for everyday	Quarterly exam
possible forms. (HSPS3-1),(HS-	consider limitations on the		situations and apply	
PS3-2)	precision of the data (e.g.,	Energy and Matter	conservation concepts for	
	number of trials, cost, risk,	Changes of energy and	energy.	
At the macroscopic scale, energy	time), and refine the design	matter in a system can		
manifests itself in multiple ways,	accordingly. (HS-PS2-5)	be described in terms of	Make predictions about the	
such as in motion, sound, light,		energy and matter flows	changes in kinetic energy of	
and thermal energy. (HSPS3-2)	Developing and Using		an object in a system based	
(HS-PS3-3)	Models	that system. (HSPS3-3)		
	Develop and use a model		direction of the net force on	
These relationships are better	based on evidence to	•••	the object as the object	
understood at the microscopic	illustrate the relationships	,	moves.	
scale, at which all of the different	between systems or	only moves between		
	between components of a	one place and another	Use net force and velocity	
modeled as a combination of	system. (HS-PS3-	, , ,	vectors to determine	
	2),(HSPS3-5)	and/or fields, or between		
motion of particles and energy		systems. (HS-PS3-2)	kinetic energy of an object	

associated with the configuration Using Mathematics and (relative position of the particles). Computational Thinking In some cases the relative Create a computational position energy can be thought of model or simulation of a as stored in fields (which mediate phenomenon, designed interactions between particles). device, process, or system. This last concept includes (HS-PS3-1) (HS-PS3-2) Explanations and Designing Solutions PS3.B: Conservation of Energy Design, evaluate, and/or and the Natural World a system and justify the mathematical routines used in the total energy transfer or out of the system. (HS-PS3-1) (HS-PS3-1) (HS-PS3-2) Explanations and Designing Solutions or scient/file knowledge, student-generated sources of vertered into a complex real-world destroyed, but it can be transported from one place to another and transferred between and the advert welported in advert expension, since devices of a system (HS-PS3-1), (HS-PS3-4) (Information Communicate scientific and Tisks. (HS-PS3-3) (Information configuration in development and the matual place to and the edsign and performanced a system depends on its development and the design and performanced for configuration in the design and performanced a system in which basic (IS-PS3-4) (Information Constructing and Tisks. (HS-PS3-3) (Information Constructing and Tisks. (HS-PS3-3) (Information Constructing and Tisks. (HS-PS3-3) (Information Constructing the depends on its development and the matually, (HS-PS2-3) (Information Constructing and Tisks. (HS-PS3-3) (Information Constructing the devices of a system in which basic scientific transfered between and the matually, (HS-PS2-3) (Information Constructing the matually, (HS-PS3-4) (Information Construct					
In some cases the relative create a computational position energy can be thought of model or simulation of a stored in fields (which mediate/phenomenon, designed interactions between particles). device, process, or system. (HS-PS3-1) device, process, or system. (HS-PS3-2) Explanations and Designing Solutions Operations of Energy Design, evaluate, and/or and the Natural World and the Natural World and the total energy of an object. Engineering, and the Natural World and the total energy of an object and the object. Conservation of energy means is always equal to considerations. (HSPS3-3) or out of the system. (HS-PS3-1) of evidence, prioritized for total energy transfered between student-generated sources the total energy transfered total energy in problem, based on ganetic considerations. (HSPS3-3) of evidence, prioritized for total energy transferred between and transferred between systems. (HS-PS3-1) of evidence, prioritized for considerations. (HSPS3-3) of evidence, prioritized for considerations. (HSPS3-3) of evidence, prioritized for considerations. (HSPS3-3) another and transferred between gan d Communicating systems. (HS-PS3-1), (HS-PS3-4) information (e.g. quantify how the stored energy in about the process of a system depends on its configuration (e.g. relative deviced and performance of positions of charged particles, storem is number and transferred between sources or system in multiple formats (including orally, graphically, textually, and performance of conservation of a system) in multiple formats (including orally, graphically, textually, and system depends on its concept of conservation of an system) in multiple formats (including orally, graphically, textually, and some system since and speed, allow the concept of conservation of an external on conservation of an external on conservation of an external on the displacement of the conservation of an external on conservation of an external on the displacement of the conservation of an external on the displacement of the conservation of an externa	associated with the configuration	Using Mathematics and		would increase, decrease, or	
position energy can be thought of model or simulation of a as stored in fields (which mediate behomenon, designed interactions between particles).Connections to Engineering, Technology, and Applications of ScienceApply mathematical routines to determine the change in kinetic energy of an objectThis last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)Constructing Design, evaluate, and/or refine a solutions to Designing SolutionsInfluence of Science, Engineering, and Technology on Society Calculate the total energy of and Energy Transfer erifie a solution to a complex real-world the total energy transferred into or out of the system. (HS-PS3-1)Constructing Design, evaluate, and/or rechnological systems. Engineering, and Technological systems. Engineering, and Technological systems. Engineering design problem, based on student-generated sources modify theseApply mathematical routines to determine the change in kinet total energy of an object Science exerted on the total energy transferred into or out of the system. (HS-PS3-1)Apply mathematical routines to determine the change in the total energy in problem, based on scientific knowledge, student-generated sources modify theseConstructing technological systems by applying scientific technological systems by applying scientific practices to increase to and transferred between system.Apply mathematical routines to determine the change in the object.Energy cannot be created or destroyed, but it can be transported from one place to a system depends on its configuration (e.g. relative positions of charged particles, problement of the design and perform	(relative position of the particles).	Computational Thinking		remain unchanged.	
as stored in fields (which mediate phenomenon, designed interactions between particles). This last concept includes This last concept includes (HS-PS3-1) Technology, and Applications of Science Influence of Science, Engineering, and Science Influence of Science, Engineering, and Technology on Societty Calculate the total energy of a system and justify the mathematical routines used in the calculation of technological systems by applying scientific Knowledge and energy of a system due to charges in position and practices to increase Influence of Science, Engineers continuously within the system whose sum is the total energy. Predict changes in the total energy of a system due to charges in position and practices to increase benefits while energy of a system. Mathematical expressions, which technical information component and the design and performance of a system depends on its configuration (e.g. relative positions of charged particles, system) in multiple formats a proposed process of a system depends on its compression of a spring) and how kinetic energy depends on mass and Speed, allow the concept of conservation of mathematically). (HS-PS2-	In some cases the relative	Create a computational			
Interactions between particles).device, process, or system.Technology, and Applications of Sciencekinetic energy of an object given the forces exerted on the object and theThis last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)Constructing Explanations and Designing Solutions effine a solution to a complex real-world that the total energy transfer or out of the system. (HS-PS3-1)Constructing Constructing Technology on Society and the Natural World a system is always equal to scientific knowledge, student-generated sources of evidence, prioritized considerations. (HSPS3-1)Technology, and Applications of Sciencekinetic energy of an object given the forces exerted on the object.PS3.B: Conservation of energy any system is always equal to or out of the system. (HS-PS3-1)Constructing problem, based on destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-4)Technology, and Applications of scientific knowledge, student-generated sources of evidence, prioritized considerations. (HSPS3-3)Technology, and the total energy of an object device, evidence, prioritized by applying scientific howledge and engineering design another and transferred between system. (HS-PS3-4)Technology, and the technical information (e.g. communicate scientific and the system component to protion and practices to increase by applying scientific a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on including orally, textually, and prosed process or system) in multiple formats d	position energy can be thought of	model or simulation of a	Connections to	Apply mathematical routines	
This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)(HS-PS3-1)Applications of Science Engineering, and Technology on Society and the Natural World and Energy Transfer complex real-world complex real-world problem, based on scientific knowledge, scientific knowledge, or out of the system. (HS-PS3-1)Applications of Science Engineering, and Technology on Society Calculate the total energy of and the Natural World mathematical routines used in the calculation of technological systems. by applying scientific knowledge and transported from one place to another and transferred between another and transferred between systems. (HS-PS3-1), (HS-PS3-4)Applications of Science Engineering, and Technology on Society Calculate the total energy or and the Natural World mathematical routines used in the calculation of technological systems. by applying scientific considerations. (HSPS3-3)Applications of Science Engineering, and Technology on Society Calculate the total energy or and the Natural World mathematical routines used in the calculation of technological systems by applying scientific considerations. (HSPS3-3)Applications of Science Science technological systems by applying scientific and frams or factors within the system.Mathematical expressions, which congurating (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofApplications of Science Scientific Knowledge Assumes and tradeoff consistency in Natural SpitemsMake predictions about the conservation of the displacement of the center of mass.<	as stored in fields (which mediate	phenomenon, designed	Engineering,	to determine the change in	
radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) Explanations and Designing Solutions PS3.B: Conservation of Energy Design, evaluate, and/or 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) that the total energy transferred into or out of the system. (HS-PS3-1) that the total energy transferred into or out of the system. (HS-PS3-1) that the total energy transferred into or out of the system. (HS-PS3-1) that the total energy transferred into or out of the system. (HS-PS3-1) transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4) Mathematical expressions, which technological systems is always equal to another and transferred between system due to echnical information (e.g. quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of mass and speed, allow the concept of conservation of mass and speed, allow the concept of conservation of mass and speed, allow the concept of conservation of mathematically). (HS-PS2-2) mass and speed, allow the concept of conservation of mathematically). (HS-PS2-2) mathematically). (HS-PS2-2)	interactions between particles).	device, process, or system.	Technology, and	kinetic energy of an object	
which energy stored in fields moves across space. (HS-PS3-2) PS3.B: Conservation of Energy Design, evaluate, and/or 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) fer energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) Mathematical expressions, which econfiguration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy denergy positions of charged particles, compression of a spring) and how kinetic energy denergy positions of charged particles, compression of a spring) and how kinetic energy denergy compression of a spring) and how kinetic energy denergy for conservation of conservation of conservation of the system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy denergy benchically, textually, and concept of conservation of concept of conservation of concept of conservation of conservation of the total energy of a system due to considerations. (HSPS3-3) Mathematical expressions, which configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy denergy bencess or compression of a spring) and how kinetic energy denergy bencess or compression of a spring) and how kinetic energy denergy bencess or compression of a spring) and how kinetic energy depends on including orally, graphically, textually, and conset conservation of conset conservation of	This last concept includes	(HS-PS3-1)	Applications of	given the forces exerted on	
moves across space. (HS-PS3-2) Explanations and Designing Solutions 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 or out of the system. (HS-PS3-1) of evidence, prioritized transported from one place to another and transferred between another and transferred between any systems. (HS-PS3-1). (HS-PS3-4) Information computer solution to a considerations. (HSPS3-3) Mathematical expressions, which technical information configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of expression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of conservation of the mathematically). (HS-PS2- the total energy technological systems of evelopment and the design and performance of mass and speed, allow the concept of conservation of	radiation, a phenomenon in		Science	the object and the	
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),(HS-PS3-4)Designing Solutions Design, evaluate, and/or and the Natural World molem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HSPS3-3)Technology on Society Calculate the total energy of a system single scientific howledge and energy of a system due to engineering design systems. (HS-PS3-1),(HS-PS3-4)Mathematical expressions, which technical information configuration (e.g. relative positions of charged particles, compression of a spring) and now kinetic energy depends on mass and speed, allow the concept of conservation ofDesigning Solutions Design, evaluate, and/or a system due to enside and tradeoff considerations. (HSPS3-3)Technology on Society Calculate the total energy of a system due to engineering design practices to increase benefits while decreasing costs and consiter and dradeef design and performance of a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and now kinetic energy depends on mass and speed, allow the concept of conservation ofDesigning Solutions refine a solution to a consisterationTechnological systems modify these technological systems by applying scientific tand tradeoff consisterationTechnological systems by applying scientific tand tradeoff consisterationTechnological s	which energy stored in fields	Constructing	Influence of Science,	displacement of the object.	
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 or out of the system. (HS-PS3-1) or out of the system. (HS-PS3-1)and the Natural World refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HSPS3-3)and the Natural World Modern civilization depends on major technological systems. Engineers continuously within the system whose sum is the total energy.Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)Obtaining, Evaluating, and Communicating and Communicating and Communicate scientific and risks. (HS-PS3-3)and the Natural World Modern civilization depends on major technological systems. by applying scientific practices to increase benefits while decreasing costs and Communicate scientific and risks. (HS-PS3-3)a system due to technological systems by applying scientific energy of a system due to changes in the total energy of a system when a component type of objects or frictional interactions within the system.Mathematical expressions, which technical information configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of mass and speed, allow the concept of conservation of matematically). (HS-PS2-and the Natural World Modern civilization depends on major technological system benefits while design and performance of a proposed process or system) in multi	moves across space. (HS-PS3-2)	Explanations and	Engineering, and		
and Energy Transfer Conservation of energy means that the total change of energy in any system is always equal to or out of the system. (HS-PS3-1)refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources or out of the system. (HS-PS3-1)Modern civilization depends on major technological systems. Engineers continuously modify these to or out of the system. (HS-PS3-1)mathematical routines used in the calculation of component types of energy within the system whose sum is the total energy.Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)Obtaining, Evaluating, and Communicating and Communicating and Communicate scientific and technical information (e.g. quantify how the stored energy in a system depends on its compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofModern civilization depends on major technological systems. knowledge and engineering design practices to increase benefits while decreasing costs and gromenticate scientific and triks. (HS-PS3-3)mathematical energy of a system due to changes in the total energy of a system when a component of an external force acts parallel or system) in multiple formats consistency in Natural system in multiple formats force acts parallel or system) in multiple formats consistency in Natural systems tickluing orally, graphically, textually, and concept of conservation ofModern civilization depends on major technological systems practices to increase benefits while decreasing costs and a proposed process or solut the process of a p				÷.	
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)complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HSPS3-3)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 component of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofcomplex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HSPS3-3)depends on major technological systems. by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and component to the process of development and the design and performance of a system depends on mass and speed, allow the concept of conservation ofcomplex real-world problem, based on student-generated sources of evidence, prioritized criteria, and tradeoff obtaining, Evaluating, and Communicating and Communicating about the process of development and the consistency in multiple formatsin the calculation of connections to Nature of Science Scientific of Science Scientific an Order and systemsin the calculation of connections to Nature of Science assumes the consistency in Natural antiparallel to the direction of the displacement of the consistency in Natural spatemsMathematical expression of a spring) and how kinetic energy d	PS3.B: Conservation of Energy	Design, evaluate, and/or	and the Natural World	a system and justify the	
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) destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4) Mathematical expressions, which configuration (e.g. relative positions of charged particles, compression of a spring) and maxs and speed, allow the concept of conservation of mass and speed, allow the concept of conservation of		refine a solution to a	Modern civilization	mathematical routines used	
any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HSPS3-3)Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and communicate scientific and transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and communicate scientific and risks. (HS-PS3-3)within the system whose sum is the total energy.Mathematical expressions, which technical information configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofscientific knowledge, student-generated sources of evidence, prioritized considerations. (HSPS3-3)Engineers continuously within the system whose sum is the total energy.Mathematical expressions, which technical information compression of a spring) and how kinetic energy depends on mass and speed, allow the 		-	depends on major	in the calculation of	
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),(HS-PS3-4) Mathematical expressions, which technical information communicate scientific and force acts parallel to the direction of positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of	that the total change of energy in	problem, based on	technological systems.	component types of energy	
or out of the system. (HS-PS3-1)of evidence, prioritized criteria, and tradeoff considerations. (HSPS3-3)technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and Communicate scientific and risks. (HS-PS3-3)Predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the systems.Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. repositions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofof evidence, prioritized tradeoff tradeoff Obtaining, Evaluating, and Communicating and Communicating and Communicate scientific and communicate scientific and technical information communicate scientific and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2- universe is a vast singlePredict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system.Mathematically.mathematically). (HS-PS2- universe is a vast single	any system is always equal to	scientific knowledge,	Engineers continuously	within the system whose	
Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)criteria, and tradeoff considerations. (HSPS3-3)by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and Communicate scientific and risks. (HS-PS3-3)Predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system.Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofand tradeoff considerations. (HSPS3-3)Make predictions about the consistency in Naturel of Science Scientific an Order and SystemsMake predictions about the consistency in Naturel antiparallel to the direction of the displacement of the graphically, textually, and mathematically). (HS-PS2- universe is a vast singlePredict changes in the total energy of a system of a system of the component of an external force acts parallel or consistency in Naturel		U U	•	sum is the total energy.	
Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)considerations. (HSPS3-3)knowledge and engineering design practices to increase benefits while decreasing costs and Communicate scientific and risks. (HS-PS3-3)energy of a system due to changes in position and speed of objects or frictional interactions within the system.Mathematical expressions, which technical information (e.g. quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofconsiderations. (HSPS3-3)Make predictions about the consistency in Natural Science assumes the universe is a vast singleenergy of a system due to changes in position and speed of objects or frictional interactions within the system.	or out of the system. (HS-PS3-1)		0,		
destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)Obtaining, Evaluating, and Communicating and Communicate scientific and Communicate scientific and technical information (e.g. quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofObtaining, Evaluating, and Communicating and Communicating and Communicate scientific and technical information (e.g. development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically). (HS-PS2-engineering design practices to increase benefits while decreasing costs and consistency in Natural Science assumes the universe is a vast singlechanges in position and speed of objects or frictional interactions within the system.Mathematical expressions, which technical information (e.g. quantify how the stored energy in a system depends on its compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofObtaining, Evaluating, and Communicate scientific design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-engineering design practices to increase benefits while decreasing costs and rest.changes in position and speed of objects or frictional interactions within the system.Make predictions about the consistency in Natural concept of conservation ofobjects or frictional mathematically). (HS-PS2- </td <td></td> <td></td> <td></td> <td>-</td> <td></td>				-	
transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of			•		
another and transferred between systems. (HS-PS3-1),(HS-PS3-4)and Communicating Information Communicate scientific and risks. (HS-PS3-3)interactions within the system.Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofand Communicating Information Communicate scientific and risks. (HS-PS3-3)interactions within the systemand Communicate scientific and communicate scientific and risks. (HS-PS3-3)Make predictions about the system.Mathematical expressions, which technical information (e.g. a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofand Communicating Information (including orally, graphically). (HS-PS2-benefits while decreasing costs and risks. (HS-PS3-3)mass and speed, allow the 			0 0 0	0	
systems. (HS-PS3-1),(HS-PS3-4) Information Communicate scientific and Mathematical expressions, which a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of			practices to increase	speed of objects or frictional	
Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofCommunicate scientific and risks. (HS-PS3-3)Make predictions about the connections to Nature of Science Scientific an Order andCommunicate scientific quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofCommunicate scientific and risks. (HS-PS3-3)Make predictions about the connections to Nature of Science Scientific a proposed process or system) in multiple formats (including orally, graphically, textually, and 				interactions within the	
Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation oftechnical information (e.g. technical information (e.g. development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and concept of conservation ofMake predictions about the changes in the mechanical energy of a system when a compression fa spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofMake predictions about the changes in the mechanical energy of a system when a composed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-Make predictions about the changes in the mechanical energy of a system when a component of an external force acts parallel or SystemsMake predictions about the of Science Scientific a proposed process or system) in multiple formats (including orally, mathematically). (HS-PS2-Make predictions about the changes in the mechanical energy of a system when a component of an external force acts parallel or the displacement of the center of mass.	systems. (HS-PS3-1),(HS-PS3-4)		•	system.	
quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofabout the process of development and the design and performance of a proposed process or system) in multiple formatsConnections to Nature of Science Scientific An Order and Systemschanges in the mechanical energy of a system when a component of an external force acts parallel or antiparallel to the direction of Systemscompression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofincluding orally, graphically, textually, and mathematically). (HS-PS2-Science assumes the universe is a vast singlechanges in the mechanical energy of a system when a component of an external force acts parallel or antiparallel to the direction of the displacement of the center of mass.					
a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of	-				
 configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and concept of conservation of Knowledge Assumes and proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2- Knowledge Assumes and operational proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2- 		-		Ū.	
positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofa proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-an Order and Consistency in Natural Systemsforce acts parallel or antiparallel to the direction of the displacement of the center of mass.		•			
compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation ofsystem) in multiple formats including orally, graphically, textually, and mathematically). (HS-PS2-Consistency in Natural Systemsantiparallel to the direction of the displacement of the center of mass.		- · ·	-	•	
how kinetic energy depends on mass and speed, allow the concept of conservation of(including orally, graphically, textually, and mathematically). (HS-PS2- universe is a vast singlethe displacement of the center of mass.	.				
mass and speed, allow the concept of conservation ofgraphically, textually, and mathematically). (HS-PS2- universe is a vast singlecenter of mass.			-	-	
concept of conservation of mathematically). (HS-PS2- universe is a vast single			-		
	•	.		center of mass.	
energy to be used to predict and 6) system in which basic	•	• / 、	•		
	energy to be used to predict and	6)	system in which basic		

describe system behavior. (HS-	laws are consistent.	Design an experiment to test	
PS3-1)		conservation concepts.	
F 33-1)	(13-33-1)	conservation concepts.	
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),(HS-PS3-4)			
ETS1 A. Defining and			
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-			
PS3-3)			

Resources: Essential Materials, Supplementary Materials, Links to Best Practices	Instructional Adjustments:
	Instructional Adjustments: Modifications will be made to accommodate IEP mandates for classified students

TARGETED STATE STANDARDS: NGSS

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. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

NJSLS/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). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4) P.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4) HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-4),(HS-PS2-5) HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4) HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4) HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2) HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities: graph equations on coordinate axes with

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)

HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason CRP8. Utilize critical thinking to make sense of problems and persevere in solving them CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

Waves are a repetitive disturbance which translate energy without translating matter. Transverse waves oscillate perpendicular to the direction of motion and longitudinal waves oscillate parallel to the direction of motion. Waves have an amplitude, period, frequency, wavelength, and wave velocity. The wave source determines the frequency and amplitude. The medium determines the wave speed. Wavelength depends on frequency and velocity.

Mechanical Waves wave motion mechanical waves wave characteristics amplitude wavelength frequency period wave speed

Sound vs. Light Waves sound is a longitudinal wave light is an electromagnetic wave amplitude is loudness for sound $\lambda = \frac{v}{f}$

amplitude is brightness/intensity for light frequency is pitch for sound frequency is color for light

ESSENTIAL QUESTIONS:

How can you hear someone on a "can phone"? How do noise canceling headphones work? How are sound waves and light waves different?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?) Quarterly Exam Tests and quizzes Laboratory activities and reports

Concepts	Skills	Progress Indicators	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
NJSLS/HS-PS4-1: Use mathematical	Analyzing and Interpreting		Use appropriate classroom	
representations to support a claim		Different patterns may	,	Exit tickets
regarding relationships among the	, ,		textbook resources (i.e.	Laboratory activities
frequency, wavelength, and speed of	technologies, and/or models		,	Classwork
waves traveling in various media.		system is studied and	tools/instruments/software)	Homework
	,	can provide evidence for		
				<u>Summative</u>
PS3.B: Conservation of Energy and		•	and laboratory activities,	Assessments:
Energy Transfer	determine an optimal design	PS2-4)	and problem solving:	Tests
Mathematical expressions, which	solution. (HS-PS2-1)			Quizzes
quantify how the stored energy in a			Use a visual representation	
system depends on its configuration	•	•	to construct an explanation	
(e.g. relative positions of charged				Quarterly exam
particles, compression of a spring) and			transverse and longitudinal	
how kinetic energy depends on mass	1		waves by focusing on the	
and speed, allow the concept of		•	vibration that generates the	
conservation of energy to be used to		causes and effects. (HS-	wave.	
-	2),(HS-PS2-4)	PS2- 1),(HS-PS2-5)		
(HS-PS3-1)			Describe representations	
	Connections to Nature of	•••	of transverse and	
			longitudinal waves.	
		created or destroyed—		
			Describe sound in terms of	
	-	•	transfer of energy and	
		p / /	momentum in a medium	
	-		and relate the concepts to	
	explanations in science. (HS-PS2- 1),(HS-PS2-4)	systems. (HS-PS3-2)	everyday examples.	

		· · · · · · · · · · · · · · · · · · ·	
	• •	Use graphical	
		representation of a periodic	
descriptions of the	Models can be used to	mechanical wave to	
relationships among	predict the behavior of a	determine the amplitude of	
observable phenomena.	system, but these	the wave.	
(HS-PS2-1),(HS-PS2-4)	predictions have limited		
	precision and reliability	Use a graphical	
	due to the assumptions	representation of a periodic	
Developing and Using	and approximations	mechanical	
Models	inherent in models.	wave (position versus time)	
Develop and use a model	(HSPS3-1)	to determine the period	
based on evidence to		and frequency of the wave	
illustrate the relationships		and describe how a	
between systems or		change in	
between components of a		the frequency would modify	
system. (HS-PS3-		features of the	
2),(HSPS3-5)		representation.	
		Use a visual representation	
		of a periodic mechanical	
		wave to determine the	
		wavelength of the wave	
		Explain and/or predict	
		qualitatively how the	
		energy carried by a sound	
		wave relates to the	
		amplitude of the wave	
		and/or apply this concept	
		to a real-world example.	

Resources: Essential Materials, Supplementary Materials, Links to Best Practices	Instructional Adjustments:
Resources: Essential Materials, Supplementary Materials, Links to Best Practices Textbook: Conceptual Physics Custom Edition (Hewitt) Phet online simulations (https://phet.colorado.edu/en/simulations/category/physics) Gizmos (https://gizmos.explorelearning.com/) PAER Rutgers (http://www.islephysics.net/pt3/) The Physics Classroom (http://www.physicsclassroom.com/) Pivot Interactives (https://www.pivotinteractives.com/) Physics textbooks Experimental equipment pertinent to lab activities	Instructional Adjustments: Modifications will be made to accommodate IEP mandates for classified students

Unit 8: Electrostatics

TARGETED STATE STANDARDS: NGSS

NJSLS/HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the electrostatic forces between objects.

[Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of electric fields.]

[Assessment Boundary: Assessment is limited to systems with two objects.]

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

[Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.]

[Assessment Boundary: Assessment is limited to systems containing two objects.]

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-4),(HS-PS2-5) HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason CRP8. Utilize critical thinking to make sense of problems and persevere in solving them CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

Two different electric charges, which are conventionally referred to as positive charge and negative charge, determine how charged objects interact. Charge is conserved. Electric forces are exerted by electric fields created by changes

$$F_e = k \frac{Q_{source} q_{system}}{\Delta r^2} \qquad k = 9x 10^9 Nm^2 / C^2$$

The particles which make up atoms are neutrons with no charge and positive protons in the nucleus, and negative electrons outside the central nucleus.

 $|q_e| = 1.6 x 10^{-19} C \qquad \qquad m_p = 1.673 x 10^{-27} \text{ kg} \qquad \qquad m_n = 1.675 x 10^{-27} \text{ kg}$

 $m_e = 9.11 \ x \ 10^{-31} \ kg \qquad \qquad 1 \ u = 1.66 \ x \ 10^{-27} \ kg$

An object can either allow the flow of electrons (conductor), not allow the flow of electrons (insulator), or somewhat allow the flow of electrons (semiconductor).

ESSENTIAL QUESTIONS:

What is the fundamental force responsible for most everyday interactions? What are the parallels between gravitational force and electrostatic force? **UNIT ASSESSMENTt:** (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

Quarterly Exam

Tests and quizzes

Laboratory activities and reports

			Activities/Strategies	
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
PS1.A: Structure and	Analyzing and	Patterns	Use appropriate classroom	Formative Assessments:
Properties of Matter	Interpreting Data	Different patterns may	materials, online and	Exit tickets
The structure and interactions of	Analyze data using tools,	be observed at each of	textbook resources (i.e.	Laboratory activities
matter at the bulk scale are	technologies, and/or	the scales at which a	simulations, measurement	Classwork
determined by electrical forces	models (e.g.,	system is studied and	tools/instruments/software)	Homework
within and between atoms.	computational,	can provide evidence	for presentation,	
(secondary to HS-PS2-6)	mathematical) in order to	for causality in	demonstration, classroom	Summative Assessments:
	make valid and reliable	explanations of	and laboratory activities, and	Tests
PS2.B: Types of Interactions	scientific claims or	phenomena. (HS-PS2-	problem solving.	Quizzes
Coulomb's law provides the	determine an optimal	4)		Laboratory reports
mathematical model to describe	design solution. (HS-PS2-1)		Make predictions, using the	Project
and predict the effects of		Cause and Effect	conservation of electric	Quarterly exam
electrostatic force between	Using Mathematics and	Empirical evidence is	charge, about the sign and	
distant objects. (HS-PS2-4)	Computational Thinking	required to differentiate	relative quantity of net	
	Use mathematical	between cause and	charge of objects or systems	
Forces at a distance are	representations of	correlation and make	after various charging	
explained by fields (gravitational,	phenomena to describe	claims about specific	processes, including	
electric, and magnetic)	explanations. (HS-PS2-	causes and effects.	conservation of charge in	
permeating space that can	2),(HS-PS2-4)	(HS-PS2- 1),(HS-PS2-	simple circuits.	
transfer energy through space.		5)		
(HS-PS2-4),(HS-PS2-5)	Connections to Nature of		Use Coulomb's law	
	Science	Energy and Matter	qualitatively and	
Attraction and repulsion between	Science Models, Laws,	Energy cannot be	quantitatively to make	
electric charges at the atomic	Mechanisms, and	created or destroyed—	predictions about the	
scale explain the structure,	Theories Explain Natural	only moves between	interaction between two	
properties, and transformations	Phenomena	one place and another	electric point charges.	
of matter, as well as the contact	Theories and laws provide	place, between objects		
forces between material objects.	explanations in science.	and/or fields, or		

(HS-PS2-6),(secondary to HS-	(HS-PS2- 1),(HS-PS2-4)	between systems. (HS-	Connect the concepts of	
PS1-1),(secondary to HS-PS1-3)		PS3-2)	gravitational force and	
	Laws are statements or		electric force to compare	
PS3.A: Definitions of Energy	descriptions of the		similarities and differences	
"Electrical energy" may mean	relationships among		between the forces.	
energy stored in a battery or	observable phenomena.			
energy transmitted by electric	(HS-PS2-1),(HS-PS2-4)			
currents. (secondary to HS-PS2- 5)				
	Developing and Using			
PS3.C: Relationship Between	Models			
Energy and Forces	Develop and use a model			
When two objects interacting	based on evidence to			
through a field change relative	illustrate the relationships			
position, the energy stored in the	-			
field is changed. (HS-PS3-5)	between components of a			
	system. (HS-PS3-			
PS3.B: Conservation of Energy				
and Energy Transfer				
Mathematical expressions, which				
quantify how the stored energy in				
a system depends on its				
configuration (e.g. relative				
positions of charged particles,				
compression of a spring) and				
how kinetic energy depends on				
mass and speed, allow the				
concept of conservation of				
energy to be used to predict and				
describe system behavior. (HS-				
PS3-1)				
PS3.C: Relationship Between				
Energy and Forces				
When two objects interacting				

Unit 9: DC Circuits

TARGETED STANDARDS:

NGSS

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.

[Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.]

[Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5),(HS-PS2-5),(HS-PS2-4),(HS-PS2-5

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2- 4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason CRP8. Utilize critical thinking to make sense of problems and persevere in solving them CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

Electric circuits are conductors connecting a voltage source (like a battery or generator) to a resistor which uses that voltage to convert electric energy to another form.

The amount of charge which flows over time is called electric current

$$I = \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}$$

Current in a circuit is dependent on the voltage provided to the circuit's resistors

$$I = \frac{\Delta V}{R}.$$

Voltage used by resistors is dependent on the current and resistance

 $I = \Delta V/R.$

Resistance of an object is dependent on the shape and size of the object, along with the resistivity the material it is made from.

Multiple resistors can be simplified to a single equivalent resistance.

$$R_{series} = \sum \qquad R \qquad \frac{1}{R_{parallel}} = \sum \qquad \frac{1}{R}$$

Due to conservation of charge, all currents going into a junction must be the same as all currents leaving a junction.

Due to conservation of energy, the sum of all voltages in any loop is zero.

ESSENTIAL QUESTIONS:

Why does a smartphone charge faster when it isn't being used, but slow when it is? How do the outlets in a house work? How can we use electrical energy?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

Quarterly Exam

Tests and quizzes

Laboratory activities and reports

			Activities/Strategies	
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
PS3.A: Definitions of Energy	Using Mathematics and		Use appropriate classroom	Formative Assessments:
Energy is a quantitative	Computational Thinking		materials, online and	Exit tickets
property of a system that	Create a computational		textbook resources (i.e.	Laboratory activities
depends on the motion and	model or simulation of a	Systems and System	simulations, measurement	Classwork
interactions of matter and	phenomenon, designed	Models	tools/instruments/software)	Homework
radiation within that system.	device, process, or system.	Models can be used to	for presentation,	
That there is a single quantity	(HS-PS3-1)	predict the behavior of a	demonstration, classroom	Summative Assessments:
called energy is due to the fact		system, but these	and laboratory activities,	Tests
that a system's total energy is	Obtaining, Evaluating,	predictions have limited	and problem solving.	Quizzes
conserved, even as, within the	and Communicating	precision and reliability		Laboratory reports
system, energy is continually	Information	due to the assumptions	Create a simple circuit and	Project
transferred from one object to	Communicate scientific and	and approximations	determine quantities of	Quarterly exam
another and between its	technical information (e.g.	inherent in models.	voltage, resistance, current	
various possible forms.	about the process of	(HSPS3-1)	and electrical power.	
(HSPS3-1),(HS-PS3-2)	development and the			
	design and performance of		Conduct and experiment to	
At the macroscopic scale,	a proposed process or		devise Ohm's Law.	
energy manifests itself in	system) in multiple formats			
multiple ways, such as in	(including orally,		Create a series circuit and	
motion, sound, light, and	graphically, textually, and		a parallel circuit and	
thermal energy. (HSPS3-2)	mathematically). (HS-PS2-		determine quantities of	
(HS-PS3-3)	6)		voltage, resistance, current	
			and electrical power.	
These relationships are better	Connections to Nature of			
understood at the microscopic	Science			
scale, at which all of the	Science Models, Laws,			
different manifestations of	Mechanisms, and			
energy can be modeled as a	Theories Explain Natural			

combination of energy	Phenomena		
associated with the motion of	Theories and laws provide		
particles and energy associated	explanations in science.		
with the configuration (relative	(HS-PS2- 1),(HS-PS2-4)		
position of the particles). In			
some cases the relative	Laws are statements or		
position energy can be thought	descriptions of the		
of as stored in fields (which	relationships among		
mediate interactions between	observable phenomena.		
particles). This last concept	(HS-PS2-1),(HS-PS2-4)		
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),(HS-PS3-4)			
1,(13-13-4)			
Mathematical expressions,			
which quantify how the stored			
energy in a system depends on			
its configuration (e.g. relative			
ite seringeration (e.g. relative			

positions of charged particles,				
compression of a spring) and				
how kinetic energy depends on				
mass and speed, allow the				
concept of conservation of				
energy to be used to predict				
and describe system behavior.				
(HS-PS3-1)				
The availability of energy limits				
what can occur in any system.				
(HS-PS3-1)				
PS3.C: Relationship Between				
Energy and Forces				
When two objects interacting				
through a field change relative				
position, the energy stored in				
the field is changed. (HS-PS3-				
5)				
Resources: Essential Material	s, Supplementary Material	ls, Links to Best	Instructional Adjustments	:
Practices				
			Modifications will be made t	o accommodate IEP mandates for
Textbook: Conceptual Physics Custom Edition (Hewitt)		classified students		
Phet online simulations (<u>https://phet.colorado.edu/en/simulations/category/physics</u>)				
Gizmos (<u>https://gizmos.explorelearning.com/</u>)				
PAER Rutgers (<u>http://www.islephysics.net/pt3/</u>) The Physics Classroom (<u>http://www.physicsclassroom.com/</u>)				
Pivot Interactives (<u>https://www.pivotinteractives.com/</u>)				
Physics textbooks				
Experimental equipment pertinent to lab activities				

Unit 10: Electromagnetism

TARGETED STANDARDS: NGSS

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

[Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.]

NJSLS/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.

[Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.]

[Assessment Boundary: Assessment is limited to systems containing two objects.]

ELA/ Literacy

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-4),(HS-PS2-5) HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4)

HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2- 4)

HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)

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. (HS-PS2-1),(HS-PS2-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2) HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason CRP8. Utilize critical thinking to make sense of problems and persevere in solving them CRP11. Use technology to enhance productivity.

UNIT OBJECTIVES/ENDURING UNDERSTANDINGS: (Students will be able to...)

Magnetic properties.

Magnetic fields are created by changing electric fields and exert magnetic force on changing electric fields.

Similarly, a changing magnetic flux over time creates a voltage.

ESSENTIAL QUESTIONS:

What is the relationship between electricity and magnetism?

UNIT ASSESSMENT: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?) Quarterly Exam Tests and quizzes Laboratory activities and reports

Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
 PS2.B: Types of Interactions Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5) PS3.C: Relationship Between Energy and Forces When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5) 	collaboratively to produce data to serve as the basis for evidence, and in the	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2- 1),(HS-PS2- 5)	textbook resources (i.e. simulations, measurement tools/instruments/software) for presentation, demonstration, classroom and laboratory activities, and problem solving.	Exit tickets Laboratory activities Classwork Homework Summative Assessments: Tests Quizzes Laboratory reports Project Quarterly exam

Using Mathematics and Computational Thinking Use mathematical representations of phenomena to describe explanations. (HS-PS2- 2),(HS-PS2-4)		
Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2- 6) Developing and Using Models Develop and use a model based on evidence to illustrate the relationships botwoon systems or		
between systems or between components of a system. (HS-PS3- 2),(HSPS3-5)		

Resources: Essential Materials, Supplementary Materials, Links to Best Practices	s Instructional Adjustments:
Textbook: <i>Conceptual Physics Custom Edition</i> (Hewitt) Phet online simulations (<u>https://phet.colorado.edu/en/simulations/category/physics</u>) Gizmos (<u>https://gizmos.explorelearning.com/</u>) PAER Rutgers (<u>http://www.islephysics.net/pt3/</u>) The Physics Classroom (<u>http://www.physicsclassroom.com/</u>) Pivot Interactives (<u>https://www.pivotinteractives.com/</u>) Physics textbooks Experimental equipment pertinent to lab activities	Modifications will be made to accommodate IEP mandates for classified students