ROBBINSVILLE PUBLIC SCHOOLS

OFFICE OF CURRICULUM AND INSTRUCTION

SCIENCE

PHYSICS

Board of Education

Curriculum Writing Committee

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BOARD OF EDUCATION INITIAL ADOPTION DATE:

Course Philosophy

Every individual develops intellectually by applying the scientific method through experimentation. Students will apply their algebra-based math skills to model phenomena seen in everyday life and create a scientific foundation to be applied in further science courses. Utilizing these skills to approach the physical phenomena described by Newton's Laws will lend as a stepping stone for the more abstract concepts approached in chemistry and later in biology. It is the desire of the science department to create not only a more scientifically literate community, but to generate excitement and interest for their students and produce more positive attitudes towards science. Through studying physics, students will develop an appreciation for the devices and activities that make up the world they live in.

Course Description

Physics is a laboratory-based science course covering the following topics: metric conversion, kinematics, dynamics, gravity, energy, and wave behavior. Students will approach these topics through the lens of inquiry by utilizing hands-on experiences and mathematical representations to develop an understanding of physics concepts. Students will be required to utilize all levels of Bloom's Taxonomy to express mastery of the subject and a foundational knowledge of science to be used in further science courses.

Core and Supplemental Instructional Materials

Core Materials	Supplemental Materials
• Conceptual/ CP - Hewitt Conceptual Physics textbook and supporting resources • Honors - Glencoe Physics: Principles and Problems	• NJCTL materials • PHET interactive simulations • physicsclassroom.com Concept Builders • Positive Physics Online materials • Student-designed lab investigations • Teacher-created POGILS

Social Emotional Learning Connections
Below are the five core SEL Competencies as outlined by CASEL, and examples of how each may be addressed within this curriculum
Self-awareness: The ability to accurately recognize one's emotions and thoughts and their influence on behavior. This includes accurately assessing one's strengths and limitations and possessing a well-grounded sense of confidence and optimism. **Example 1:** Students explore how to utilize their strengths in the setting of a collaborative group environment to generate solutions. **Example 2:** Students explore their limitations through challenging problems that may require resilience in the face of a challenge.
Self-management: The ability to regulate one's emotions, thoughts, and behaviors effectively in different situations. This includes managing stress, controlling impulses, motivating oneself, and setting and working toward achieving personal and academic goals. **Example 1:** Self-motivation is fundamental to the processes of problem-solving and time-management required by physics. **Example 2:** Students practice individual strategies to manage the stress involved in problem solving through inquiry.
Social awareness: The ability to take the perspective of and empathize with others from diverse backgrounds and cultures, to understand social and ethical norms for behavior, and to recognize family, school, and community resources and supports. **Example 1:** Students frequently collaborate with peers and consider the thoughts and feelings of others while observing different perspectives. **Example 2:** Students build self-confidence and social awareness through class presentations and the study of scientists that contributed to physics.
Relationship skills: The ability to establish and maintain healthy and rewarding relationships with diverse individuals and groups. This includes communicating clearly, listening actively, cooperating, resisting inappropriate social pressure, negotiating conflict constructively, and seeking and offering help when needed. **Example 1:** Students must practice communication skills while working cooperatively with peers on various problems in the lab environment. **Example 2:** Students must practice group management skills to create a productive lab environment.
Responsible decision-making: The ability to make constructive and respectful choices about personal behavior and social interactions based on consideration of ethical standards, safety concerns, social norms, the realistic evaluation of consequences of various actions, and the well-being of self and others.

Example 1: Students must practice safe behavior in the lab environment.
Example 2: Students consider the consequences of various decisions while problem solving and researching as they relate to academic integrity and personal ethics.

Integration of 21st Century Themes and Skills

NJSLS-CLKS 9.4: Life Literacies and Key Skills	
Creativity and Innovation	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 2, 3
Critical Thinking and Problem Solving	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 1, 3, 5
Digital Citizenship	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 4
Global and Cultural Awareness	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 4
Information and Media Literacy	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 3, 4
Technology Literacy	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 2, 4, 5

Robbinsville Ready 21st Century Skill Integration

The following skills will be embedded throughout the curriculum and instruction of this course.

Collaborative Team Member: Robbinsville students will learn more by working together than in isolation. As educational theorist Lev Vygotsky advocated, learning is a social process. Many workplaces today encourage employees to work in teams to solicit diverse perspectives, brainstorm new ideas and/or products, and solve problems. Further, collaboration fosters interpersonal relationships, self-management skills, cooperation, and a sense of collective responsibility. Collaborative team members are able to work with diverse groups of people who hold a variety of perspectives.

Effective Communicator: Robbinsville students must be able to clearly articulate their ideas orally, in writing, and across various media in order to successfully connect to the world around them. As the world becomes increasingly globalized, communication is more than just sharing one's ideas. Effective communicators are able to communicate their convictions, actively listen and analyze others' work to identify perspective and/or potential bias.

Emotionally Intelligent Learner: Robbinsville students who are emotionally intelligent learn to be empathetic, demonstrate integrity and ethical behavior, are kind, are self-aware, willing to change, and practice self-care. They are better able to cope with the demands of the 21st century digital society and workplace because they are reliable, responsible, form stable and healthy relationships, and seek to grow personally and professionally. Emotionally intelligent people are able to manage their emotions, work effectively on teams and are leaders who can grow and help to develop others.

Informed and Involved Citizen: Robbinsville students need to be digital citizens who are civically and globally aware. The concept of what it means to be "literate" has evolved along with 21st century technological and cultural shifts. Our progressive vision of literacy entails having our students explore real world problems in the classroom. Informed and involved citizens are able to safely and accurately communicate with people all around the world and are financially, environmentally and informationally literate.

Innovative Thinker: Robbinsville students must encompass innovative thinking skills in order to be successful lifelong learners in the 21st century world. As stated by Karl Fisch and Scott McLeod in the short film Shift Happens, "We are currently preparing students for jobs that don't yet exist . . . using technologies that haven't been invented . . . in order to solve problems we don't even know are problems yet." Innovative thinkers are able to think analytically, solve problems critically, creatively engage in curiosity and tinkering, and demonstrate originality.

Resilient and Self-Directed Learner: Robbinsville students need to take risks and ultimately make independent and informed decisions in an ever-changing world. Author of Life, the Truth, and Being Free, Steve Maraboli stated, “Life doesn’t get easier or more forgiving, we get stronger and more resilient.” Self-directed scholars of the 21st century are able to set goals, initiate resolutions by seeking creative approaches, and adjust their thinking in light of difficult situations. Resilient students are able to take risks without fear of failure and overcome setbacks by utilizing experiences to confront new challenges. Resilient and self directed scholars will consistently embrace opportunities to initiate solutions and overcome obstacles.

Career Awareness and Planning Standards 9.2	
9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.	**Example:** Students develop general science skills and physics-specific knowledge to be used for entrance requirements for both college and career opportunities.
9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.	**Example:** Students are exposed throughout the course to available opportunities in the field of science that are accessible through higher education such as industry and research positions.
9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.	**Example:** Students will decide whether their postsecondary plans involve the STEM field and what steps may be necessary to effectively apply for such programs.

Robbinsville Public Schools
Scope, Sequence, Pacing and Assessment

Physics

Unit Title	Unit Understandings and Goals	Recommended Duration/ Pacing	Assessments
Unit 1 - About Science	- Scientists frequently utilize the metric system and converting between metric units is fundamental. - Graphs are used as mathematical representations of data sets. - The scientific method allows us to determine how variables affect other variables through experimentation.	2-3 Weeks (September)	Formative · Do now feedback · Exit ticket feedback · Formative worksheets · Teacher and peer feedback
			Summative · Dimensional Analysis Test · Teacher feedback · Project rubric/Presentation
			Common Benchmark Assessments (mid/end of course) · Course final exam
			Alternative Assessments (projects, etc when appropriate) · CER lab report · Full lab report · Project rubric
Unit 2 - Linear Motion and Newton's Laws	- Predicting the motion of objects experiencing uniform acceleration in 1 Dimension. - The vector sum of forces acting on an object with a certain mass will produce a predictable acceleration. - Objects with mass resist changes in motion. - All forces exist as force pairs. - Objects in free fall accelerate uniformly due to gravity.	8-9 Weeks (October - December)	Formative · Do now feedback · Exit ticket feedback · Formative worksheets · Teacher and peer feedback
			Summative · Linear Motion Test · Linear Motion Concept Map · Newton's Laws Applications Test · Free Fall Test
			Common Benchmark Assessments (mid/end of course) · Course final exam

			Alternative Assessments (projects, etc when appropriate) · CER lab report · Full lab report · Project rubric
Unit 3 - Rotation and Gravity	- Objects in uniform circular motion must be experiencing a net centripetal force that causes them to turn. - Newton describes that all objects with mass create a gravitational field and attract other objects with mass. - Einstein describes gravity as a bending of spacetime.	5-6 Weeks (December - January)	Formative · Do now feedback · Exit ticket feedback · Formative worksheets · Teacher and peer feedback
			Summative · Circular Motion and Centripetal Forces Test · Gravitation Test · Planetary Brochure Project
			Common Benchmark Assessments (mid/end of course) · Course final exam
			Alternative Assessments (projects, etc when appropriate) · CER lab report · Full lab report · Project rubric
Unit 4 - Conservation Laws	- Newton's Second Law can be described as forces changing the momentum of an object. - Newton's Third Law implies that momentum must be conserved in isolated systems. - Energy conservation can be used to describe the conversion of energy between different forms.	8-9 Weeks (February - April)	Formative · Do now feedback · Exit ticket feedback · Formative worksheets · Teacher and peer feedback
			Summative · Momentum and Impulse Test · Phone Case Project · Energy, Work, and Power Test · Rube Goldberg Project · Alternative Energy Sources Project
			Common Benchmark Assessments (mid/end of course) · Course final exam
			Alternative Assessments (projects, etc when appropriate) · CER lab report · Full lab report · Project rubric
Unit 5 - Wave Behavior	- Waves transfer energy through different mechanisms based on their wave type - Wavelength and frequency are inversely proportional; analyzing them determines the type of sound or light wave and its	3-4 Weeks (May - June)	Formative · Do now feedback · Exit ticket feedback · Formative worksheets · Teacher and peer feedback

	implications for humans and ability to explain natural phenomena - Light is a phenomenon that can be explained both as a particle and a wave.		Summative · Waves and Resonance Test · Teacher feedback · Project rubric/Presentation
			Common Benchmark Assessments (mid/end of course) · Course final exam
			Alternative Assessments (projects, etc when appropriate) · CER lab report · Full lab report · Project rubric

Unit #: 1 - About Science

Enduring Understandings:	**Essential Questions:**
• In any laboratory design, claims are investigated, evidence is analyzed & interpreted, and reasoning is data- & observation-driven • Unit conversion, both standard & metric, is vital in terms of a common scientific language and global perspective	• Should the entire world use one, universal system of measurement? • How can I design the best possible device to build a paper bridge within the given design / time constraints & parameters? • How can questions be framed / modeling occur to drive a solid laboratory design?

Interdisciplinary Connections

MP.2 - Reason abstractly and quantitatively.
Ex: Students will need to utilize numerical and qualitative data to design a solution to a challenge

MP.4 - Model with mathematics.
Ex: Students will utilize graphs and data sets to make predictions and affirm hypotheses.

SL.9-10.1.B Collaborate with peers to set rules for discussions (e.g. informal consensus, taking votes on key issues, presentation of alternate views); develop clear goals and assessment criteria (e.g. student developed rubric) and assign individual roles as needed.
Ex: Students will be solving design challenges in group lab settings and will need to collaborate and reach a consensus with peers to succeed.

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
HS-ETS1-1 9.4.12.CT.2:	What is the value of knowing the metric system and conversion? Why did the Mars Climate Orbiter crash? How can we use the CER framework to describe the results of an experiment?	Analyze the pros and cons of both English and metric systems while debating the hypothetical implementation of one universal measurement system worldwide Accurately convert both metric & standard units (Ladder Method & Dimensional Analysis), and apply conversions to real world scenarios (ie., cosmetic & toiletry products, recipes, etc.) Design & model multiple ways of experimental design, data collection & organization, and experimental design revision Construct & effectively communicate evidence-based claims	Pasta and marshmallow tower competition ice breaker Paper bridge building design challenge: What was successful? What failed? How would you redesign? CER introduction: Students given example data to create a report Metric conversion by moving the decimal Dimensional analysis through ladder method	Spaghetti and mini marshmallows Printer paper, textbooks, mass set Sample data sets, spreadsheet program. Physics Classroom concept builder: https://www.physicsclassroom.com/Concept-Builders/Measurement-and-Units/Metric-Con	Daily Do Nows Teacher and peer feedback Exit Tickets Individual activity guided worksheets/POGILs Lab group CER reports Unit summative test

				versions/Concept-Builder	Project rubrics

Unit #: 2 - Linear Motion and Newton's Laws

Enduring Understandings:	**Essential Questions:**
● Speed, velocity, and acceleration are different but related quantities that depend on the motion and position of an object ● Motion can be represented in a variety of data formats (graphs, observations, etc.), and can be used to describe and predict the future motion of an object. ● Students can use their motion data to: o Interpret given motion data to predict the behavior of moving objects o Generate, analyze, and express self-generated motion data o Develop written explanations to describe the motion of objects o Distinguish between objects moving at constant velocity (zero acceleration) and changing velocities (acceleration) ● Students will be able to analyze and categorize real world scenarios according to Newton's 3 Laws of motion, both conceptually and mathematically	● Why do I feel like I'm being tossed forward when a car brakes? ● Why do I feel like I'm being pinned back when a roller coaster starts? ● How do headrests in cars help to protect passengers from neck injuries if their car is rear-ended? ● Why is it important to wear your seatbelt in a car? ● Why is it more difficult to push an object across a bumpy surface, than across ice? ● How does a car's velocity relate to the distance it needs to stop? ● Why do dull knives not work as well? ● Why do high heels sink into mud, but sneakers aren't as likely to?

Interdisciplinary Connections

HSA-CED.A.1 - Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
Ex: Students will be utilizing mathematical representations of phenomena and will need to utilize algebra skills to make qualitative predictions.

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.
Ex: Kinematics and the motion of objects are expressed through graphs and students will utilize spreadsheets, among other resources, to create and analyze graphs that represent the motion of objects.

Guiding / Topical Questions with Specific Standards	Content, Themes, Concepts, and Skills	Teaching Strategies	Instructional Resources and Materials	Assessment Strategies

HS-PS2-1 9.4.12.CI.1 9.4.12.TL.2	What does it mean to accelerate? How do forces cause objects to move? How can the motion of objects be modeled? How can forces acting on objects be represented? How can spreadsheets be utilized to organize data and create graphs?	Given a graph of position or velocity as a function of time, recognize in what time intervals the position, velocity and acceleration of an object are positive, negative, or zero and sketch a graph of each quantity as a function of time. Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. Understand and apply the relationship between the net force exerted on an object, its inertial mass, and its acceleration to a variety of situations. 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.	Constant Velocity Lab: Creating a graph to represent constant velocity by measuring the distance between dropped objects. Running Teacher Lab: Students with timers are spaced at set intervals, time is taken as the teacher runs past while speeding up, slowing down, constant pace, etc. Newton's First Law Demos: nickels and knife, snap the card, tablecloth, dinosaur on cart. Free Body Diagram Modelling: Students are shown different objects and are tasked to create a free body diagram for each. Apparent Weight Lab: Students utilize a spring scale, a mass, and their phone camera to see how the scale reading changes as the weight is pulled up/dropped down. Friction Lab: Students use the digital force gauge to read the force of friction as they pull a weight OR students tilt a surface until the object on top begins to slide. Dive Coaster project: students model the motion of roller coasters that drop at 90° to model free fall.	PHET Moving Man: https://phet.colorado.edu/en/simulation/moving-man Newton's Laws Concept Builders https://www.physicsclassroom.com/Concept-Builders/Newtons-Laws PASCO SparkVue with motion sensors/force sensors Dive Coaster Example: https://www.youtube.com/watch?v=zcTDD0JR0SA PearDeck interactive lectures	Daily Do Nows Teacher and peer feedback Exit Tickets Individual activity guided worksheets/POGILs Lab group CER reports Unit summative test Project rubrics

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Unit #: 3 - Rotation and Gravity

Enduring Understandings:	**Essential Questions:**
● Centripetal forces and their corresponding accelerations are directed inward, and cause circular motion. There are many sources of centripetal forces, including friction and gravity. ● The force of gravity is directly proportional to the product of the masses involved, and inversely proportional to the distance squared between their centers of gravity ● An object will remain balanced if its center of gravity is aligned with its area of support (especially if its center of gravity is beneath its area of support). If the center of gravity is not aligned with the area of support, the object will experience and effect of rotation called torque, and will topple ● Astronauts in the International Space Station still experience ~90% earth's gravity; they simply lack a support force as they are projectiles circling earth with a large enough tangential velocity to fall about earth, not into it.	● Why am I stuck on earth but astronauts are 'weightless' in space? ● Why do I feel like there is a force tossing me outward when I make a turn? ● Why is it easier to balance in certain scenarios? ● Why do things orbit? (satellites orbit earth, planets orbit stars, etc.) ● How do space agencies minimize fuel usage on missions and maximize acceleration due to gravity? ● How is our understanding of the universe constantly changing?

Interdisciplinary Connections

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.
Ex: Students will create a presentation centered around the experience of gravity on an object of their choice in the Solar System.

MP.4 Model with mathematics
Ex: Students will utilize simulations and graphs to mathematically model the relationship between the strength of gravity, distance between objects, and mass.

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
HS-PS2-1 HS-PS2-4 9.4.12.CI.1	How can Newton's Second Law be applied to an object moving in a circular path? Why does an object need to constantly accelerate in order to travel in a circle?	Apply Newton's 2nd Law to objects in uniform circular motion; from 2nd Law, derive the centripetal force equation and apply it to predict unknown variables in cases of circular motion Conceptually and mathematically analyze the proportional relationship between period, orbital radius, and speed of an object in circular motion and apply the circular velocity and	Flying Pig demonstration: Students determine period and frequency. Uniform Circular Motion Lab: Students utilize the centripetal force apparatus (A glass rod with a rope through it, a hanging mass at one end and a rubber stopper at the other) to balance the centripetal force from the	PearDeck interactive lectures Virtual circular motion lab: https://www.thephysicsaviary.com/Physics/Programs/Labs/ClassicCircularForceLab/	Daily Do Nows Teacher and peer feedback Exit Tickets

9.4.12.CT.2 9.4.12.IML.4	How can circular motion be applied to orbiting objects? What parameters affect the gravitational force according to Newton's Law of Gravitation? How does Einstein's model of gravity differ from Newton's?	angular speed equations to predict future quantities Calculate the gravitational force two objects exert on each other, and use it to predict planetary motion. Use Newton's Universal Law of Gravitation to derive the acceleration due to gravity for the surface of the Earth and for the surfaces of other planets Use mathematical and conceptual representations of Kepler's Third Law to analyze orbital radii, periods, etc. Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational and forces between objects. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.	stopper with the weight of the hanging mass. Tangential velocity is measured and plotted. Free Body Diagram Modelling: Students will now create the FBD for objects moving in circular paths, centripetal acceleration annotated. Gravity and Orbits Simulation: Students explore the connection between orbiting and circular motion Modelling the Universal Law of Gravitation: Students utilize a simulation to create graphs demonstrating the relationship between the gravitational force, distance, and mass.	Gravity and Orbits Simulation https://phet.colorado.edu/en/simulation/gravity-and-orbits Gravitational force interactive: https://www.physicsclassroom.com/Physics-Interactives/Circular-and-Satellite-Motion/Gravitational-Fields	Individual activity guided worksheets/POGILs Lab group CER reports Unit summative test Project rubrics

Unit #: 4 - Conservation Laws

Enduring Understandings:	**Essential Questions:**
● The total momentum in a closed system does not change; it is conserved. (i.e., net initial momentum = net final momentum) ● Momentum is a vector quantity, with a direction that corresponds with its velocity ● impulse is a vector quantity, with a direction that corresponds with its causing force ● Concepts of momentum and impulse can be applied to real world examples, such as to collisions or explosions. ● The proportional relationships between work, force and displacement. ● The relationships between work and the various energy types ● The law of conservation of energy and how it relates to the concepts of work, kinetic energy, potential energy, and thermal energy, including the transfer of energy through a system due to heat, sound and/or light. ● Describe and apply the concepts of work and power, as well energy concepts of efficiency, to everyday situations.	● How does the concept of momentum and its conservation impact the design process for safety devices, such as those present in cars? ● How do we know something has energy? ● How can the effects of energy transfer be utilized to design more efficient devices? ● How has our understanding of work, energy and heat impacted the development of modern technology?

Interdisciplinary Connections

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research
Ex: Students will engage in research about alternative energy sources to determine the advantages and disadvantages of greener sources of energy.

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.
Ex: Students will utilize units to determine the viability of equations as well as a method to remember various equations.

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
HS-PS2-2 HS-PS2-3	How can momentum be explained using colloquial terms? How does a phone case work to limit the forces	Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved.	Momentum Conservation Lab: Students use motion detectors to track the velocity of carts during a collision to prove momentum conservation.	PearDeck interactive lectures PASCO carts, tracks, motion detectors, and masses.	Daily Do Nows Teacher and peer feedback Exit Tickets

HS-PS3-1 HS-PS3-3 9.4.12.IML.2 9.4.12.TL.3 9.4.12.GCA.1 9.4.12.DC.8	experienced by a phone when it is dropped? How does the concept of energy conservation affect the design of a roller coaster? How can I determine the inherent bias behind a source of information?	If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. Identify and quantify the various types of energies within a system of objects in a well-defined state, such as elastic potential energy, gravitational potential energy, kinetic energy, and thermal energy and represent how these energies may change over time. 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. Calculate changes in kinetic energy and gravitational potential energy of a system using representations of that system. 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). 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. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	Determining the use of safety devices in cars. Phone Case Project: students are tasked to create a "phone case" for a ceramic tile to protect it from a fall. Must connect to impulse and limiting force. Happy/Sad Balls: Students differentiate between elastic and inelastic collisions Energy Conservation: Students will use a simulation to determine how potential energy can be converted to kinetic energy and how initial energy can determine the motion of a system. Rube Goldberg Project: Students are tasked to create a device that converts individual forms of energy from one form to another to accomplish a task. Stair Climbing Lab: Students determine the power they generate by climbing the stairs. Alternative Energy Project: Students research how we use energy in our lives and how we can use different sources to lessen our impact on the environment.	Collision Carts Interactive https://www.physicsclassroom.com/Physics-Interactives/Momentum-and-Collisions/Collision-Carts Energy Skate Park https://phet.colorado.edu/en/simulation/energy-skate-park	Individual activity guided worksheets/POGILs Lab group CER reports Unit summative test Project rubrics

Unit #: 5 - Wave Behavior

Enduring Understandings:	**Essential Questions:**
● Waves transfer energy through different mechanisms based on their wave type ● Wavelength and frequency are inversely proportional; analyzing them determines the type of sound or light wave and its implications for humans and ability to explain natural phenomena ● Electromagnetic radiation has both helpful and harmful implications for humans; the only part of this spectrum we can see is visible light ● White light consists of a continuous spectrum of colors (ROY G BIV); this spectrum can be refracted, reflected, transmitted or absorbed by different materials, producing a variety of optical effects	● Why can adults typically not hear the 'mosquito ringtone'? ● What mechanisms do instruments use to enrich and amplify sound? ● How are waves used to transfer energy and send and store information? ● Why has digital technology replaced analog technology? ● Why does UV radiation cause cancer, but microwave radiation is safe to use on food?

Interdisciplinary Connections

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.
Ex: When speaking of waves, students must understand how terms like frequency, period, and wavelength apply to different types of waves.

HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
Ex: Students must be able to utilize equations relating wave speed, frequency, and wavelength to determine unknown quantities.

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
HS-PS4-1 HS-PS4-2 HS-PS4-3 HS-PS4-4 HS-PS4-5	What does it mean for a radio station to have a specific frequency? What changes the speed of a wave? How do musical instruments create different sounds? How do our computers talk to each other?	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. Analyze and describe wave motion through various media Model and explain wave interference. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a	Theremin demonstration of frequency and pitch Slinky Waves Lab: Students discover longitudinal, transverse, and standing waves and how the medium affects wave speed. Musical instrument resonance demos: How does wave interference result in music? How do standing waves connect to musical instruments?	PearDeck Interactive Lectures Slinkies Waves on a string simulation https://phet.colorado.edu/en/simulation/wave-on-a-string Breaking a wine glass through resonance https://www.youtube.c	Daily Do Nows Teacher and peer feedback Exit Tickets Individual activity guided worksheets/POGILs Lab group CER reports

9.4.12. TL.3 9.4.12. CT.1	Why is it important to frequently use sunscreen? How can light act as both a particle and a wave?	particle model, and that for some situations one model is more useful than the other. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. Evaluate questions about the advantages of using a digital transmission and storage of information.	Tuning fork resonance with tubes of varying length. Discussion of the electromagnetic spectrum and the uses of different wavelengths of light. Optics demonstrations: lenses, diffraction, refraction, wave interference, optical spectrum, additive and subtractive colors.	om/watch?v=Oc27GxSD_bI	Unit summative test Project rubrics

General Differentiated Instruction Strategies	
• Leveled texts • Chunking texts • Choice board • Socratic Seminar • Tiered Instruction • Small group instruction • Guided Reading • Sentence starters/frames • Writing scaffolds • Tangible items/pictures • Adjust length of assignment	• Repeat, reword directions • Brain breaks and movement breaks • Brief and concrete directions • Checklists for tasks • Graphic organizers • Assistive technology (spell check, voice to type) • Study guides • Tiered learning stations • Tiered questioning • Data-driven student partnerships • Extra time

Possible Additional Strategies for Special Education Students, 504 Students, At-Risk Students, and English Language Learners (ELLs)			
Time/General	**Processing**	**Comprehension**	**Recall**
• Extra time for assigned tasks • Adjust length of assignment • Timeline with due dates for reports and projects • Communication system between home and school • Provide lecture notes/outline	• Extra Response time • Have students verbalize steps • Repeat, clarify or reword directions • Mini-breaks between tasks • Provide a warning for transitions • Reading partners	• Precise step-by-step directions • Short manageable tasks • Brief and concrete directions • Provide immediate feedback • Small group instruction • Emphasize multi-sensory learning	• Teacher-made checklist • Use visual graphic organizers • Reference resources to promote independence • Visual and verbal reminders • Graphic organizers

Assistive Technology	Assessments and Grading	Behavior/Attention	Organization
• Computer/whiteboard • Tape recorder • Spell-checker • Audio-taped books	• Extended time • Study guides • Shortened tests • Read directions aloud	• Consistent daily structured routine • Simple and clear classroom rules • Frequent feedback	• Individual daily planner • Display a written agenda • Note-taking assistance • Color code materials

Enrichment
The goal of Enrichment is to provide learners with the opportunity to participate in extension activities that are differentiated and enhance the curriculum. All enrichment decisions will be based upon individual student needs. • Show a high degree of intellectual, creative and/or artistic ability and demonstrate this ability in multiple ways. • Pose questions and exhibit sincere curiosity about principles and how things work. • The ability to grasp concepts and make real world and cross-curricular connections. • Generate theories and hypotheses and pursue methods of inquiry. • Produce products that express insight, creativity, and excellence. • Possess exceptional leadership skills. • Evaluate vocabulary • Elevate Text Complexity • Inquiry based assignments and projects • Independent student options • Tiered/Multi-level activities • Purposeful Learning Center • Open-ended activities and projects • Form and build on learning communities • Providing pupils with experiences outside the 'regular' curriculum • Altering the pace the student uses to cover regular curriculum in order to explore topics of interest in greater depth/breadth within their own grade level • A higher quality of work than the norm for the given age group. • The promotion of a higher level of thinking and making connections. • The inclusion of additional subject areas and/or activities (cross-curricular). • Using supplementary materials in addition to the normal range of resources.

English Language Learner (ELL) Resources

- Learning style quiz for students- http://www.educationplanner.org/students/self-assessments/learning-styles-quiz.shtml
- "Word clouds" from text that you provide-http://www.wordle.net/
- Bilingual website for students, parents and educators: http://www.colorincolorado.org/
- Learn a language for FREE-www.Duolingo.com
- Time on task for students-http://www.online-stopwatch.com/
- Differentiation activities for students based on their Lexile-www.Mobymax.com
- WIDA-http://www.wida.us/
- Everything ESL - http://www.everythingESL.net
- ELL Tool Box Suggestion Site http://www.wallwisher.com/wall/elltoolbox
- Hope4Education - http://www.hope4education.com
- Learning the Language http://blogs.edweek.org/edweek/learning-the-language/
- FLENJ (Foreign Language Educators of NJ) 'E-Verse' wiki: http://www.flenj.org/Publications/?page=135
- OELA - http://www.ed.gov/offices/OBEMLA
- New Jersey Department of Education- Bilingual Education information http://www.state.nj.us/education/bilingual/

Special Education Resources

- Animoto -Animoto provides tools for making videos by using animation to pull together a series of images and combining them with audio. Animoto videos or presentations are easy to publish and share. https://animoto.com
- Bookbuilder -Use this site to create, share, publish, and read digital books that engage and support diverse learners according to their individual needs, interests, and skills. http://bookbuilder.cast.org/
- CAST -CAST is a non-profit research and development organization dedicated to Universal Design for Learning (UDL). UDL research demonstrates that the challenge of diversity can and must be met by making curriculum flexible and responsive to learner differences. http://www.cast.org
- CoSketch -CoSketch is a multi-user online whiteboard designed to give you the ability to quickly visualize and share your ideas as images. http://www.cosketch.com/
- Crayon -The Crayon.net site offers an electronic template for students to create their own newspapers. The site allows you to bring multiple sources together, thus creating an individualized and customized newspaper. http://crayon.net/ Education Oasis -Education Oasis offers a collection of graphic organizers to help students organize and retain knowledge – cause and effect, character and story, compare and

contrast, and more! http://www.educationoasis.com/printables/graphic-organizers/

- Edutopia -A comprehensive website and online community that increases knowledge, sharing, and adoption of what works in K-12 education. We emphasize core strategies: project-based learning, comprehensive assessment, integrated studies, social and emotional learning, educational leadership and teacher development, and technology integration. http://www.edutopia.org/
- Glogster -Glogster allows you to create "interactive posters" to communicate ideas. Students can embed media links, sound, and video, and then share their posters with friends. http://edu.glogster.com/?ref=personal
- Interactives – Elements of a Story -This interactive breaks down the important elements of a story. Students go through the series of steps for constructing a story including: Setting, Characters, Sequence, Exposition, Conflict, Climax, and Resolution. http://www.learner.org/interactives/story/index.html
- National Writing Project (NWP) -Unique in breadth and scale, the NWP is a network of sites anchored at colleges and universities and serving teachers across disciplines and at all levels, from early childhood through university. We provide professional development, develop resources, generate research, and act on knowledge to improve the teaching of writing and learning in schools and communities. http://www.nwp.org
- Pacecar -Vocab Ahead offers videos that give an active demonstration of vocabulary with audio repeating the pronunciation, definition, various uses, and synonyms. Students can also go through flash cards which give a written definition and visual representation of the word. http://pacecar.missingmethod.com/