**Rumson-Fair Haven Regional High School Curriculum**

**Course:** *Physics 9 Honors*
**Staff Writers:** Alex Cafiero and Sam Haughwout
**Supervisor:** Jon Pennetti
**Approved:** September 2021

## Section I: Course Description

Physics 9 Honors is a laboratory course designed for students to learn and discover all major aspects of a traditional high school physics course with the application of Algebra 1 and trigonometry concepts. This course is taught beyond state standards for a comprehensive understanding of physics. Topics include mechanics, energy, wave motion, electricity, and magnetism, in 1D and 2D vector analysis. An in depth look at two dimensional motion, forces, and other phenomena will be included. Assessments will include tests, quizzes, lab reports, and projects. This course will meet five days per week.

## Section II: NJSLS: New Jersey Student Learning Standards/Learning Objectives

1. **2020 New Jersey Student Learning Standards – Science:**
    - "Scientific and technological advances have proliferated and now permeate most aspects of life in the 21st century. It is increasingly important that all members of our society develop an understanding of scientific and engineering concepts and processes. Learning how to construct scientific explanations and how to design evidence-based solutions provides students with tools to think critically about personal and societal issues and needs. Students can then contribute meaningfully to decision-making processes, such as discussions about climate change, new approaches to health care, and innovative solutions to local and global problems."

**HS-PS1 Matter and Its Interaction**

**HS-PS1-1.** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

**HS-PS2 Motion and Stability: Forces and Interactions**

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

**HS-PS2-2.** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

**HS-PS2-3.** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

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

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

**HS-PS2-6.** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

**HS-PS3 Energy**

**HS-PS3-1.** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

**HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.

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

**HS-PS3-4.** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

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

**HS-PS4 Waves and Their Applications in Technologies for Information Transfer**

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

**HS-PS4-2.** Evaluate questions about the advantages of using a digital transmission and storage of information.

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

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

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

**HS-ESS1 Earth's Place in the Universe**

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

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

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

**HS-ESS2 Earth's Systems**

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

**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes change to other Earth's systems.

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

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

**HS-ETS1 Engineering Design**

**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.

2. **2016 English Language Arts Companions for Grades 9-10 (History, Social Studies, Science and Technical Subjects):**
    - The ELA Standards were revised in 2016, with the recommendations of teams of teachers, parents, administrators, supervisors and other stakeholders and reflect the strong beliefs that, "...Literacy must be recognized and guided in content areas so that students

recognize the academic vocabulary, media representations, and power of language inherent in the work of scholars and experts..."

**Anchor Standards for Reading**

**Integration of Knowledge and Ideas**

**NJSLSA.R7**. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

**NJSLSA.R10.** Read and comprehend complex literary and informational texts independently and proficiently with scaffolding as needed.

**Progress Indicators Reading Science and Technical Subjects**

**Key Ideas and Details**

**RST.9-10.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

**Craft and Structure**

**RST.9-10.4.** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.

**RST.9-10.5.** Analyze the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

**RST.9-10.6.** Determine the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

**Integration of Knowledge and Ideas**

**RST.9-10.7.** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

**RST.9-10.8**. Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

**RST.9-10.9**. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

**Range of Reading and Level of Text Complexity**

**RST.9-10.10.** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

**Anchor Standards for Writing**

**Text Types and Purposes**

**NJSLSA.W3.** Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

**Production and Distribution of Writing**

**NJSLSA.W4**. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

**NJSLSA.W6.** Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

**Research to Build and Present Knowledge**

**NJSLSA.W7.** Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.

**NJSLSA.W8**. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

**Range of Writing**

**NJSLSA.W10.** Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

**Progress Indicators for Writing History, Science and Technical Subjects**

**Production and Distribution of Writing**

**WHST.9-10.4.** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

**WHST.9-10.6**. Use technology, including the Internet, to produce, share, and update writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

**Research to Build and Present Knowledge**

**WHST.9-10.7**. 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.

**Range of Writing**

**WHST.9-10.10.** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

3. **Career Ready Practices:**
   - "Career Ready Practices describe the career-ready skills that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study."

     **CRP1** Act as a responsible and contributing citizen and employee.
     **CRP2** Apply appropriate academic and technical skills.
     **CRP3** Attend to personal health and financial well-being.
     **CRP4** Communicate clearly and effectively and with reason.
     **CRP5** Consider the environmental, social and economic impacts of decisions.
     **CRP6** Demonstrate creativity and innovation.
     **CRP7** Employ valid and reliable research strategies.
     **CRP8** Utilize critical thinking to make sense of problems and persevere in solving them.
     **CRP9** Model integrity, ethical leadership and effective management.
     **CRP10** Plan education and career paths aligned to personal goals.
     **CRP11** Use technology to enhance productivity.
     **CRP12** Work productively in teams while using cultural global competence.

4. ***Standard 8.1 (Computer Science) and 8.2 (Design Thinking)* of the *2020 NJSLS*:**
   - "The 'Intent and Spirit of the Computer Science and Design Thinking Standards' is to focus on deep understanding of concepts that enable students to think critically and systematically about leveraging technology to solve local and global issues. Authentic learning experiences that enable students to apply content knowledge, integrate concepts across disciplines, develop computational thinking skills, acquire and incorporate varied perspectives, and communicate with diverse audiences about the use and effects of computing prepares New Jersey students for college and careers."

**8.1 Computer Science**

**8.1.12.CS.4**: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.

**8.1.12.DA.1**: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

**8.1.12.DA.2**: Describe the trade-offs in how and where data is organized and stored.

**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

**8.1.12.DA.6**: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

**8.1.12.AP.8**: Evaluate and refine computational artifacts to make them more usable and accessible

**8.2 Design Thinking**

**8.2.12.ED.2**: Create scaled engineering drawings for a new product or system and make modifications to increase optimization based on feedback.

**8.2.12.ED.6**: Analyze the effects of changing resources when designing a specific product or system

**8.2.12.NT.1**: Explain how different groups can contribute to the overall design of a product.

**8.2.12.NT.2**: Redesign an existing product to improve form or function.

**8.2.12.EC.3**: Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.

5. ***Standard 9.4 (Life Literacies and Key Skills)* of the *2020 NJSLS*:**
   - "This standard outlines key literacies and technical skills such as critical thinking, global and cultural awareness, and technology literacy* that are critical for students to develop to live and work in an interconnected global economy."

     **9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

     **9.4.12.CI.2**: Identify career pathways that highlight personal talents, skills, and abilities.

     **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice.

     **9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

     **9.4.12.CT.4**: Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.

     **9.4.12.DC.7**: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society.

     **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

     **9.4.12.IML.4**: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.

     **9.4.12.TL.1**: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

     **9.4.12.TL.2**: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

     **9.4.12.TL.3**: Analyze the effectiveness of the process and quality of collaborative environments.

     **9.4.12.TL.4**: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.
   - **Climate Change:** The state of New Jersey has mandated instruction in, "Climate Change across all content areas, leveraging the passion students have shown for this critical issue and providing them opportunities to develop a deep understanding of the science behind the changes and to explore the solutions our world desperately needs."
6. ***LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35*:**
   - A transformative approach to the inclusion of lessons and resources/texts on the contributions and issues concerning the LGBTQ+ population and people with disabilities will be implemented across all core subjects in accordance with state law: "A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36). A board of education shall have policies and procedures in place

pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35."

7. **Acquisition/development/refinement of the higher-order critical thinking skills aligned with the *Revised Bloom's Taxonomy of Cognitive Objectives***

**Section III: Curriculum Modifications**

The *Physics Honors Curriculum* is subject to case-by-case modifications to support/advance the needs of all students, including special education students, English language learners, gifted students and those at risk of school failure. These modifications are based on Individualized Learning Programs (IEPs), recommendations made by the district's English Language Learners (ELL) coordinator, feedback from members of the Intervention & Referral Services Team (*I&RS*) for at-risk students, and 504 Plans.

Coursework and assessments will be modified on an individual basis for students when necessary. Modifications may include but are not limited to:

- Small group instruction
- One on one instruction
- Independent work stations
- Use of graphic organizers
- Interest inventories and questionnaires
- Audio resources to complement written texts and concepts
- Visual resources to complement written texts and concepts
- Extra time on assessments and large scale projects
- Reduced length of written assignments
- Large projects broken into smaller tasks and timelines
- Tiered Instruction
- Individual help during practice
- Diagrams and color coding for visual learners
- Verbal and written directions for visual and auditory learners
- Provided class notes
- Preferential seating
- Spelling not penalized
- Varied supplemental activities
- Assessments delivered orally

**Section IV: Preparation for Standardized Testing**

Instruction in *Physics Honors* is aligned with the requirements of state and national standardized assessments, including the *NJSLA*, the *ACT*, the *PSAT* and the *SAT*. The *End of Marking Period Assessments* for *Physics Honors* also demonstrate alignment with the aforesaid standardized assessments.

**Section V: Curriculum Pacing Guide**

| **Curriculum Pacing Guide** | |
|---|---|
| **Course Title:** *Physics 9 Honors* | **Grade Level:** *9th Grade* |
| **Unit 1:** Kinematics & Dynamics | September-November; 9 Weeks |
| **Unit 2:** | November-January; 9 Weeks |

| | |
|---|---|
| Conservative Laws: Energy & Momentum | |
| **Unit 3:** Electricity & Magnetism | January-March; 10 Weeks |
| **Unit 4:** Waves, Sound, and Light | April-June; 10 Weeks |

**Section VI: Technology Skills**

Students in *Physics Honors* are required to complete the technology skills components of the curriculum: (physics tech curriculum)

- Collect raw data using technology
- Evaluate raw data
- Evaluate a graphical representation of raw data through the use of technology
- Analyze a graphical representation of raw data to determine relevance
- Evaluate multiple representations of data.
- Determine the relationship between position and time during motion..
- Describe the relationship between position and time in a mathematical equation.
- Identify the value of the slope of a position time graph.
- Use data to make predictions.
- Operate a Vernier GoDirect Interface
- Use probes and sensors correctly with the Vernier GoDirect Interface
- Collect raw data using technology
- Study the relationship between position and time for different types of motion.
- Determine from the data and graph, the mathematical relationship between position and time for different types of relationships.

**Section VII: Primary Texts and Year Long Instructional Resources**

The following texts and instructional resources are employed in *Physics Honors* :

- *Common Sense Education* (www.commonsense.org)
- Google Classroom
- Online Resources
- NJCTL Resources
- PhET Simulation: https://phet.colorado.edu/en/simulations/filter?subjects=physics&sort=alpha&view=grid
- The Physics Classroom: https://www.physicsclassroom.com/
- HyperPhysics http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
- Khan Academy: https://www.khanacademy.org/science/high-school-physics
- Current events and videos used as necessary from NYTimes.com, YouTube.com, DiscoveryEducation.com, etc.
- Primary and secondary sources for research available through Google.com, EBSCOhost Web, JSTOR, etc.

**Section VIII: Grading Formula and Assessment Modes**

Marking period grades in *Physics Honors* are determined via a percentage weighting model. The specific grading categories and weightings of each will be determined prior to the start of each academic year and will be published in the posted/distributed course syllabi.

**Section IX: Unit Templates**

The following unit templates have been established for the *Physics Honors* Curriculum by the *Physics Honors* Instructional Team:

## Unit 1:
## Kinematics & Dynamics

In Kinematics, students will study and discuss motion both in 1 and 2 dimensions. Students will distinguish between vector and scalar quantities. Students will describe in both vector and scalar frameworks. Kinematic equations enable students to describe motion quantitatively. Skills that will be learned and exhibited by the students include: breaking apart vectors into vector components, adding and subtracting vectors, and describing velocity relative to other moving objects. Both horizontal and angled projectiles will be described quantitatively and conceptually. Students will be expected to use labs, graphs, data, and calculations to further their understanding of kinematics.

An investigation into Dynamics uses the experiments and discoveries of Aristotle to Galileo to Newton. Through these past experiments, students will gain an understanding of the descriptions and causes of motion. Using Galileo's ideas and Newton's three laws of motion, students learn to describe motion and its causes using a more sophisticated scientific method. Through labs and problems, the students will question and confirm Newton's three laws and Galileo's ideas.

Students will also have an opportunity to apply their knowledge of objects in motion to objects in circular motion. This can apply to the simple rotation of a ball or the movements of planetary bodies in the known universe. This unit is also important because internationally these same phenomena are expressed in the exact same way.

Students will...

- Distinguish between scalar and vector quantities.
- Determine the components of a vector.
- Add and subtract vectors.
- Define displacement, velocity, and acceleration.
- Analyze graphs, dot diagrams, pictures, etc. of objects in motion (constant acceleration, constant velocity).
- Calculate kinematic quantities.
- Calculate projectile motion.
- Apply Newton's three laws of motion to actions in everyday life.
- Identify and evaluate friction.
- Apply circular kinematics to objects that undergo circular motion; such as planets and satellites.
- Create and evaluate free-body diagrams

### Standards/Core Ideas/Performance Expectations

The state standards outlined below, and established by New Jersey Department of Education, will guide instruction throughout this unit in Physics Honors:

- *2020 New Jersey Student Learning Standards: Science*
  - HS-PS2-1, HS-PS2-4, HS-ETS1-2
- *2016 New Jersey Student Learning Standards: English Language Arts Companions for Grades 9-10*
  - NJSLSA.R7., RH.9-10.7, RST.9-10.3, RST.9-10.4., RST.9-10.5. , RST.9-10.7., RST.9-10.10., NJSLSA.W3., NJSLSA.W8., WHST.9-10.4., WHST.9-10.7.
- *2020 New Jersey Student Learning Standards: Computer Science and Design Thinking*
  - 8.1.12.DA.1, 8.1.12.DA.2, 8.1.12.DA.5, 8.1.12.DA.6, 8.1.12.AP.8, 8.2.12.ED.2, 8.2.12.ED.6, 8.2.12.NT.1, 8.2.12.NT.2, 8.2.12.EC.3
- *2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies and Key Skills*
  - 9.4.12.CI.1, 9.4.12.CI.2, 9.4.12.CT.1, 9.4.12.CT.2, 9.4.12.CT.4, 9.4.12.DC.7, 9.4.12.IML.3, 9.4.12.IML 4, 9.4.12.TL.1, 9.4.12.TL.2, 9.4.12.TL.3,9.4.12.TL.4
  - CRP1, CRP2, CRP3, CRP4, CRP5, CRP6, CRP7, CRP8, CRP9, CRP10, CRP11, CRP12

| Unit Essential Questions | Unit Enduring Understandings |
|---|---|
| • Why is it important to think for oneself and experiment with new ideas?<br>• What variables can you manipulate to affect the movement of objects?<br>• In what ways can mathematical relationships be applied to describe and predict motion?<br>• How can motion be represented and described?What is the cause of accelerated motion?<br>• How can motion be described if an object is moving in two different directions within a two-dimensional space?<br>• What is a resultant?<br>• How do the laws of motion apply to circular motion? | • Students will understand the value of experimentation and innovation by regularly engaging in scientific argumentation and inquiry.<br>• Physical properties (specifically kinematics and dynamics) allow you to predict and describe the motion of an object in the real world.<br>• The motion of an object can be modeled mathematically through algebra and/or trigonometry.<br>• The relationship between physical quantities (mostly with respect to time) can be represented graphically to describe and predict motion.<br>• Kinematic equations are used to describe velocity, displacement, time and acceleration of objects.<br>• Unbalanced forces create a nonzero external net force, which causes accelerated motion.<br>• All projectile motion can be described in terms of vertical and horizontal components and they are completely independent of each other, with the exception of the time of flight.<br>• The resultant is the summative vector of independently analyzed components, which has applications in both projectile motion and FBD problems.<br>• Centripetal forces and accelerations govern the motion of rotating bodies. |

| Evidence of Learning | | |
|---|---|---|
| **Formative Assessment:**<br>• Classwork<br>• Homework<br>• Performance activities<br>• Do-nows/Exit tickets | **Summative Assessment:**<br>• Quizzes<br>• Tests<br>• Projects<br>• Graph Matching lab<br>• Projectile Motion lab<br>• Ball Toss lab<br>• Speed/ Velocity/ Acceleration lab<br>• Newton's Second Law lab<br>• Acceleration Motion lab<br>• Atwood's Machine lab<br>• Newton's Third Law lab<br>• Static and Kinetic Friction lab<br>• Centripetal motion lab<br>• Water Bottle Race Car activity | **Resources Needed:**<br>• Common Sense Media - Truth in News<br>• Chromebooks<br>• Constant Motion cars<br>• Accelerated Motion cars<br>• Vernier Dynamics carts<br>• Vernier motion sensors<br>• Vernier force sensors<br>• Ball<br>• Pulleys<br>• Pulley String<br>• Stopwatches<br>• Meter Sticks<br>• Vernier software<br>• Tracks<br>• PhET simulations |

## Unit 2:
## Conservative Laws: Energy & Momentum

In Conservative Laws: Energy and Momentum, topics such as momentum, changes in energy, and circular motion will all be examined using the principles and guidelines laid out by Galileo, Kepler and Newton. Energy changes are necessary for any changes in motion. Students will see these phenomena based on everyday events and activities.

This unit is designed to delve deeper into the rationale behind objects in motion. In applying Newton's Three Laws students learn why seatbelts, air bags and crumple zones are extremely important life-saving devices in their cars today. Collisions and momentum are examined and can help students understand seemingly simple ideas such as two billiard balls colliding as well as what happens to momentum in car crashes. Collisions will also be discussed and calculated in two dimensions. Students have a feeling for kinetic and potential energy even if they do not have a name for them to begin with. They learn the relationship and the conservation of energy law that governs the entire universe and leads to an understanding of the appliances and simple machines they use in everyday life.

Students will...

- Apply Newton's three laws of motion to actions in everyday life in both 1D and 2D using vector analysis.
- Apply the law of conservation of momentum to different types of collisions.
- Analyze the conservation of energy in terms of moving objects.
- Compare the potential and kinetic energies of different objects.
- Define and perform calculations based on the principle of work.
- Evaluate the forces involved with circular motion using kinematics.
- Distinguish between angular and tangential values.
- Calculate the work done on an object when its energy is changed.
- Investigate simple machines and their efficiency.
- Understand the relationship between the potential and kinetic energy of a system.
- Multiply vectors with dot and cross products.
- Relate energy concepts to kinematics and dynamics. (Using energy conservation for freefall, deriving PE and momentum from Newton's 2nd Law, etc.)
- Discuss other types of energy (thermal, etc.)

### Standards/Core Ideas/Performance Expectations

The state standards outlined below, and established by New Jersey Department of Education, will guide instruction throughout this unit in Physics 9 Honors:

- *2020 New Jersey Student Learning Standards: Science*
  - HS-PS2-1, HS-PS2-2, HS-PS2-3, HS-PS3-1, HS-PS3-2, HS-PS3-3, HS-PS3-5, HS-ESS2-4, HS-ETS1-2
- *2016 New Jersey Student Learning Standards: English Language Arts Companions for Grades 9-10*
  - NJSLSA.R7., RH.9-10.7, RST.9-10.3, RST.9-10.4., RST.9-10.5. , RST.9-10.7., RST.9-10.10., NJSLSA.W3., NJSLSA.W8., WHST.9-10.4., WHST.9-10.7.
- *2020 New Jersey Student Learning Standards: Computer Science and Design Thinking*
  - 8.1.12.DA.1, 8.1.12.DA.2, 8.1.12.DA.5, 8.1.12.DA.6, 8.1.12.AP.8, 8.2.12.ED.6, 8.2.12.NT.1, 8.2.12.EC.3
- *2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies and Key Skills*
  - 9.4.12.CI.1, 9.4.12.CI.2, 9.4.12.CT.1, 9.4.12.CT.2, 9.4.12.CT.4, 9.4.12.IML.3, 9.4.12.IML.4, 9.4.12.TL.1, 9.4.12.TL.2, 9.4.12.TL.3,9.4.12.TL.4
  - CRP1, CRP2, CRP3, CRP4, CRP5, CRP6, CRP7, CRP8, CRP9, CRP10, CRP11, CRP12

| Unit Essential Questions | Unit Enduring Understandings |
|---|---|

| | |
|---|---|
| • How is energy conserved and not created nor destroyed?<br>• What is an isolated/closed system and how is the total momentum of it affected by collisions and explosions?<br>• How does an impulse affect the momentum of a mass to which it is applied? | • Energy exists in many forms such as work, kinetic, and potential energy, which can only transform from one form to one another.<br>• An isolated/closed system is a collection of objects isolated from outside forces and to/from which no net energy flows and the total momentum is conserved.<br>• The momentum of a mass is changed proportionately when an impulse is applied to it. |

**Evidence of Learning**

| **Formative Assessment:** | **Summative Assessment:** | **Resources Needed:** |
|---|---|---|
| • Classwork<br>• Homework<br>• Performance activities<br>• Do-nows/Exit tickets | • Quizzes<br>• Tests<br>• Projectile Motion activity<br>• Impulse and Momentum lab<br>• Energy of a Tossed Ball lab<br>• Momentum, Energy, and Collisions lab<br>• Simple Machine Project and Presentation<br>• Design a Ramp Challenge**<br>• Alternate Energy Presentation<br>• Egg Drop activity | • Computer/Chromebook<br>• Energy and Climate Change<br>• GO Motion sensors<br>• Vernier Dynamics carts<br>• Vernier motion sensors<br>• Vernier force sensors<br>• Pulley<br>• Pulley String<br>• Ball<br>• Centripetal Motion apparatus<br>• Stopwatches<br>• Meter Sticks<br>• Vernier software<br>• Tracks<br>• PhET simulations |

**Unit 3:**
**Electricity & Magnetism**

In this unit, the students will study one of the most used and yet overlooked pieces of science in their everyday lives: electricity. They will examine this phenomenon down to some of its simplest qualities: charges. Coulomb's Law will be used to see how electric particles interact with each other and the forces they create. Protons and electrons will be viewed for their inherent electric charges and how we can use them today, i.e. electron beams that work to show pictures on older televisions. Electric potential and electric potential energy will be investigated, along with their properties and practical uses. Some important effects of electric fields will be introduced. Field lines will be questioned and viewed. Finally, the students will learn how to develop and create the series and parallel circuits that they see and use every day. The magnetism component of this unit aims to open the students' eyes to the invisible world that is magnetic forces and fields. Laws such as the pole-force law will be brought up to teach the students the fundamental principles of a magnet, its poles, and the forces attributed to them. Magnetic domains, magnetic poles, and magnetic fields will be explained for things as simple as bar magnets. The biggest type of magnetic field we can examine may come as a surprise to the students: Earth's magnetic field. We can look into the effects of the magnetic field as well as the reversal of the poles every so often in history

as evidenced in Earth's crust. Finally we will investigate the interconnectedness of Electricity and Magnetism when we investigate electromagnetic induction, a technology that makes our day-to-day lives simple and plays a fundamental role in our global economy.

*Students will…*

- Identify the relationship between positive and negative charges.
- Apply Newton's three laws of motion to electric and magnetic forces in 1D and 2D using vector analysis.
- Solve problems involving charge, electric forces, electric fields, and electric potential.
- Use Ohm's Law to investigate resistance in electric circuits.
- Apply the law of conservation of charge to different situations.
- Identify and describe the methods of charging.
- Describe and calculate electric fields in 1D and 2D using vector analysis.
- Distinguish between electric potential energy and electric potential.
- Distinguish between alternating and direct current.
- Calculate electric power.
- Compare and contrast Coulomb's Law to Newton's Law of Gravitation
- Label, identify, and create circuit diagrams
- Relate work in mechanics to work in E&M (as well as any other parallels).
- Relate resultant springs to equivalent resistances.

## Standards/Core Ideas/Performance Expectations

The state standards outlined below, and established by New Jersey Department of Education, will guide instruction throughout this unit in Physics 9 Honors*:*

- *2020 New Jersey Student Learning Standards: Science*
  - HS-PS1-1, HS-PS2-1, HS-PS2-4, HS-PS2-5, HS-PS3-2. HS-PS3-5, HS-ESS2-2, HS-ESS2-3
- *2016 New Jersey Student Learning Standards: English Language Arts Companions for Grades 9-10*
  - NJSLSA.R7., RH.9-10.7, RST.9-10.3, RST.9-10.4., RST.9-10.5. , RST.9-10.7., RST.9-10.10., NJSLSA.W3., NJSLSA.W8., WHST.9-10.4., WHST.9-10.7.
- *2020 New Jersey Student Learning Standards: Computer Science and Design Thinking*
  - 8.1.12.CS.4, 8.1.12.DA.2, 8.1.12.DA.5, 8.1.12.DA.6, 8.1.12.AP.8, 8.2.12.EC.3
- *2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies and Key Skills*
  - 9.4.12.CT.1, 9.4.12.CT.2, 9.4.12.CT.4, 9.4.12.DC.7, 9.4.12.IML.3, 9.4.12.TL.1, 9.4.12.TL.2, 9.4.12.TL.3, 9.4.12.TL.4
  - CRP1, CRP2, CRP3, CRP4, CRP5, CRP6, CRP7, CRP8, CRP9, CRP10, CRP11, CRP12

| Unit Essential Questions | Unit Enduring Understandings |
|---|---|
| • What laws govern electricity?<br>• How do charges interact?<br>• How can circuits be configured?<br>• Why is the relationship between electricity and magnetism significant?<br>• How is magnetism related to the Earth? | • Current through a circuit is dependent on the applied voltage and net resistance.<br>• Charges attract proportionally to their magnitude but inversely to the squared distance between them.<br>• Components of circuits can be arranged in series and/or parallel order.<br>• Charge, mass, and their interactions with nature are oftentimes parallels and have analogs to each other.<br>• Current can exist outside of a conventional circuit and can be interpreted as the motion of charged particles.<br>• Electromagnetism is magnetism created by current flowing through a conductor. Flowing electrons produce a magnetic field and spinning magnets cause an electric current to flow. |

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| | ● All moving charge causes magnetism, so Earth's core must have moving metallic, magnetic substances to create Earth's magnetic field |

| Evidence of Learning | | |
|---|---|---|
| **Formative Assessment:**<br>● Do Now Questions<br>● Homework<br>● Class Participation<br>● Exit slips<br>● Check your neighbor questions | **Summative Assessment:**<br>● Unit Quizzes<br>● Electrostatic Test<br>● Circuits Test<br>● Magnetism Test<br>● Light Brightness Lab (Inverse Square relationship)<br>● Ohm's Law Lab (PHet or Live)<br>● Series and Parallel Circuits Lab<br>● Light the Lamp Activity<br>● Magnetic Field in a Slinky Lab<br>● Faraday's Law Intro Activity (PHet)<br>● Appliance Scavenger Hunt | **Resources Needed:**<br>● Vernier Software<br>● Vernier Current Sensors<br>● Vernier Voltage Sensors<br>● 10 ohm, 50 ohm, and 100 Ohm resistors<br>● Banana and Alligator Wires<br>● Knife Switches<br>● Light Bulbs<br>● Light Sockets<br>● Adjustable DC Power Sources<br>● Multimeters<br>● Ammeters<br>● Voltmeters<br>● Van de Graaff Generator<br>● Hand Crank Generators<br>● PhET Simulations |

## Unit 4:
## Waves, Sound and Light

In this unit, students will witness and test the phenomena surrounding waves, sounds and light. When dealing with waves, students will be able to identify the characteristics and properties of waves. Further, they will use equations to solve for a wave's speed, frequency, and period. The interesting Doppler effect will be explained in this unit, i.e. They will learn why a siren changes pitch as it comes closer and moves away and apply this understanding to investigate evidence that supports the Big Bang theory and the expanding universe. Sound will also be looked at as a type of wave. Students can account for the speed of sound in air and how that speed changes in different mediums, information that has helped us make sense of the Earth's internal structure. Interference and reflection are introduced with harmonics in the study of standing waves on a string and open and closed tube resonance. They will also be able to explain what beats and echoes are when dealing with sound waves. Electromagnetic radiation and the digital information transmitted using this type of wave will be discussed. The study then moves to light as a wave phenomenon beginning with plane and curved mirrors, object image formation and magnification. The unit concludes with refraction and Snell's law, total internal reflection and finally moves to object image relationships formed by a thin lens.

Students will…

- Identify properties and characteristics of waves.
- Compare and contrast between transverse and longitudinal waves.
- Describe the characteristics of standing waves.
- Perform simple harmonic motion calculations.
- Explain the cause of a sonic booms
- Analyze the speed of a wave.

- Distinguish between the period and frequency of a wave.
- Analyze how waves interact with each other.
- Define the Doppler effect and give practical examples.
- Describe the astronomical evidence of the redshift of light from galaxies as an indication that the universe is currently expanding
- Calculate the beat frequency from multiple sources.
- Calculate the speed of sound in air for different temperatures.
- Describe the human range of hearing.
- Analyze the impact of resonance.
- Investigate simple harmonic motion.
- Describe the nature of light and electromagnetic radiation
- Analyze reflection and refraction of light with lenses and mirrors
- Investigate optical interference and diffraction
- Analyze the different parts of the electromagnetic spectrum including wavelengths and frequencies of radiation.
- Derive the speed of light from E&M waves.
- Examine and study the human eye and/or brain to understand how we perceive light.
- Examine and study the human ear to understand how we perceive vibrations and sound.
- Investigate how light and sound change with different media.
- Apply their knowledge of reflection to define focal length of a curved mirror.

## Standards/Core Ideas/Performance Expectations

The state standards outlined below, and established by New Jersey Department of Education, will guide instruction throughout this unit in Physics 9 Honors*:*

- *2020 New Jersey Student Learning Standards: Science*
  - HS-PS1-1, HS-PS2-1, HS-PS2-2, HS-PS2-4, HS-PS2-5, HS-PS2-6, HS-PS3-1, HS-PS3-2, HS-PS3-3, HS-PS3-5, HS-PS4-1, HS-PS4-2, HS-PS4-3, HS-PS4-4, HS-PS4-5, HS-ESS1-2, HS-ESS1-4, HS-ETS1-2
- *2016 New Jersey Student Learning Standards: English Language Arts Companions for Grades 9-10*
  - NJSLSA.R7., RH.9-10.7, RST.9-10.3, RST.9-10.4., RST.9-10.5. , RST.9-10.7., RST.9-10.10., NJSLSA.W3., NJSLSA.W8., WHST.9-10.4., WHST.9-10.7.
- *2020 New Jersey Student Learning Standards: Computer Science and Design Thinking*
  - 8.1.12.CS.4, 8.1.12.DA.1, 8.1.12.DA.2, 8.1.12.DA.5, 8.1.12.DA.6, 8.1.12.AP.8, 8.2.12.ED.6, 8.2.12.NT.1, 8.2.12.NT.2, 8.2.12.EC.3
- *2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies and Key Skills*
  - 9.4.12.CT.1, 9.4.12.CT.2, 9.4.12.CT.4, 9.4.12.DC.7, 9.4.12.IML.3, 9.4.12.TL.1, 9.4.12.TL.2, 9.4.12.TL.3, 9.4.12.TL.4
  - CRP1, CRP2, CRP3, CRP4, CRP5, CRP6, CRP7, CRP8, CRP9, CRP10, CRP11, CRP12

| Unit Essential Questions | Unit Enduring Understandings |
|---|---|
| • How do waves transfer energy?<br>• How is a real image different from a virtual image?<br>• How/why is the speed of light constant?<br>• What implications does a constant speed of light have in relation to the travel of information? | • Waves transfer energy without transferring matter. Mechanical waves require a medium, while EM waves do not.<br>• Sounds and vibrations travel as waves, while light includes properties of both waves and particles.<br>• A real image occurs where rays of light physically converge, whereas a virtual image is produced by the observer's eye tracing back diverging rays.<br>• The constant speed of light is a phenomenon that leads to all EM waves having an upper limit of speed. This |

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| • How do waves react with different media and other waves?<br>• Why isn't Simple Harmonic Motion observed in nature as often as we expect? | dictates how fast information, including all of our digital information and signals, can travel from one place to another. All other waves must travel this speed or slower.<br>• All waves can be refracted, reflected, and diffracted.<br>• Simple Harmonic Motion only truly exists in a vacuum, but it's repetitive motion leads to a better understanding of wave behavior. |

**Evidence of Learning**

| **Formative Assessment:** | **Summative Assessment:** | **Resources Needed:** |
|---|---|---|
| • Do Now Questions<br>• Homework<br>• Class Participation<br>• Exit slips<br>• Check your neighbor questions | • Unit Quizzes<br>• Waves and SHM test<br>• Sound test<br>• Light test<br>• Speed of Sound in Air Lab<br>• Pendulum Activity (PHet)<br>• Doppler Effect (EdPuzzle)<br>• Bending Light Activity (PHet)<br>• Reflection and refraction of light<br>• End of Marking Period Assessment | • Vernier Software<br>• Vernier Microphones<br>• Vernier Motion Detectors<br>• Vernier Photogates<br>• Springs<br>• Weight Sets<br>• Weight Hangers<br>• Pulley String<br>• Ring Stands<br>• Pendulum Arms<br>• Meter Sticks<br>• Wave Generators<br>• Standing Wave Apparatus<br>• Tuning Forks<br>• Glass Resonance Tubes<br>• 1000 mL Graduated Cylinders<br>• PhET Simulations |

**Section X: Unit Reflection**

The Physics HonorsInstructional Team must confer upon the completion of each instructional unit in the *Kinematics and Dynamics* and rate the degrees to which the instructional units meet performance criteria established by the New Jersey Department of Education using the *Unit Reflection Form*. Completed unit reflection forms must be submitted to the Department Supervisor for approval upon completion of curriculum implementation with a complementing list of suggested modifications to the *Physics Honors* Curriculum.

| **Lesson Activities:** | **Strongly** | **Moderately** | **Weakly** |
|---|---|---|---|
| **Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills;** | | | |
| **Are challenging and require higher order thinking and problem solving skills;** | | | |

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| **Allow for student choice;** | | | |
| **Provide scaffolding for acquiring targeted knowledge/skills;** | | | |
| **Integrate global perspectives;** | | | |
| **Integrate 21st century skills;** | | | |
| **Provide opportunities for interdisciplinary connection and transfer of knowledge and skills;** | | | |
| **Are varied to address different student learning styles and preferences;** | | | |
| **Are differentiated based on student needs;** | | | |
| **Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process;** | | | |
| **Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives;** | | | |
| **Provide opportunities for student reflection and self-assessment;** | | | |
| **Provide data to inform and adjust instruction to better meet the varying needs of learners;** | | | |