AP Physics C Overview

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Course(s): **AP PHYSICS**
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Cover

EAST BRUNSWICK PUBLIC SCHOOLS

East Brunswick New Jersey

Superintendent of Schools

Dr. Victor P. Valeski

Science

AP Physics C

Course Number: 1141

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Course Overview

1141 A.P. PHYSICS

Prerequisite: A final grade of B- in Physics H

Corequisite: Calculus

A.P. Physics is a course for highly motivated science students who are considering a science related career. This is a mathematically rigorous study of physics designed to prepare the student for the A.P. Physics examination. It provides an opportunity for students to gain expertise in the mathematical analysis of physical phenomena not possible in first year physics. Vector analysis is stressed, with an emphasis of solving the more sophisticated physics problems. Laboratory experiences are provided to help students to understand some of the more abstract concepts.

The Big Ideas (Major Concepts) that we seek to convey to the students are the following:

- Basic physics principles should not only be understood, they should be expanded, interpreted and expressed in graphical form, used to obtain reasonable estimates, and applied to solve problems that require the determination of physical quantities in either numerical or symbolic form.
- Solving problems with physics concepts involves drawing and interpreting diagrams, interpreting and expressing physical relationships in graphical form, accounting for observed phenomena, manipulating equations that describe physical relationships, and explaining steps taken to arrive at a result or predict a future behavior. Problem solutions often require the application of multiple physical concepts.
- When interpreting experimental data it is important to explain any limitations and uncertainties. When constructing and using conceptual models, it is important to explain any limitations in the model.
- When analyzing data it is important to display data in graphical or tabular form, fit lines and curves to data points in graphs, perform calculations with data, and/or make extrapolations and interpolations from data.
- When analyzing error, it is essential to identify sources of errors and how they propagate, estimate magnitude and direction of errors, and/or identify ways to reduce errors.

The Enduring Understandings that we expect students to take away from this course are as follows:

- Things might be logical to our way of thinking, but not found to be true in actual examination via scientific inquiry, experimentation, or empirical data analysis. Sources of error and experimental limitations need to be analyzed in order to understand discrepancies between theory and experimental results.
- Problem solving first involves a clear understanding of how information is organized for solving and discoveries may be proven false or supported, but never proven true for all conditions.
- Units are a necessary part of measurement and can be used to establish relationships between quantities and concepts.
- Graphs are a valuable way to display relationships between variables.
- Acceleration, or its lack, determines the relationship between displacement, velocity, and time and is related to the forces involved in a system.
- Equilibrium is a condition for which opposing forces are equal, or balanced.
- Starting, stopping, speeding up, slowing down, and turning are caused by unbalanced forces, whereas

objects at rest tend to stay at rest, and objects in motion tend to keep that same motion unless acted upon by an outside, unbalanced force. The motion of a body can be predicted accurately be analyzing the forces acting on it.

- For every action, there is an equal and opposite reaction.
- Many physical quantities have both magnitude and direction in space; they are vector quantities. Both magnitude and direction of a vector must be considered for the analysis of phenomena; vectors can be added in unique ways as well as broken into components.
- Force and motion can be related in a number of equivalent ways defining work, energy, power, momentum, and impulse.
- Circular motion is caused by forces which are perpendicular to a translational motion and are always directed inward and rotary motion is caused by forces that are tangential to an object's surface.
- The laws of linear dynamics and kinematics have analogous counterparts in rotary and circular motions.
- Energy is conserved in all closed systems but may be converted from one form to another form of energy.
- Electrical current stems from the flow of charge.
- Electric and magnetic fields pervade every space due to charges that create them.
- Wave characteristics are uniquely different from the world of moving particles. Waves interact with matter differently than moving particles do.
- Certain types of phenomena show characteristics of both waves and particles.
- Diverse optical instruments affect light through various interactions.
- Sound waves are distinct from light and other electromagnetic waves, and yet have characteristics in common.
- Harmonic motion illustrates rotational motion and its properties while waves illustrate both rotational and translational motion

Modifications

Each teacher, each student, each classroom is unique and adaptations are specific to each situation. Differentiating instruction and providing multiple ways to assess allows more flexibility for students to meet the standards and requirements of the class. Below are samples of the types of adaptations/modifications that may occur for students based on need including ELLs, students with a 504 Plan, Special Education, Basic Skills and Gifted and Talented students.

Adaptations/Modifications:

Input Adapt the way instruction is delivered to the learner. ***For example:*** • Use different visual aids, • Plan more concrete examples, • Provide hands-on activities, • Place students in cooperative groups.	**Output** Adapt how the learner can respond to instruction. ***For example:*** • Allow a verbal vs. written response, • Use a communication book for students, • Allow students to show knowledge with hands-on materials.	**Time** Adapt the time allotted and allowed for learning, task completion or testing. ***For example:*** • Individualize a timeline for completing a task, • Pace learning differently (increase or decrease) for some learners.
Difficulty Adapt the skill level, problem	**Level of Support** Increase the amount of personal	**Size** Adapt the number of items that the

type, or the rules on how the learner may approach the work. ***For example:*** • Simplify task directions. • Use of calculator.	assistance with specific learner. ***For example:*** • Assign peer buddies, teaching assistants, peer tutors or cross-age tutors.	learner is expected to learn or complete. ***For example:*** • Reduce the number of vocabulary words a learner must learn at any one time.
Degree of Participation Adapt the extent to which a learner is actively involved in the task. ***For example:*** • Allow for small group/individual presentations vs. presentations to the whole class.	**Alternate Goals** Adapt the goals or outcome expectations while using the same materials. ***For example:*** • Students in the same class are expected to either write a paragraph, write a bulleted response, or meet with the teacher to provide a verbal response.	**Substitute Curriculum** Provide differentiated instruction and materials to meet a learner's individual goals. ***For example:*** • Individualize a timeline for completing a task, pace learning differently (increase or decrease) for some learners, • Use of Learning Ally.

Materials and Resources

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Content Specific Standards

SCI.HS-PS1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
	Planning and Carrying Out Investigations
SCI.HS.PS1.A	Structure and Properties of Matter
SCI.HS.PS2.B	Types of Interactions
	Patterns

SCI.HS-PS2	Motion and Stability: Forces and Interactions
SCI.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.
	Analyzing and Interpreting Data
SCI.HS.PS2.A	Forces and Motion
SCI.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.
SCI.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.
SCI.HS.ETS1.A	Defining and Delimiting Engineering Problems
SCI.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.
SCI.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.
SCI.HS.PS3.A	Definitions of Energy
SCI.HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
SCI.HS-PS3	Energy
SCI.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.
SCI.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).
	Energy and Matter
SCI.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.
SCI.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).
SCI.HS.PS3.B	Conservation of Energy and Energy Transfer
SCI.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.
	Developing and Using Models
SCI.HS.PS3.C	Relationship Between Energy and Forces
SCI.HS-PS4	Waves and Their Applications in Technologies for Information Transfer
SCI.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
	Using Mathematics and Computational Thinking
SCI.HS.PS4.A	Wave Properties
	Cause and Effect
SCI.HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.

	Asking Questions and Defining Problems
	Stability and Change
SCI.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.
	Engaging in Argument from Evidence
SCI.HS.PS4.B	Electromagnetic Radiation
	Systems and System Models
SCI.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.
SCI.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.
	Obtaining, Evaluating, and Communicating Information
SCI.HS.PS3.D	Energy in Chemical Processes
SCI.HS.PS4.C	Information Technologies and Instrumentation
SCI.HS-ESS1	Earth's Place in the Universe
SCI.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.
SCI.HS.ESS1.A	The Universe and Its Stars
SCI.HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
SCI.HS.ESS1.B	Earth and the Solar System
	Scale, Proportion, and Quantity
SCI.HS-ETS1	Engineering Design
SCI.HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
SCI.HS.ETS1.A	Delimiting Engineering Problems
SCI.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.
SCI.HS.ETS1.C	Optimizing the Design Solution
SCI.HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
	Constructing Explanations and Designing Solutions
SCI.HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
SCI.HS.ETS1.B	Developing Possible Solutions

Interdisciplinary Standards

MA.K-12.1	Make sense of problems and persevere in solving them.

MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.K-12.8	Look for and express regularity in repeated reasoning.
LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
LA.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.
LA.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.
LA.RST.9-10.5	Analyze the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
LA.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.
LA.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.
LA.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.
LA.WHST.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant sufficient textual and non-textual evidence.
LA.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
LA.WHST.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
LA.WHST.9-10.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
LA.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.
LA.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.
LA.WHST.9-10.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

LA.WHST.9-10.9	Draw evidence from informational texts to support analysis, reflection, and research.

21st Century Life and Career Ready Practice Standards

CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP3.1	Career-ready individuals understand the relationship between personal health, workplace performance and personal well-being; they act on that understanding to regularly practice healthy diet, exercise and mental health activities. Career-ready individuals also take regular action to contribute to their personal financial well-being, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the

	actions of others.
CRP.K-12.CRP9.1	Career-ready individuals consistently act in ways that align personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the directions and actions of a team or organization, and they apply insights into human behavior to change others' action, attitudes and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morals and organizational culture.
CRP.K-12.CRP10.1	Career-ready individuals take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.
CRP.K-12.CRP11.1	Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.
CRP.K-12.CRP12.1	Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

Technology Standards

TECH.8.1.12	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.C	Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
TECH.8.1.12.D	Digital Citizenship: Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
TECH.8.1.12.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
TECH.8.1.12.F	Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
TECH.8.2.12	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

TECH.8.2.12.A	The Nature of Technology: Creativity and Innovation: Technology systems impact every aspect of the world in which we live.
TECH.8.2.12.B	Technology and Society: Knowledge and understanding of human, cultural and society values are fundamental when designing technology systems and products in the global society.
TECH.8.2.12.C	Design: The design process is a systematic approach to solving problems.
TECH.8.2.12.D	Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
TECH.8.2.12.E	Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.

Pacing Guide

Marking Period 1	
Topic	**Pacing (blocks)**
Kinematics	9 blocks with 4.5 cycles of A/B days Subtopics include: • Kinematics and algebra • Calculus with kinematics • Rotational kinematics • Relative velocity • Difference between angular acceleration, tangential acceleration, and centripetal acceleration
Forces	9 blocks with 4.5 A/B cycles Subtopics include: • Algebraic forces including pulleys, friction, tension, weight, and springs • non -constant forces • Drag Forces • Centripetal Force
Work and Energy	7 blocks with 3.5 A/B cycles Subtopics • Algebraic work and energy problems • Non constant forces with work

	• Potential energy graphs • Conservative and non-conservative forces and potential energy
Momentum	9 blocks with 4.5 A/B cycles Sub topics • Impulse • Conservation of momentum • Momentum and kinetic energy • Center of mass • Center of mass and momentum
Rotation	11 blocks with 5.5 A/B cycles Subtopics • Torque - equilibrium • Torque - accelerating • Moment of inertia • Newton's second law - rotation • Rotational kinetic energy Angular momentum

Marking Period 2	
Topic	**Pacing (blocks)**
Gravitation	7 blocks with 3.5 A/B cycles
Electrostatics/Gauss	11 blocks with 5.5 A/B cycles Subtopics: • Continuous charge distributions • Gauss • Conductors • Insulators • Electroscopes • Charge distribution in electrostatic equilibrium
Potential/Energy/Capacitors	12 blocks with 6 cycles Subtopics:

	• Electric potential • Electric potential energy • Potential and field connection • Capacitors • dielectrics

Marking Period 3	
Topics	**Pacing (blocks)**
Circuits	9 blocks Subtopics • Ohms' Law - traditional circuit analysis • Kirchoff's Laws • Steady State Circuits • Time Dependent Circuits
Electromagnetism	7 blocks Subtopics • Magnetic force on charges and wires • Magnetic field from wires • Biot-Savart • Ampere's Law
Electromagnetic Induction	8 blocks Subtopics: • Faraday and Lenz • Inductors • L-R circuits • L-C Circuits

Marking Period 4
AP Exam Review - The first few weeks of marking period 4 is designated to AP Exam Review. Students work practice tests and practice problems collaboratively and individually in order to prepare for the AP Physics C Exams.

Post-AP Exam - All Collegeboard objectives are complete and students will work collaboratively to reinforce objectives through project learning and development in various content areas.

Grading and Evaluation Guidelines

Marking period grades for Advanced Placement Physics will be determined by the following weights:

65% Tests

25% Lab

10% Quizzes

Other Details

03156 AP Physics C

Designed by the College Board to parallel college-level physics courses that serve as a partial foundation for science or engineering majors, AP Physics C courses primarily focus on 1) mechanics and 2) electricity and magnetism, with approximately equal emphasis on these two areas. AP Physics C courses are more intensive and analytical than AP Physics B courses and require the use of calculus to solve the problems posed.