NEW JERSEY CENTER
FOR TEACHING & LEARNING

**Progressive Science Initiative® (PSI®)**
**PHYS6654: Learning & Teaching AP Physics 1: Waves, Rotation, and Electricity & Magnetism**


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**Course Credit:** 3.0 NJCTL credits

**Dates & Times:**
This is a 3-credit, self-paced course, covering 7 modules of content. The exact number of hours that you can expect to spend on each module will vary based upon the module coursework, as well as your study style and preferences. You should plan to spend approximately 15 hours per credit working online, and up to 30 hours per credit working offline.

**Graduate Student Handbook:** www.njctl.org/graduate-handbook/

**COURSE DESCRIPTION:**
This course is designed for those who are learning to teach Algebra-Based Physics and Trigonometry-Based Physics for middle school or high school students, focusing on conveying physics and mathematical concepts. Underlying themes are physics connections to everyday life, applications of algebra and trigonometry in physics, problem solving, and hands-on laboratory experience. The course presents physics as the foundation for studying chemistry, biology and advanced mathematics. Technology serves as a tool to establish these connections through exploration, problem solving, formative assessment, presentation, and communication.

This course focuses on the topics explored in AP Physics I including energy, momentum, rotational motion, simple harmonic motion, and fluids. Big ideas investigated include that objects and systems have properties such as mass and charge; the interactions of an object with other objects can be described by forces; interactions between systems can result in changes in those systems; changes that occur as a result of interactions are constrained by conservation laws.

**STUDENT LEARNING OUTCOMES:**
Upon completion of the course, the student will be able to:

1. Demonstrate an understanding of advanced energy and motion topics.
2. Students will solve energy problems.
3. Students will solve momentum problems.
4. Students will solve rotational kinematics problems.
5. Students will solve rotational dynamics, energy and momentum problems.
6. Students will solve simple harmonic motion problems.
7. Students will solve fluids problems.
8. Integrate PSI materials (including presentations, labs, practice problems, etc.) and teaching methods to support student learning and deliver effective instruction.

**TEXTS, READINGS, INSTRUCTIONAL RESOURCES:**
**Required Texts:**

- PSI AP Physics 1 uses a free digital textbook accessible at: https://njctl.org/courses/science/ap-physics-1/
- Participants will download SMART Notebook presentations, homework files, labs, and teacher resources from the PSI AP Physics 1 Course

**Recommended Texts:**

- Giancoli (2005). *Physics: Principles with Applications / Edition 6* ISBN-13: 9780130352569
- *The Character of Physical Law*; Richard Feynman; The MIT Press

**COURSE REQUIREMENTS:**
In order to receive a Passing grade, the participant must complete the following course requirements:

1. Activities: A number of different learning activities will ensure participant engagement and learning in the course. These include:
   - Engage in video module lessons which demonstrate minimized direct instruction followed by frequent formative assessment
   - Completion of formative assessments aligned to learning objectives which include detailed analysis when answered incorrectly.
   - Interaction with module discussion boards that allow conversation with peers and course instructors about the module's content, delivering that content to students. Discussion boards also serve as a place to ask and answer questions related to the module's content.
2. Short Answer Assignment: Each module requires one (1) original response to a given prompt. These prompts are typically based upon course lessons and require teachers to analyze, reflect, and make connections between the module's content and their own classroom practice.
3. Mastery Exercises: For each module, these multiple-choice question quizzes assess the content knowledge gained in a module. Participants have the opportunity to retake; random questions are pulled from a larger question bank on each attempt ensuring varied

questions.

4. Virtual Labs: In each module, a virtual lab write-up will be submitted. Virtual Labs are interactive lab simulations that promote a deeper understanding of the content knowledge being learned through real-world applications and analysis.
5. Module Exam: One is completed at the end of each module. It is a culminating exam consisting of multiple choice and free response questions aligned to the standards and objectives of the module.
6. Reflection Paper: At the end of the course, participants are required to reflect on the knowledge taught in the course, make connections, and compare/contrast their current pedagogy with new strategies gained in this assignment.
7. Final Exam: At the end of the course, a comprehensive exam consisting of Multiple Choice and Free Response questions assesses the content knowledge learned throughout the course and aligns to the AP College Board Exams.

**GRADE DISTRIBUTION AND SCALE:**

**Grade Distribution:**

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| Module Exams | 70% |
| Final Exam | 10% |
| Labs | 6% |
| Short Answer Assignments | 6% |
| Mastery Exercises | 6% |
| Reflection Paper | 2% |

**Grade Scale:**

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| A | 93 – 100 |
| A- | 90 – 92 |
| B+ | 86 – 89 |
| B | 83 – 86 |
| B- | 80 – 82 |
| C+ | 77 – 79 |
| C | 73 – 76 |
| C- | 70 – 72 |
| D | 60.0 – 69.9 |
| F | 59.9 or below |

**GRADING RUBRIC:**
The following rubric is used to score:

- Short Answer Assignment – 6% of grade
- Reflection Paper – 2% of grade

| | **Meets Expectation** | **Approaches Expectation** | **Below Expectation** | **Limited Evidence** |
|---|---|---|---|---|
| | ***7 points*** | ***5 points*** | ***3 points*** | ***1 point*** |
| **Content** | ● Demonstrates excellent knowledge of concepts, skills, and theories relevant to topic. | ● Demonstrates fair knowledge of concepts, skills, and theories. | ● Demonstrates incomplete or insubstantial knowledge of concepts, skills, and theories. | ● Demonstrates little or no knowledge of concepts, skills, and theories. |
| **Depth of Reflection** | ● Content is well supported and addresses all required components of the assignment. | ● Content is partially supported; addresses most of the required components of the assignment. | ● Content contains major deficiencies; addresses some of the required components of the assignment. | ● Content is not supported and/or includes few of the required components of the assignment. |
| **Evidence and Practice** | ● Response shows strong evidence of synthesis of ideas presented and insights gained throughout the entire course. The implications of these insights for the respondent's overall teaching practice are thoroughly detaile d, as applicable. | ● Writing is mostly clear, concise, and well organized with good sentence/paragraph construction. Thoughts are expressed in a coherent and logical manner. There are no more than five spelling, grammar, or syntax errors per page of writing. | ● Response is missing some components and/or does not fully meet the requirements indicated in the instructions. Some questions or parts of the assignment are not addressed. Some attachments and additional documents, if required, are missing or unsuitable for the purpose of the assignment. | ● Response excludes essential components and/or does not address the requirements indicated in the instructions. Many parts of the assignment are addressed minimally, inadequately, and/or not at all. |
| | ***4 points*** | ***3 points*** | ***2 points*** | ***1 point*** |
| **Writing Quality** | ● Writing is well-organized, clear, concise, and focused; no errors. | ● Some minor errors or omissions in writing organization, focus, and clarity. | ● Some significant errors or omissions in writing organization, focus, and clarity. | ● Numerous errors in writing organization, focus, and/or clarity. |

The minimum possible score for this rubric is 4 points, and the score will be converted to the minimum grade available in this module (which is zero unless the scale is used). The maximum score of 25 points will be converted to the maximum grade.

Intermediate scores will be converted respectively and rounded to the nearest available grade. If a scale is used instead of a grade, the score will be converted to the scale elements as if they were consecutive integers.

The following rubric is used to score:

- Labs – 6% of grade

The minimum possible score for this rubric is 2 points, and the score will be converted to the minimum grade available in this module (which is zero unless the scale is used). The maximum score of 14 points will be converted to the maximum grade.

Intermediate scores will be converted respectively and rounded to the nearest available grade. If a scale is used instead of a grade, the score will be converted to the scale elements as if they were consecutive integers.

| | **Meets Expectation** | **Approaches Expectation** | **Below Expectation** | **Limited Evidence** |
|---|---|---|---|---|
| | ***7 points*** | ***5 points*** | ***3 points*** | ***1 point*** |
| **Completeness** | ● Lab write-up is complete with no missing fields. | ● Lab write-up has 1-2 missing fields. | ● Lab write-up has 3-5 missing fields. | ● There are more than 5 missing fields on the lab write-up. |
| **Calculations** | ● All answers are calculated correctly. | ● Most answers are calculated correctly, but there are 1-2 minor calculation errors. | ● Most answers are calculated correctly, but there are multiple minor calculation errors, or 1-2 gross miscalculations. | ● There are calculation errors throughout the lab. |

The remaining types of assignments are not scored using a rubric. These assignments are scored using percentage correct to assign a letter grade. The assignments in this manner are as follows:

- Mastery Exercises – 6% of grade
- Module Exams – 70% of grade
- Final Exam – 10% of grade

Mastery Exercises can be retaken as many times as desired to ensure a high score. Due to the nature of these assignments, each time they are taken, they will be comprised of ten unique questions pulled randomly from a larger question bank.

Module and Final Exams are scored using a curve, which allows us to keep content exams rigorous. Module Exams can be retaken one time. Final Exams cannot be retaken.

**ACADEMIC STANDING:**
NJCTL has established standards for academic good standing within a student's academic program. Students enrolled in any NJCTL online course must receive an 80 or higher to successfully complete a course and receive credit for that course. An 80 is equivalent to a GPA of 2.7 or B-. Additionally, students in an endorsement program must receive a cumulative GPA of 3.0 for all courses combined in order to successfully complete the program.

**ACADEMIC INTEGRITY:**
Students must assume responsibility for maintaining honesty in all work submitted for credit and in any other work designated by the instructor of the course. Academic dishonesty includes cheating, fabrication, facilitating academic dishonesty, plagiarism, reusing /repurposing your own work, unauthorized possession of academic materials, and unauthorized collaboration.

**CITING SOURCES WITH APA STYLE:**
All students are expected to follow proper writing and APA requirements when citing in APA (based on the APA Style Manual, 6th edition) for all assignments.

**DISABILITY SERVICES STATEMENT:**
We are committed to providing reasonable accommodations for all persons with disabilities. Any student with a documented disability requesting academic accommodations should contact the Dean of Students, Melissa Axelsson, for additional information to coordinate reasonable accommodations for students with documented disabilities (melissa@njctl.org).

**NETIQUETTE:**
Respect the diversity of opinions among the instructor and classmates and engage with them in a courteous, respectful, and professional manner. All posts and classroom communication must be conducted in accordance with the student code of conduct. Think before you push the Send button. Did you say just what you meant? How will the person on the other end read the words?

Maintain an environment free of harassment, stalking, threats, abuse, insults or humiliation toward the instructor and classmates. This includes, but is not limited to, demeaning written or oral comments of an ethnic, religious, age, disability, sexist (or sexual orientation), or racist nature; and the unwanted sexual advances or intimidations by email, or on discussion boards

and other postings within or connected to the online classroom.

If you have concerns about something that has been said, please let your instructor know.

**CLASS SCHEDULE:**

| Module | Module Learning Outcomes | Assignments |
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| **1 –Energy** | ● Make predictions about the changes in kinetic energy of an object based on considerations of the direction of the net force on the object as the object moves.<br>● Use net force and velocity vectors to determine qualitatively whether kinetic energy of an object would increase, decrease, or remain unchanged.<br>● Use force and velocity vectors to determine qualitatively or quantitatively the net force exerted on an object and qualitatively whether kinetic energy of that object would increase, decrease, or remain unchanged.<br>● Apply mathematical routines to determine the change in kinetic energy of an object given the forces on the object and the displacement of the object.<br>● Calculate the total energy of a system and justify the mathematical routines used in the calculation of component types of energy within the system whose sum is the total energy.<br>● Predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system.<br>● Make predictions about the changes in the mechanical energy of a system when a component of an external force acts parallel or antiparallel to the direction of the displacement of the center of mass.<br>● Apply the concepts of Conservation of Energy and the Work-Energy theorem to determine qualitatively and/or quantitatively that work done on a two-object system in linear motion will change the kinetic energy of the center of mass of the system, the potential energy of the systems, and/or the internal energy of the system.<br>● Define open and closed systems for everyday situations and apply conservation concepts for energy to those situations.<br>● Set up a representation or model showing that a single object can only have kinetic energy and use information about that object to calculate its kinetic energy.<br>● Translate between a representation of a single object, which can only have kinetic energy, and a system that includes the object, which may have both kinetic and potential energies.<br>● Calculate the expected behavior of a system using the object model (i.e., by ignoring changes in internal structure) to analyze a situation. | ● Short Answer Assignment<br>● Lab<br>● Mastery Exercise<br>● Module Exam |

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| **2 - Momentum** | ● Justify the selection of data needed to determine the relationship between the direction of the force acting on an object and the change in momentum caused by that force.<br>● Justify the selection of routines for the calculation of the relationships between changes in momentum of an object, average force, impulse, and time of interaction.<br>● Predict the change in momentum of an object from the average force exerted on the object and the interval of time during which the force is exerted.<br>● Calculate the change in linear momentum of a two-object system with constant mass in linear motion from a representation of the system (data, graphs, etc.).<br>● Analyze data to find the change in linear momentum for a constant-mass system using the product of the mass and the change in velocity of the center of mass.<br>● Apply the principles of conservation of momentum and restoration of kinetic energy to reconcile a situation that appears to be isolated and elastic, but in which data indicate that linear momentum and kinetic energy are not the same after the interaction, by refining a scientific question to identify interactions that have not been considered.<br>● Classify a given collision situation as elastic or inelastic, justify the selection of conservation of linear momentum and restoration of kinetic energy as the appropriate principles for analyzing an elastic collision, solve for missing variables, and calculate their values.<br>● Plan data collection strategies to test the law of conservation of momentum in a two-object collision that is elastic or inelastic and analyze the resulting data graphically.<br>● Apply the conservation of linear momentum to a closed system of objects involved in an inelastic collision to predict the change in kinetic energy.<br>● Classify a given collision situation as elastic or inelastic, justify the selection of conservation of linear momentum as the appropriate solution method for an inelastic collision, recognize that there is a common final velocity for the colliding objects in the totally inelastic case, solve for missing variables, and calculate their values. | ● Short Answer Assignment<br>● Lab<br>● Mastery Exercise<br>● Module Exam |
| **3 – Rotational Kinematics** | ● Describe the rotation of a system with respect to time using angular displacement, angular velocity, and angular acceleration.<br>● Describe the linear motion of a point on a rotating rigid system that corresponds to the rotational motion of that point, and vice versa. | ● Short Answer Assignment<br>● Lab<br>● Mastery Exercise<br>● Module Exam |

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| **4 – Rotational Dynamics, Energy, & Momentum** | ● Use representations of the relationship between force and torque.<br>● Compare the torques on an object caused by various forces.<br>● Estimate the torque on an object caused by various forces in comparison to other situations.<br>● Design an experiment and analyze data testing a question about torques in a balanced rigid system.<br>● Calculate torques on a two-dimensional system in static equilibrium, by examining a representation or model (such as a diagram or physical construction).<br>● Make predictions about the change in the angular velocity about an axis for an object when forces exerted on the object cause a torque about that axis.<br>● Plan data collection and analysis strategies designed to test the relationship between a torque exerted on an object and the change in angular velocity of that object about an axis.<br>● Predict the behavior of rotational collision situations by the same processes that are used to analyze linear collision situations using an analogy between impulse and change of linear momentum and angular impulse and change of angular momentum.<br>● In an unfamiliar context or using representations beyond equations, justify the selection of a mathematical routine to solve for the change in angular momentum of an object caused by torques exerted on the object.<br>● Plan data collection and analysis strategies designed to test the relationship between torques exerted on an object and the change in angular momentum of that object. | ● Short Answer Assignment<br>● Lab<br>● Mastery Exercise<br>● Module Exam |
| **5 – Simple Harmonic Motion** | ● Understand how restoring forces can result in oscillatory motion.<br>● Understand how a spring exerting a linear restoring force increases with mass and decreases with spring stiffness.<br>● Demonstrate simple pendulum and simple mass spring experiments.<br>● Understand the relationship between pendulum oscillation periods and pendulum length. | ● Short Answer Assignment<br>● Lab<br>● Mastery Exercise<br>● Module Exam |
| **6 – Fluids** | ● 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.<br>● Use Lenz's law to determine the direction of induced currents.<br>● Depict coupled currents and explain the term coefficient of coupling.<br>● Understand the effect that inductance has on steady direct current, and direct current that is changing in magnitude. | ● Short Answer Assignment<br>● Lab<br>● Mastery Exercise<br>● Module Exam |
| **7 – Review & Final Exam** | ● Review topics in Principles with Applications and The Character of Physical Law;<br>● Review the AP Physics 1: Algebra-Based course overview: https://apstudent.collegeboard.org/apcourse/ap-physics-1<br>● Zoom meetings with instructor and discussion board post | ● Reflection Paper<br>● Final Exam |