NEW JERSEY CENTER
FOR TEACHING & LEARNING

Progressive Science Initiative® (PSI®)
PHYS6658: Learning & Teaching AP Physics 2: Advanced Topics

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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 covers two-dimensional an introduction to electromagnetics and modern physics.

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

1. Demonstrate an understanding of advanced waves and modern physics topics.
2. Students will solve mechanical waves problems.
3. Students will solve electromagnetic waves problems.
4. Students will solve geometric optics problems.
5. Students will solve quantum physics problems.
6. Students will solve atomic models problems.

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7. Students will solve nuclear physics 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 Algebra-Based Physics uses a free digital textbook accessible at: https://njctl.org/materials/courses/ap-physics-2/
- Participants will download SMART Notebook presentations, homework files, labs, and teacher resources from the PSI Algebra-Based Physics Course

Recommended Texts:

- Giancoli (2005). *Physics: Principles with Applications / Edition 6* ISBN-13: 9780130352569

- Holton, G. J., Brush, S. G., & Holton, G. J. (2001). *Physics, the Human Adventure: From Copernicus to Einstein and Beyond*. New Brunswick, N.J: Rutgers University Press. ISBN-13: 9780813529080

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:

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

Grade Scale:

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

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.

	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 detailed , 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 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 composed of 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
1 – Mechanical Waves	● Understand how waves can propagate via different oscillation modes, such as transverse and longitudinal. ● Use graphical representation of a periodic mechanical wave to determine the amplitude of the wave. ● Explain and predict qualitatively how the energy carried by a wave relates to the amplitude of the wave. ● Describe wave refraction, diffraction and interference. ● Understand how sound waves can propagate via different oscillation modes, such as transverse and longitudinal. ● Use a graphical representation of a periodic mechanical wave to determine the amplitude of the sound wave. ● Explain and predict qualitatively how the energy carried by a sound wave relates to the amplitude of the wave and apply this concept to a real-world example. ● Apply the Doppler Effect to real-life scenarios.	● Short Answer ● Lab ● Mastery Exercises ● Module Exam
2 - Electromagnetic Waves	● Contrast mechanical and electromagnetic waves in terms of the need for a medium in wave propagation. ● Qualitatively apply the wave model to quantities that describe the generation of interference patterns to make predictions about interference patterns that form when waves pass through a set of openings when spacing and widths are small compared to the wavelength of the waves. ● Predict and explain, using representations and models, the ability or inability of waves to transfer energy around corners and behind obstacles in terms of the diffraction property of waves in	● Short Answer ● Lab ● Mastery Exercises ● Module Exam

	situations involving various kinds of wave phenomena, including sound and light. ● Solve for wave speed, velocity or frequency using the wave equation and solve for wavelength and velocity using Snell's Law. ● Make qualitative comparisons of the wavelengths of types of electromagnetic radiation. ● Describe representations and models of electromagnetic waves that explain the transmission of energy when no medium is present. ● Understand properties of electromagnetic radiation.	
3 - Geometric Optics	● Understand that light can be modeled as a ray. ● Describe reflection and refraction. ● Calculate the aspects of an image formed by reflection and refraction in terms of height, virtual/real, upright/inverted for mirrors and thin lenses. ● Explain how light refracts when it passes through different media. Solve Snell's Law equations. ● Demonstrate how to draw ray diagrams to find the location of an image.	● Short Answer ● Lab ● Mastery Exercises ● Module Exam
4 – Quantum Physics	● Explain how the model of light as a particle worked for many phenomena that were previously only thought of as waves. ● Understand the early history of modern physics, including the discovery of the electron and its charge, and the nucleus, X-rays, and radiation. ● Understand how Max Planck's analysis of Blackbody radiation started the formation of quantum physics. ● Solve equations for Blackbody radiation, photoelectric effect and the Compton effect.	● Short Answer ● Lab ● Mastery Exercises ● Module Exam
5 – Atomic Models	● Compare and contrast the plumb pudding model with the Bohr Model and the beginning of quantum physics. ● Solve equations derived from the Bohr Model that yield the size and energy of the quantized energy levels ● Explain how physical phenomena can be explained via a particle or a wave model depending on the situation. ● Discuss the standard model and understand the size and structure of the nucleus.	● Short Answer ● Lab ● Mastery Exercises ● Module Exam

	● Solve problems within Special Relativity.	
6 – Nuclear Physics	● Continue the explanation of the structure of the nucleus from the Atomic Models module. ● Understand and calculate binding energy and the mass defect of nuclei. The mass of component particles in a nucleus are greater than the mass of the nucleus. ● Describe the three types of radioactivity and solve problems involving the nuclear half-life ● Write nuclear reaction equations. ● Describe fission and fusion and how they are alike and different.	● Reflection Paper ● Final Exam
7– Final Exam & Reflection	● Review course topics in preparation for final exam ● Zoom meetings with instructor and discussion board posts	● Reflection Paper ● Final Exam