NEW JERSEY CENTER
FOR TEACHING & LEARNING

Progressive Science Initiative® (PSI®)

PHYS6643: Learning & Teaching Algebra-Based Physics: Modern Physics

Primary Student Contact:	Yuriy Zavorotniy	yuriy@njctl.org
Faculty Team:	Dr. Bob Goodman	bob@njctl.org
	Dr. John Ennis	john@njctl.org
	Yuriy Zavorotniy	yuriy@njctl.org
	Katy Goodman	katy@njctl.org

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 is the last of three mini-courses which, together, are designed for those who are learning to teach Algebra-Based physics for middle school or high school students, focusing on conveying physics and mathematical concepts and understandings. Underlying themes are physics connections to everyday life, applications of mathematics 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 final course comprises modern physics, including Simple Harmonic Motion, Waves, Light and the Bohr model of the Hydrogen atom for the last 20% of a year-long Physics course, with some additional topics that are beyond the scope of a first year high school course but are needed for the Praxis exam..

The order of the topics has been geared towards reinforcing skills in algebra and requires no trigonometry. This is accomplished by only including problems that can be simplified to one dimensional form. While vectors are introduced, they are only added and subtracted in one dimension at a time. Connections are also developed between the analysis of motion and graphical

analysis, collision problems and the solving of systems of equations.

Teachers will learn core foundational concepts in mechanics topics as well as the pedagogical content knowledge needed to successfully teach introductory physics to students.

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

1. Understand and apply concepts of modern physics.
2. Students will solve simple harmonic motion problems.
3. Students will solve sound waves problems.
4. Students will solve electromagnetic waves problems.
5. Students will solve quantum physics and atomic models problems.
6. Students will solve special relativity problems.
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/courses/science/algebra-based-physics/
- Participants will download SMART Notebook presentations, homework files, labs, and teacher resources from the PSI Algebra-Based Physics Course

Recommended Texts:
The Physics Classroom - http://www.physicsclassroom.com/

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

HyperPhysics - http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

PhET (simulations) - http://phet.colorado.edu/en/simulations/category/physics

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.

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 – Simple Harmonic Motion	• Predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties. • Design a plan and collect data in order to ascertain the characteristics of the motion of a system undergoing oscillatory motion caused by a restoring force. • Analyze data to identify qualitative or quantitative relationships between given values and variables (i.e., force, displacement, acceleration, velocity, period of motion, frequency, spring constant, string length, mass) associated with objects in oscillatory motion to use that data to determine the value of an unknown. • Construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force. • Predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties.	• Short Answer • Lab • Mastery Exercises • Module Exam
2 – Sound Waves	• Use a visual representation to construct an explanation of the distinction between transverse and longitudinal waves by focusing on the vibration that generates the wave. • Describe representations of transverse and longitudinal waves. • Analyze data (or a visual representation) to identify patterns that indicate that a particular mechanical wave is polarized and construct an explanation of the fact that the wave must have a vibration perpendicular to the direction of energy propagation. • Use a visual representation to construct an explanation of the distinction between	• Short Answer • Lab • Mastery Exercises • Module Exam

	transverse and longitudinal waves by focusing on the vibration that generates the wave. • Explain and predict qualitatively how the energy carried by a sound wave relates to the amplitude of the wave, and/or apply this concept to a real-world example.	
3 – 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 whose spacing and widths are small compared to the wavelength of the waves. • 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.	• Short Answer • Lab • Mastery Exercises • Module Exam
4 – Quantum Physics & Atomic Models	• Understand the applications of electricity and magnetism that led to the discovery of electrons and X-rays. • Use Planck's constant to solve for energy of a photon and explain the photoelectric effect. • Apply principles of electricity and magnetism to understand the development of atomic models. • Explain and describe the structure of the atom. • Differentiate between classical physics and quantum mechanics.	• Short Answer • Lab • Mastery Exercises • Module Exam
5 - Special Relativity	• Describe and explain Einstein's postulates. • Describe the time dilation, length contraction, and mass-energy equivalent. • Describe simultaneity of events. • Describe relativistic momentum and energy.	• Short Answer • Lab • Mastery Exercises • Module Exam
6 - Nuclear Physics	• Describe the physical properties that constrain the behavior of interacting nuclei, subatomic particles, and nucleons. • Describe the strong force is exerted at nuclear scales and dominates the interactions of nucleons (protons or neutrons). • Solve problems related to possible nuclear reactions by applying the laws of conservation of nucleon number and conservation of mass-energy.	• Short Answer • Lab • Mastery Exercises • Module Exam

	● Describe the nuclear fusion is the process by which two or more smaller nuclei combine to form a larger nucleus, as well as subatomic particles. ● Describe the Nuclear fission is the process by which the nucleus of an atom splits into two or more smaller nuclei, as well as subatomic particles. ● Describe the radioactive decay of a given sample of material consisting of a finite number of nuclei.	
7 – Final Reflection	• Review topics as desired in *Physics, the Human Adventure* (recommended) • Zoom meeting with instructor	• Discussion Board • Reflection Paper • Final Exam