NEW JERSEY CENTER
FOR TEACHING & LEARNING

Progressive Science Initiative® (PSI®)
PHYS6646: Learning and Teaching PSI Trigonometry-Based Physics: Advanced Topics

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Course Credit: 3.0 NJCTL credits

Dates & Times:
This is a 3-credit, self-paced course, covering 6 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 for teachers to learn the content of PSI Trigonometry-Based Physics and how to teach that course to students, while providing teachers a greater depth of understanding to support their teaching of PSI Algebra-Based Physics. Topics include two-dimensional mechanics, two-dimensional electric force and field, rotational motion, geometric optics, fluids, and thermal physics.

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

1. Students will solve 2-dimensional mechanics problems.
2. Students will solve 2-dimensional electrostatics problems.
3. Students will solve rotational physics problems.
4. Students will solve geometric optics problems.
5. Students will solve fluids problems.
6. Students will solve thermal physics problems.
7. 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, AP Physics 2 uses a free digital textbook accessible at: https://njctl.org/materials/courses/ap-physics-1/ and https://njctl.org/materials/courses/ap-physics-2/
- Participants will download SMART Notebook presentations, homework files, labs, and teacher resources from the PSI AP Physics 1 and AP Physics 2 courses

Recommended Texts and Resources:

- Next Generation Science Standards for Physical Science: https://www.nextgenscience.org/sites/default/files/HS%20PS%20topics%20combined%206.12.13.pdf

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 discovery-based student learning 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%
Short Answer Assignments	6%
Labs	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 detail ed, as applicable.	• Writing is mostly clear, concise, and well organized with good sentence/paragrap h 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,	• Some minor errors or omissions in writing	• Some significant errors or omissions in writing	• Numerous errors in writing organization,

	and focused; no errors.	organization, focus, and clarity.	organization, focus, and clarity.	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 – Physics in Two Dimensions	● Differentiate between vector and scalar quantities. ● Express the motion of an object using narrative, mathematical, and graphical representations in two dimensions. ● Design an experimental investigation of the motion of an object. ● Analyze experimental data describing the motion of an object and is able to express the results of the analysis using narrative, mathematical, and graphical representations. ● Use vector diagrams and trigonometry to solve two dimensional and projectile motion problems. ● Solve problems in 2 dimensional dynamics. Select appropriate instructional strategies for teaching the module content using trigonometry.	● Short Answer Assignment ● Lab ● Mastery Exercise ● Module Exam
2 - Electrostatics in Two Dimensions	● Describe the electric force and electric field that results from the interactions between charged objects or systems. ● Express the electric field due to multiple charges using narrative, mathematical, and graphical representations in two dimensions. ● Design an experimental investigation to determine the electric field (magnitude and direction) of multiple charges located on the two-dimensional plane. ● Analyze experimental data describing the two-dimensional electric filed and express the results of the analysis using narrative, mathematical, and graphical representations. ● Use vector diagrams and trigonometry to solve problems involving two- dimensional electric field. ● Select appropriate instructional strategies for teaching the module content using trigonometry.	● Short Answer Assignment ● Lab ● Mastery Exercise Module Exam

3 – Rotational Physics	● Use representations of the relationship between force and torque. ● Compare the torques on an object caused by various forces. ● Estimate the torque on an object caused by various forces in comparison to other situations. ● Calculate torques on a two-dimensional system in static equilibrium, by examining a representation or model (such as a diagram or physical construction). ● 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. ● 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. ● 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. ● Design an experiment testing questions about torque. ● Analyze data collected from an experiment to draw conclusions about torque. ● Calculate the magnitude of angular momentum of a point object about an axis. ● Calculate the magnitude of angular momentum of an extended object. ● Predict the behavior of rotational collision using an analogy between impulse and change of linear momentum and angular impulse and change of angular momentum.	● Short Answer Assignment ● Lab ● Mastery Exercise ● Module Exam
4 – Geometric Optics	● Plan data collection strategies for finding the relationship between the angle of incidence and the angle of refraction for light crossing boundaries from one transparent material to another (Snell's law). ● Evaluate data to describe the relationship between the angle of incidence and the angle of refraction for light crossing boundaries from one transparent material to another. ● Make predictions about the locations of object and image relative to the location of a reflecting surface based on the model of specular reflection with all angles measured relative to the normal to the surface. ● Use quantitative and qualitative representations and models to analyze situations and solve problems about image formation occurring due to the reflection of light from surfaces. ● Use quantitative and qualitative representations and models to analyze situations and solve problems about image formation occurring due to the refraction of light through thin lenses. ● Select appropriate instructional strategies for teaching the module content using trigonometry.	● Short Answer Assignment ● Lab ● Mastery Exercise ● Module Exam

5 – Fluids	● Predict densities, differences in densities or changes in densities under different conditions for natural phenomena and design an investigation to verify the prediction. ● Select from experimental data the information necessary to determine the density of an object and/or compare densities of several objects. ● Use Bernoulli's equation to make calculations related to a moving fluid. ● Use Bernoulli's equation and/or the relationship between force and pressure to make calculations related to a moving fluid. ● Use Bernoulli's equation and the continuity equation to make calculations related to a moving fluid. ● Construct an explanation of Bernoulli's equation in terms of the conservation of energy. ● Explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces and that they therefore have certain directions. ● Select appropriate instructional strategies for teaching the module content using trigonometry.	● Short Answer Assignment ● Lab ● Mastery Exercise ● Module Exam

6 – Thermal Physics	● Make predictions about the direction of energy transfer due to temperature differences based on interactions at the microscopic level. ● Calculate the expected behavior of a system using the object model to analyze a situation. ● Justify the use of conservation of energy principles to calculate the change in internal energy due to changes in internal energy due to changes in internal structure. ● Develop predictions about the internal energy of systems. ● Calculate changes in kinetic energy and potential energy of a system using information from representations of that system. ● Design an experiment and analyze data to examine how a force exerted on an object or system does work. ● Make claims about the interaction between a system and its environment in which the environment exerts a force on the system, thus doing work on the system and changing the energy of the system. ● Predict and calculate the energy transfer to an object or system from information about a force exerted on the object or system through a distance. ● Design and analyze graphical data in which interpretations of the area under a pressure-volume curve are needed to determine the work done on or by the object or system. ● Describe the models that represent processes by which energy can be transferred between a system and its environment because of differences in temperature: conduction, convection and radiation. ● Predict qualitative changes in the internal energy of a thermodynamic system involving transfer of energy due to heat or work done and justify those predictions in terms of conservation of energy principles. ● Create a plot of pressure versus volume for thermodynamic process from given data. ● Use a plot of pressure versus volume for a thermodynamic process to make calculations of internal energy changes, heat, or work, based upon conservation of energy principles. ● Select appropriate instructional strategies for teaching the module content using trigonometry.	● Short Answer Assignment ● Lab ● Mastery Exercise ● Module Exam
7 – Reflection and Final Exam	● Review course topics ● Zoom with course instructor, as needed	● Reflection Paper ● Final Exam