Ph-112B Physics I: Mechanics

Spring 2025

Course description: Static equilibrium, kinematics, Newton's Laws, non-inertial frames of reference, system of particles, work and energy, linear and angular momentum, rigid body motion, conservation laws, oscillation.

Instructor:	Emily Palmer
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	41 Cooper Square Room 511
Meeting times:	Wednesday 10-11:50 AM in 41 Cooper Square, Room 502
	Friday 12-2:50 PM in 41 Cooper Square, Room 504
Office hours:	Tuesday 3-4 PM in 41 Cooper Square, Room 511
	Thursday 2-4 PM in 41 Cooper Square, Room 511
Required text:	*Fundamentals of Physics* by Halliday, Resnick, and Walker. The Cooper Union library can provide a digital copy. You may refer to most recent versions of the text, as they are generally aligned on content; I will assign readings out of the 9^{th} edition and homework problems will not be drawn directly from the textbook.
	Additional resources may be provided throughout the course via Teams.

Class structure: In order to be an effective engineer or scientist, you must master the relevant technical material, effectively communicate with your peers and other stakeholders, and recognize pertinent and interesting challenges to motivate your work. In this course, we will attempt to develop and assess our skills in all three areas. Table 1 provides information on the grading scheme that will be used.

Table 1 Grading scheme

Activity	Description	Weight
Exams	Three equally weighted exams administered throughout the semester.	45%
Final exam	Cumulative final exam.	25%
Homework	Weekly equally-weighted assignments, with the lowest two scores dropped. Homework will be due Fridays at 5 pm virtually. Late homework assignments will not be accepted.	15%
Project	See description below and rubric in Table 4.	10%
Participation	Each of us has different levels of comfort with participation and different areas of comfort. For example, some may shine while working in small groups, while others may be at more at ease presenting a homework problem to the class as a whole. Throughout the semester, you will be presented with varied opportunities to participate and should seek to expand your comfort and skill with a variety of forms of communication. Please note here that you should not necessarily aspire to speak the most in the group. Instead, aim to hone all your communication skills, including active listening, respect, clarity, and concision. See rubric in Table 3.	5%

A tentative course schedule is provided in Table 2. This schedule is subject to change; please check the course Teams page for updates.

Table 2 Tentative course schedule

Date	Topic	Reading
Jan 22	Introduction to Ph-112; dimension	HRW 1
Jan 24	Motion and vector review	HRW 2-3
Jan 29	2- and 3-D motion	HRW 4
Jan 31	Newton's Laws I	HRW 5.1-5
Feb 5	Newton's Laws II	HRW 5.6-9
Feb 7	Friction	HRW 6.1-4
Feb 12	Circular motion and review	HRW 6.5
Feb 14	No class	
Feb 19	**Exam I**	
Feb 21	Work and kinetic energy	HRW 7
Feb 26	Potential energy and conservative forces	HRW 8.1-4
Feb 28	Conservation of energy	HRW 8.5-8
Mar 5	Center of mass and momentum	HRW 9.1-5
Mar 7	Collisions	HRW 9.6-11
Mar 12	No class	
Mar 14	Varying mass and review	HRW 9.12
Mar 19	**Exam II**	
Mar 21	Rotation I: Rotational kinematics	HRW 10.1-5
Mar 26	Rotation II: Energy and work	HRW 10.6-10
Mar 28	Rotation III: Momentum	HRW 11
Apr 2	Statics and equilibrium	HRW 12
Apr 4	Modeling and review	
Apr 8	Gravitation	HRW 13.1-6
Apr 9	**Exam III**	
Apr 11	Satellite motion and Kepler's laws	HRW 13.7-9
Apr 12-20	Spring recess	
Apr 23	Simple harmonic oscillators	HRW 15.1-7
Apr 25	Fluids	
Apr 30	Not-so-simple harmonic oscillators	HRW 15.8-9
May 2	Review	
May 7	**Project symposium**	
May 8-9	Study period	
May 14	**Final exam**	

Course goals: In this course you will gain a physical and mathematical understanding of the fundamental laws of physics governing mechanics. The intended goal of the course structure outlined in this syllabus is for you walk away with

- An intuitive understanding of physical quantities and how they relate to one another
- The ability to set up and solve a wide variety of problems
- The ability to interpret the physical meaning of your results
- The ability to present your work in clear and impactful ways and
- The ability to foster a respectful and collaborative classroom environment.

The expected high-level learning outcomes for the course are:

- Perform vector and scalar operations including addition, subtraction, and multiplication. Determine vector magnitudes and angles relative to a given reference frame and transform between reference frames.
- Analyze the relationships between position, velocity, acceleration, and time in 1-, 2-, and 3-D.
- Understand static and dynamical Newtonian mechanics, including forces, energy, work, and momentum.
- Apply Newton's laws and conservation laws to quantitatively describe linear and rotational motion.
- Identify relevant forces, their origins, and their points of application for given problems.
- Graphically represent bodies and the forces acting upon them.
- Predict the behavior of bodies following collisions.
- Evaluate whether static equilibrium is relevant for a given problem and quantitatively determine the forces involved.

Accommodations: I strive to maintain an environment where all students can thrive. Students seeking accommodations are required to notify the Dean of Students, who will issue a letter detailing the accommodations. You must then meet with me to discuss how I can ensure the accommodations you are eligible for are met. Accommodations will not be applied unless the student notifies me directly. For more information on student support services, please see here.

Academic integrity: Collaboration is expected and encouraged on homework assignments and in developing your final projects. However, your submitted work should reflect your level of understanding and not that of your peers. While this leaves room for interpretation, let our core values and your own judgment guide you. You are also advised to note who you have collaborated with and cite any references you have used (as well as use of any AI tools). Please keep in mind also that homework is principally an opportunity for learning, and treat it as such.

You will be given a reference sheet during exams. You will not have access to the textbook or the internet. You will need a calculator that cannot connect to the internet. Any plagiarism will result in a zero grade for all participants.

Attendance: Students are expected to attend all class hours unless ill, quarantined, or observing a religious holiday. If you anticipate missing a class, please inform me beforehand if possible. Unplanned absences on the day of exams should be avoided. If there is a serious medical reason or other valid emergency, you must communicate your needed absence immediately both to me and to the Director of Student Care and Support, Alex Fischer. The Student Care team will validate your specific circumstances, generally requiring documentation of some kind, and will then communicate the excused absence to me and your other professors. Without this step, your absence will be considered "unexcused" and you will not be permitted to make up any assignments or exams.

Table 3 Participation rubric

	Level		
Criteria	Exemplary (5 points)	Satisfactory (3 points)	Unsatisfactory (1 point)
Listening	Actively and respectfully listens to peers and instructor.	Sometimes displays lack of interest when others are speaking.	Projects lack of interest of disrespect for others.
Preparation	Arrives to class fully prepared, as demonstrated by completed assignments or demonstrated effort on all problems, questions and/or comments, and/or ready responses to questions from peers.	Sometimes arrives unprepared or with only superficial preparation.	Exhibits little evidence of having completed or thought about assigned material.
Impact	Comments are relevant and reflect understanding of material and/or previous remarks of others. Comments frequently help move the group forward and/or aid others in understanding material.	Comments sometimes are irrelevant and/or reflect a lack of attention to comments made by others. Comments sometimes do little to drive the group forward.	Comments do not advance the group and are actively harmful to it.

Project description: This open-ended project will allow you to apply the physics we learn this semester via experimentation, simulation, or analysis of some system you identify in the world. You may also suggest another format. Some suggestions:

- Testing a theory
- Creating a demonstration or other scientific communication tool
- Verifying a result from a problem set or class example
- Recreating a classical experiment
- Analyzing a system (consider drawing inspiration from engineered systems, the natural world, or fiction)

You may consider building something, experimentation, simulation or modeling, or another format. A one-page project proposal will be due April 1. Final projects will be due May 7, including a brief written report on the work you have done; on May 7 we will also have a project symposium where you will be expected to share your project with the class with a five minute talk or demonstration.

Table 4 Project rubric

	Level		
Criteria	Exemplary (5 points)	Satisfactory (3 points)	Unsatisfactory (1 point)
Proposal	Proposed project is relevant both to course material and personal interest, reflecting intellectual exploration and creativity. Proposed format is appropriate in scale and thoughtfully chosen given the selected topic. Project can be reasonably accomplished by the end of the semester, as evidenced by a comprehensive plan for completion.	Proposal reflects a lack of intellectual exploration and limited care in format selection. Project is not well-scoped (i.e., requires too little or too much work).	Proposed project is unrelated to course material. Project is trivial or impossible.
Content	Demonstrated deep understanding of project material and relevant course material. Provided some quantitative analysis of material in final report.	Only demonstrated a surface-level understanding of technical material.	Major technical errors in content, indicating a lack of understanding both of project topic and course material.
Style	Project is engaging to a wide audience, professionally composed, and free of errors.	Project is not well motivated for a general scientific audience and contains a few errors.	Project is inaccessible to a technical audience and has many errors.