Honors Physics 1 for Scientists and Engineers

Physics 0475, University of Pittsburgh *(Fall 2021)*

Syllabus – Version 4 – 2021-09-03

Course Information

Meeting Time: Mon, Tue, Wed, Thu, Fri: 11:00-11:50 AM
Meeting Location: Thaw Hall 102

Instructor Information

- Lecturer: Prof. Michael Wood-Vasey, wmwv@pitt.edu
  Office Hours: Mon 1-2 pm. Thu 10-11 am.
  Monday in person in Allen 319 or 320.
  - My office is Allen 320. We will move next door to Allen 319 if we need more space.
    Thursday via Zoom: https://pitt.zoom.us/my/michaelwv
- TA: Jared Hand, jsh89@pitt.edu
  Office Hours: Wed 3-4 pm. Thu 3-4 pm.
  Remote via Zoom: https://pitt.zoom.us/j/6692975773

Course Description

This the first term of an honors-level two-term course in university physics. Previous familiarity with introductory mechanics and calculus will be assumed. Physics 0475 and 0476 are the honors version of Physics 0174 and 0175*. Physics 0475 will cover classical mechanics, oscillating systems, wave motion, and gravitation. Emphasis will be on those aspects of classical physics that underlie the main developments of modern physics and engineering. See the Learning Objectives at the end of this syllabus for a detailed list of the things you will be able to do after successfully completing this course.

[*] Yes, yes, I know. The ending digits are off by one for the honors version – long story.

Course Structure

Lectures (MWF) will be interspersed with short exercises and synchronous group work. Homework will be due weekly on Fridays (*including the first day, August 27*). There will be 3 mid-term exams and a cumulative final. Recitations (TTh) will be led by the TA. Tuesday recitations will be a discussion of the key concepts and math along with a worksheet on that week's topics. On Thursdays recitation will be devoted to answering questions on the homework – you will get the most out of this if you have seriously attempted each of the homework problems before Thursday's recitation.

- Before each lecture class (*including the first class*) you will be expected to complete:
  (1) Reading; (2) Video; (3) Concept Quiz

Logistics

We will begin our semester with two weeks of a hybrid format. After that, the default plan is for classes to be in person. If you are planning to attend remotely in the first two weeks, please let me konw. If later during the term (when we are completely in-person) you find yourself not able to attend in person for some number of days, please let me know and I will work together with you to come up with an effective plan to supplement your experience.

Textbook, Videos, and References

1. REQUIRED: "An Introduction to Mechanics". Kleppner and Kolenkow, 2014, 2nd edition ISBN-978-0-521-19811-0
   This is our main textbook. I will refer to it as "K&K". This is around $60 on Amazon or $70 new at the Pitt Bookstore. I've seen it used for as low as $40, but make sure you're getting the 2nd edition (and not the 1st). You can rent it for $25 through Amazon (or $50-60 through the Pitt Bookstore, which seems silly at that price), but this is a foundational textbook that you will want to refer to again in the future. I recommend you buy rather than rent.

   There is a copy on reserve at the Engineering Library.

2. RECOMMENDED: OpenSTAX, University Physics, Volume 1.
   https://openstax.org/books/university-physics-volume-1/
   This online textbook provides a good free reference of an introductory calculus-based intro physics mechanics course. It reviews physics concepts in more detail than what is presented in Kleppner and Kolekow. Reviewing the same concepts in both this OpenSTAX book and K&K may be helpful in seeing things in different ways. We will also specifically use this text to discuss Waves, which are not covered in K&K. This textbook is available free through the website, as a PDF, or a Kindle ebook.

3. SUGGESTED: "Problems and Solutions in Introductory Mechanics", David Morin. 2014 ISBN 978-1482086928 https://scholar.harvard.edu/david-morin/mechanics-problem-book
   These present a nice set of exercises, problems, and solutions covering the basics of mechanics. These problems are at an "easier" level than K&K, and are excellent to practice to make sure you understand the basics of a particular topic. The print version is $18. The Kindle version is only $6. The first 4 chapters are freely available on Dr. Morin's website. I particularly recommend the guide on Problem-Solving Strategies: https://scholar.harvard.edu/files/david-morin/files/problemschap1.pdf

4. I will provide videos to watch before most of lectures. These will be a combination of videos recorded by me and additional videos from different excellent sources on the web.

5. I will provide some additional supplemental readings during the semester. Read them.

6. We are fortunate to live in a rich, interconnected time in human history. There is a wealth of information available online about each of the topics we will cover. I encourage you to pursue additional materials, particularly on issues that you are having trouble understanding initially.

Reading assignments follows the schedule outlined in the Calendar below.

Grading

Percentage	Component
10%	Participation
20%	Homework
45%	Exams (at 15% each)
25%	Final

Participation

In this course you will be responsible for both your own and your colleagues's learning. Being prepared for class is a key part of aiding both your learning and that of the class (read the book! watch the videos! take the quiz!). One way in which you can assist your colleague's learning is to ask questions. If you are confused about something, you are almost definitely not alone; others will also be confused. Another key way is to fully participate in in-class interactive discussions and small-group discussions.

We will be using TopHat for interactive student responses during the class so you can get a sense of what your classmates think about a problem and feedback about your own understanding.

Participation will be based on participating in the TopHat questions during lecture, pre-class concept quizzes, and in the group activities during class.

Homework

Homeworks will be graded on completeness, with one or two problems each week graded for correctness.

Each week you will complete a homework assignment that uses the material for the current week and builds on previous material. Assignments will be posted on Canvas. Completed homework should be submitted either (1) through the "Homework" slot under the Physics Department mailboxes on the 1st floor of Allen Hall; or (2) uploaded to Canvas in response to the respective homework assignment.

Working and discussion with classmates is very much encouraged, but solutions should be your own. Please list the names of your colleagues with whom you worked on each homework assignments. There is no particular credit assigned to such a list – this is for your own benefit to acknowledge credit and contributions.

Homework is an opportunity to develop your understanding of the course material. Be honest with yourself about whether or not you fully understand a problem. The exams will test this.

Exams

There will be three mid-term exams during the semester.

The mid-term exams and final will be closed-book. You will be allowed to bring in regular-sized piece of paper for notes. You will write your answers in the "blue books" that will be distributed along with the questions for the exam. You will be allowed calculators so that we can ask interesting real-life-inspired problems.

Exams and the Final will be graded on both correctness and completeness. Many questions will ask you to used sentences, diagrams, and equations to answer problems. You will lose points if you do not include all three methods to explain your answer.

You may turn in a new set of solutions for an exam for up to half credit on the points you missed. The new solutions should also include an explanation of what you were thinking in your original attempt and how you would explain to your past self what a correct approach and solution to the problem would be. These new solutions will be due a week after I return the graded exams to the class.

Final

There will be a cumulative final during finals week that will be worth 20% of the grade.

The there will not be the same revision opportunity for the final exam as there will be for the mid-term exams.

Calendar

Week of	Reading	Planned material	Calendar Notes
08/23	K&K 1	Vectors	*First class is Friday, August 27*
08/30	K&K 1, 2	Vectors; Newton's Laws	
09/06	K&K 3	Forces	*No class Monday, Sep 6*
09/13	K&K 4	Momentum	
09/20	*Exam 1, Fri, Sep 24*		
09/27	K&K 5	Energy	
10/04	K&K 6	Dynamics	
10/11	K&K 7	Angular Momentum	*No class Friday, Oct 15*
10/18	*Exam 2, Fri, Oct 22*		
10/25	K&K 8	Rigid Body Motion	
11/01	K&K 9	Non-Inertial Systems	
11/08	K&K 11	Simple Harmonic Oscillator	
11/15	*Exam 3, Fri, Nov 19*		
11/22	—	—	*No class this week (Thanksgiving)*
11/29	OpenStax 16	Waves	
12/06	K&K 12	Special Relativeity	
12/13	FINAL EXAM	Friday, Dec 17 10:00-11:50 am	

Acknowledgments

Attribution and credit is the core currency of respect and recognition in science.

The structure, lectures, assignments and other material in this course are based on an extensive history of physics education over the past 100 years, with roots extending beyond that. More specifically, my resources for this course are based on previous editions of this course taught by Prof. Adam Leibovich and Prof. Arthur Kosowsky.

Similarly, please credit your colleagues with whom you discuss and work with on homework.

Health and Safety Statement

During this pandemic, it is extremely important that you abide by the public health regulations, the University of Pittsburgh's health standards and guidelines, and Pitt's Health Rules. These rules have been developed to protect the health and safety of all of us. Universal face covering is required in all classrooms and in every building on campus, without exceptions, regardless of vaccination status. This means you must wear a face covering that properly covers your nose and mouth when you are in the classroom. If you do not comply, you will be asked to leave class. It is your responsibility have the required face covering when entering a university building or classroom. For the most up-to-date information and guidance, please visit https://coronavirus.pitt.edu and check your Pitt email for updates before each class.

If you are required to isolate or quarantine, become sick, or are unable to come to class, contact me as soon as possible to discuss arrangements.

Disabilities

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and the Office of Disability Resources and Services, drsrecep@pitt.edu, 140 William Pitt Union, 412-648-7890, or (412) 228-5347 for P3 ASL, as early as possible in the term. Disability Resources and Services will verify your disability and determine reasonable accommodations for this course.

Email and Canvas Communication Policy

Each student is issued a University email address (username@pitt.edu) upon admittance. This email address may be used by the University for official communication with students. Students are expected to read email sent to this account on a regular basis. Failure to read and react to University communications in a timely manner does not absolve the student from knowing and complying with the content of the communications. The University provides an email forwarding service that allows students to read their email via other service providers (e.g., GMail, Yahoo, Hotmail, AOL*). Students that choose to forward their email from their pitt.edu address to another address do so at their own risk. If email is lost as a result of forwarding, it does not absolve the student from responding to official communications sent to their University email address. To forward email sent to your University account, go to https://accounts.pitt.edu, log into your account, click on Edit Forwarding Addresses, and follow the instructions on the page. Be sure to log out of your account when you have finished. (For the full email Communication Policy, go to https://www.bc.pitt.edu/policies/policy/09/09-10-01.html.)

You are responsible for following announcements on Canvas. By default these are sent to your Pitt email account. If you choose to change these notification settings, you remain responsible for understanding the content in Canvas notifications in a timely manner.

[*] You see, once upon a time there was this company that would send CDs to your house every other week to get you sign up to use a phone line to connect your computer to get your email and look at cat pictures that people had sent you. This was back when phones had cords and

sentences had two spaces between them. They were then bought by Time Warner. Now everyone is sad. This all happened before you were born.

Academic Integrity

Cheating/plagiarism will not be tolerated. Students suspected of violating the University of Pittsburgh Policy on Academic Integrity, noted below, will be required to participate in the outlined procedural process as initiated by the instructor. A minimum sanction of a zero score for the quiz, exam or paper will be imposed. For the full Academic Integrity policy, please see https://www.provost.pitt.edu/info/ai1.html

Code of Conduct

Communication is key to a productive learning environment, and we can maintain productive communication by exhibiting respect for one another. The success of the course for yourself and others depends on all of our commitment to behavior that demonstrates respect for differences, understanding towards others and a willingness to listen and learn.

The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. For more information about policies, procedures, and practices, see: https://diversity.pitt.edu/affirmative-action/policies-procedures-and-practices.

Use of Class Recordings

Course meetings may be recorded by the instructor for the benefit of students who are not able to participate synchronously. Any such recordings are not to be used or distributed outside the context of this course.

Natural Science General Education Requirement

This course fulfills one Dietrich School of Arts and Sciences Natural Science General Education Requirement (GER) as described for the GERs starting Fall 2018 (term 2191). That GER reads as follows:

Three Courses in the Natural Sciences These will be courses that introduce students to scientific principles and concepts rather than offering a simple codification of facts in a discipline or a history of a discipline. The courses may be interdisciplinary, and no more than two courses may have the same primary departmental sponsor.

Learning Objectives

Learning objectives are the list of things that you should be able to demonstrate that you can do by the end of this course. You might thus choose to call this section the "Study Guide". After completion of course students will be able to:

1. Evaluate, using dimensional analysis, which key parameters are needed to understand a new problem.
2. Create an estimate for an approximate answer when faced with an unfamiliar problem.
3. Make a graph of the instantaneous displacement, velocity, and/or acceleration of a system based on a description of the motion or using another graph.
4. Apply the equations of 1-D kinematics to one or more objects with constant acceleration. E.g., free-fall, two objects that meet one another, and an object that has different constant acceleration at different times.
5. Add or subtract two or more vectors. (Relative velocity problems are an application of this category.)
6. Calculate the dot product or cross product of two vectors.
7. Describe the behavior of an object undergoing projectile motion based on the equations of 3-D kinematics.
8. Apply a conceptual understanding of Newton's first and third law.
9. Draw a free-body diagram and solve for an unknown force or acceleration of a system under the influence of two or more forces.
10. Apply the equations of 3-D kinematics to one or more objects. E.g., when are the forces in a system balanced? where will an object impact a wall given an initial position, velocity, and force?
11. Integrate a specified time-dependent force, together with specified initial position and velocity, to determine the position of an object over time.
12. Calculate the force of static/kinetic friction or the coefficient of friction.
13. Calculate the drag force or terminal speed of an object.
14. Identify the centripetal force that acts on a system undergoing circular motion.
15. Evaluate when the limits of a system are reached. E.g., when does a rope go slack, when does an object stop/start accelerating, how quickly can an car make a turn on an inclined bank?
16. Find the work done by a force.
17. Calculate the average power provided by a force.
18. Apply conservation of mechanical energy to describe the motion of a system.
19. Use the work-energy theorem to identify the amount of mechanical energy that has been lost.
20. Calculate the average force during a collision or series of collisions.
21. Apply conservation of momentum to an explosion or collision. Identify whether a collision is elastic, inelastic, or completely inelastic.
22. Use the rocket equation to design a rocket capable of delivering a payload to orbit, another planet, or another star system.
23. Apply kinematics to a rotating system. Covert between the tangential values of s, v, a and θ, ω, and α using the radius r.
24. Distinguish between angular, tangential, and centripetal acceleration.
25. Determine the net torque acting on a body about a given axis and/or the angular acceleration of that body. Doing so may require the use of one or more moments of inertia.
26. Use the definition of static equilibrium to solve for one or more unknown forces or torques acting on a system.

27. Calculate the motion of a rolling object using torques and/or energy conservation. “Rolling” could be due to external contact or caused by a cord wrapped around the object, like in a yo-yo.
28. Calculate the rotational kinetic energy of an object.
29. Identify whether angular momentum is or is not conserved, and if appropriate, apply conservation of angular momentum to a rotating system.
30. Analyze equilibrium for a specific real-world example and determine its range of stability.
31. Calculate the deformation of a structure using the Young’s modulus.
32. Apply the concepts of stress, strain, and ultimate strength to a deformed object.
33. Calculate a spring constant given the elastic properties of a material.
34. Calculate the gravitation acceleration for an object inside or outside of a planet, given some combination of mass, radius, and density.
35. Apply energy conservation to a system with gravity to describe the motion of an object in a case where U = mg is not an appropriate assumption.
36. Use Kepler’s laws of planetary motion to describe the motion of a planet, moon, or satellite about its parent body.
37. Identify when a system (spring, simple pendulum, or physical pendulum) is undergoing simple harmonic motion, and find the amplitude, period, frequency, angular frequency, phase angle, displacement, velocity, and/or acceleration.
38. Apply conservation of mechanical energy to a simple harmonic oscillator (spring, simple pendulum, or physical pendulum) with damping.
39. Determine the amplitude, period, frequency, angular frequency, wave number, wave length, and/or propagation speed of a transverse traveling wave. If the wave is on a string, calculate the propagation speed using the tension and linear density.
40. Predict the result of interference between two waves with identical amplitude and frequency. Specifically, identify constructive, destructive, and intermediate interference - determine the amplitude and/or phase difference in the later case.
41. Identify the resonant frequencies and/or harmonics of a string or an open or closed pipe.
42. Apply the equation for the Doppler effect to determine the shift in frequency caused by motion.
43. Describe the observed contraction of length in sources moving relative to you at a significant fraction of the speed of light.
44. Add two velocities using special relativity.
45. Explain why the twin “paradox” is not a paradox and why the twin who travels away and returns to Earth does age less.
46. Explain why simultaneity is frame-depedent, e.g., why a relativistic pole vaulter does fit in the barn.