Physics 9 : Physics for Architects II

University of Pennsylvania — Fall 2022

- An up-to-date version of this page can be found at positron.hep.upenn.edu/physics9
- The web page for the other half of this course, Physics 8 (Physics for Architects I), is at positron.hep.upenn.edu/physics8

Prospectus items

Course ID : PHYS 0009-001 2022C

Status

We will meet in-person, Mondays and Wednesdays, 3:30-5pm, in an active-learning classroom (DRL 3N1H) (my map), where we will sit in groups of three at round tables and work in teams to complete each week's worksheet problems. Since each round table seats six people, your group of three will sit opposite a different group of three each day, giving you the opportunity to get to know everyone in the class eventually, though your own three-student group will mostly remain unchanged.

Once or twice a week, we will set up at several spare tables a hands-on activity, such as (for example — this is a work in progress) using a "shake table" to simulate the effect of an earthquake on a tall building, calculating and marking out your own frets on a single-string guitar then playing a simple melody to try it out, building and testing a two-lens telescope, measuring the electrical energy needed to heat up a cup of tea, or wiring up circuits with batteries, lightbulbs, and LEDs — in order to build intuition in an engaging way about key concepts from the course.

If our plan for hands-on activities goes really well (it's a work in progress), we will aim for "a fun hands-on activity for every day of class." If that really works well, we may in later years **subtitle the course "hands-on physics."** If you're curious, here is a 45-second slo-mo clip of the projectile-motion activity from Physics 8 (our companion course) in fall 2021: youtu.be/hjXSzh2IpQw.

The *enormous* number of in-class demonstrations that in past years were the focus of our lecture time have mostly moved into asynchronous videos, but we may try to do live versions of the most fun demonstrations — or we may set them up for you to try for yourself.

Whereas in past years, students spent 2–3 hours/week at home solving pencil-and-paper homework problems individually, all of that problem-solving will now be done cooperatively during class meetings.

The lecturing that I used to do will be recast in the form of asynchronous videos. I'm aiming for something like this:

https://youtu.be/sxkiZXG-PUM

(Note the clickable table of contents below the video.)

Course description and level

We briefly review Newton's laws, then we introduce waves, sound, light, fluids, heat, electricity, and circuits, with emphasis on topics most relevant to students in architecture. We illustrate physics principles using examples drawn from architecture. The only prerequisite for PHYS 0009 is high-school physics, ie that you are familiar with using Newton's laws of motion. Students who took high-school physics may take PHYS 0008 and PHYS 0009 in either order (or can take just one or the other). If you're unsure, please email me.

We strive to make this a fun, interesting, and stress-free physics course. We pace the work evenly from week to week. As long as you consistently put in the time each week to do the work, you will do well in the course.

PHYS 0009, fulfills **Sector VII (Natural Science Across Disciplines)**, formerly called *Natural Sciences and Mathematics*, while our companion course, PHYS 0008 fulfills **Sector VI (Physical World)** of the College general-education curriculum.

Class structure for Fall 2022

In-person sessions: Mondays and Wednesdays 3:30-5pm in (DRL 3N1H) (my map). Most days, we will use this class meeting time to work together (with me, with your classmates, with the TA) on discussing and solving physics problems, which you will write up and turn in on Canvas at the end of each class meeting. For a change of pace, we will often use hands-on activities and live demonstrations to build intuition about physics concepts.

Lecture videos: I will pre-record some lectures, with two main types of content. One type will be chalkboard-style ("lightboard") introductions to a given day's topic. A second type will be demonstrations (using props from the physics department) intended to bring each physics topic to life, to make it real, to leave a visual impression that makes the key ideas easy to remember.

Reading: In a typical week, you will read a concise set of notes that I will type up to introduce and summarize the key points of the week's material, and you will quickly **skim** a chapter of Giancoli's physics textbook (an old edition, used, to keep costs low), which offers better illustrations and more examples than my notes. Most weeks, you will also read a chapter of fun anecdotes from Richard Muller's *Physics and Technology for Future Presidents,* which reads quickly, like a novel, and is filled with stories that vividly connect the physics ideas to real-world events.

Required books (2 of them, both low-cost):
(1) You need to buy or rent (or license online e.g. via scribd) a copy of *Physics and Technology for Future Presidents: An Introduction to the Essential Physics Every World Leader Needs to Know* by Richard A. Muller, ISBN 978-0691135045. The hardcover book at amazon is $19 to rent or $37 to buy. Or you can read the ebook on scribd (but some figures are redacted from the ebook) with a membership. (Be sure to get "Physics **and Technology** for Future Presidents." Omitting "and Technology" from the title finds the wrong book — a different book by the same author! Egads!) We plan to read 8 chapters from Muller's book: 1–3,6–10.

(2) You also need a copy (preferably used, preferably 5th or 6th edition, but a newer edition is perfectly OK) of Giancoli's *Physics: Principles with Applications*, available used for about $10 on amazon. Or, if you find it more convenient, you can venmo me $10 to buy one of the many used copies of Giancoli's 5th edition that I keep in my campus office; it would then be your choice either to keep it or to sell it back to me for the same $10 in January. We plan to skim/reference 11 chapters from Giancoli: 4,10–19, though I plan for my notes to condense electricity (chapters 16–19) down to the essentials.

Grading

- 45% : twice-weekly worksheets, completed cooperatively during in-person class meetings
  - You must complete these worksheets in class. You must participate fully with your workgroup in our class meetings. Because it is likely that on any given day, a few people may have personal reasons for missing class, we will offer Zoom-based make-up sessions on Friday afternoons (or possibly during the weekend), with details tbd. If you must miss a class, write to me *in advance*, and then plan for us to arrange a way for you to make up the work. Each person should only use this option a couple of times this term, for good reason (whose details you need not disclose to me), not routinely.
- 25% : completing reading/video assignments and answering online questions
- 10% : occasional short closed-book quizzes at start of class, to demonstrate that you know how to solve (on your own) worksheet problems from previous weeks' class meetings. My plan is to use the "two-stage exam" pattern for quizzes: first you solve the problem on your own and turn in your work; then you solve the same problem again in cooperation with your classmates and turn in a second solution. I will grade both versions and average the results. My main motivation for the quizzes is to help me to determine, as early as possible, if I need to adjust my teaching to help you to learn better. We will try our best to ensure that quizzes are not a source of stress for you. But we do need some objective way to assess whether our teaching is working for you.
- 20% : final exam or project or paper. The baseline plan is that we will have a sit-down exam during the registrar's scheduled exam period. But since we are a small group this year, I would be happy to replace the traditional exam with individual or small-group projects, or an individual term paper, or a chalkboard-style exam, if that is what you prefer. We can discuss this and try to reach a consensus during our first few class meetings.
- In addition, you can earn up to 5% extra credit. There are several optional chapters you can read for extra credit, and many worksheet assignments will include some extra-credit problems. I may also try to organize a few extra-credit hands-on exercises for anyone who wishes to join me. (One small-group hands-on example could be using whisk brooms to steer bowling balls around a curved path marked out on a parking lot, to feel Newton's laws in action.)
- A total score of 90% or more will earn you a letter grade no lower than A-minus. A total score of 80% or more will earn a letter grade no lower than B. If your total score 100% or more (which is feasible if you do very well and also do some extra-credit work), you can earn an A+.
- The grading system strives to reward consistent weekly effort, rather than your ability to do well on timed exams.
  - Each week, you have to read the textbook, watch videos, come to class, and cooperatively solve (in-class) worksheet problems. In exchange, you largely avoid the stress of cramming for exams.
  - This is a physics course that you can do very well in even if you generally find physics to be a challenging topic.
  - Or if you have found physics to be easy in the past, this course's emphasis on problem-solving should deepen your understanding.

Typical weekly time commitment

- 3 hours reading notes & textbook chapters
  - You submit your answers to open-ended questions responding to each reading assignment. As often as I can, I will respond individually to your answers, particularly if you ask me for clarification.
- 1–2 hours watching video lectures/demonstrations
- 3 hours solving physics problems, nearly all of which occurs during in-person class-meeting time

Contact info

Instructor

Bill Ashmanskas
senior lecturer in physics
telephone: 215-746-8210
mobile: (I'll write it down during class)
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with occasional guest lectures/visits by
Richard Farley
registered architect, professional engineer, adjunct professor in architecture
Prof. Farley has taught Architectural Structures for many years at Penn.
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Teaching Assistant

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Schedule

- *schedule may be updated as the semester proceeds*
- **(M)**uller chapters: read the listed chapter of *Physics and Technology for Future Presidents* (which I may supplement with a page of notes), and fill out a web form to answer some free-response questions on the chapter.
- **(G)**iancoli chapters: carefully read my notes, which I intend to be more concise and focused than the textbook chapter. You can skim through the chapter for worked examples, or if you want to see more detail. Then fill out the web form to answer my free-response questions about the reading material.
- **Problems:** We will work cooperatively on problem-solving during class meetings; you will scan your completed solutions to the problems and submit them on Canvas shortly after each class.
- (UPenn academic calendar)

Monday	Wednesday
	Aug 31 (day01) *first class meeting*, DRL 3N1H, 3:30-5:00pm watch intro video, preferably before class intro group activity: • each group should be a mix of people who did or didn't take physics recently • introduce ourselves briefly • draw graph of "elevator" motion • graph basketball motion in 1D • compare graphs w/ motion sensor • sketch forces for "elevator" • sketch forces for basketball • compare results w/ force sensor during upcoming weekend, read Muller ch1: energy
	Sep 7 (day02) reading: mechanics review — skim my notes 20200909 and/or skim Giancoli ch4 (Newton's laws) video: edit down from 2020-09-07 worksheet: drawing force/FBD diagrams, edited from 2020/ps01 activity: pull string fast vs slow; use FBD to reason about which string breaks first in each case

Monday	Wednesday
Sep 12 (day03) read Muller ch3 (gravity, force, space) video: edit down from ‘0914’ worksheet: from 2020/ps02a activity: understand what you see • scale → bob → scale → bob • orbiting bob balances bob suspended from string	**Sep 14** (day04) read my notes 20200916 and/or Giancoli 11: vibrations & waves video: edit down from ‘0916’ worksheet: from 2020/ps02b
Sep 19 (day05) read Muller 7: waves worksheet: from 2020/ps03a	**Sep 21** (day06) read Giancoli 12: sound worksheet: from 2020/ps03b
Sep 26 (day07) read notes 20200930 on acoustics video: edit down ‘0930’ worksheet: from 2020/ps04a	**Sep 28** (day08) skim architectural acoustics excerpt ‘acoustics_annotated.pdf’ video: ‘Acoustics 101’ by Ben Markham (Acentech) Ben’s slides worksheet: from 2020/ps04b (acoustics guest visit/lecture?)
Oct 3 (day09) read Giancoli 23: geometric optics worksheet: from 2020/ps05a	**Oct 5** (day10) read Muller 8: light read notes 20201007 video: edit down ‘1007’ worksheet: from 2020/ps05b

Monday	Wednesday
Oct 10 (day11) read Giancoli 24: wave nature of light worksheet: from 2020/ps06a	**Oct 12** (day12) read Giancoli 25: optical instruments video: edit down '1014' worksheet: from 2020/ps06b
Oct 17 (day13) read Giancoli 10: fluids worksheet: from 2020/ps07a	**Oct 19** (day14) read notes 20201021 video: edit down '1021' worksheet: from 2020/ps07b
Oct 24 (day15) read Giancoli 13: temperature & kinetic theory worksheet: from 2020/ps08a	**Oct 26** (day16) read Muller 2: atoms & heat worksheet: from 2020/ps08b
Oct 31 (day17) read Giancoli 14: heat worksheet: from 2020/ps09a	**Nov 2** (day18) read muller 9: invisible light read notes 20211104 worksheet: from 2020/ps09b
Nov 7 (day19) read "Environmental Building" material from Prof Bill Braham do Bill Braham's worksheet?	**Nov 9** (day20) read Muller 10: global warming worksheet: from 2020/ps10
Nov 14 (day21) read Giancoli 15: thermodynamics worksheet: from 2020/ps11a	**Nov 16** (day22) read Muller 6: electricity & magnetism worksheet: from 2020/ps11b

Monday	**Wednesday**
Nov 21 (day23) read Giancoli 16: electric charge & electric field worksheet: from 2020/ps12a	**Nov 23** *friday schedule: no class*
Nov 28 (day24) read Giancoli 17: electric potential worksheet: from 2020/ps12b	**Nov 30** (day25) read Giancoli 18: electric currents read notes 20201202 worksheet: from 2020/ps12c
Dec 5 (day26) read Giancoli 19: DC circuits worksheet: from 2020/ps13a	**Dec 7** (day27) worksheet: from 2020/ps13b
Dec 12 (day28) *last day of class*	

first day of term	Aug 30 (Tuesday)
our first class day	Aug 31 (Wednesday)
last day to add	Sep 13 (Tuesday)
fall break	Oct 6-9 (Thu–Sun)
last day to drop	Oct 10 (Monday)
last day to withdraw	Nov 7 (Monday)
reading days	Dec 13–14
exams	Dec 15–22
fall term ends	Dec 22 (Thursday)
authoritative source	Penn academic calendar

Handouts / PDFs

Problem-set PDFs, my written notes, etc. can be found at http://positron.hep.upenn.edu/physics9/files

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Student comments from recent years

Physics 8, fall 2021

Here are all of the student comments, unredacted, unedited, from **Physics 8** (our companion course) in fall 2021, which was taught in-person in a format very similar to our plan for fall 2022. Note that I'm working harder this year to edit videos down to manageable length!

- One of the most well organized and functional classes I have ever been in, Bill has an exceptional ability to adapt to the students and current situations without taking away from the course as a whole. As an architecture major, having to watch lectures between Monday and Wednesday was sometimes difficult as monday nights and Tuesdays were studio-heavy, but that was not too difficult to work around.
- pros: - SAILS done excellently; focus on active learning, lack of stress, efficient use of instructor/student time both in and out of class - difficulty hits a nice sweet spot for someone with just high school physics; the course and the instructors met me exactly where I was and challenged me to learn new things while making sure to build on past competences. great class for non-architects looking to remind themselves they can still do maths/physics - teaching team, esp. Dr Bill, is fantastic. Cares for his subject and his students - knows that the learning does not have to be stressful (esp for a 008 level course) while still understanding that learning must be engaging. i cannot appreciate that enough. cons: - more a suggestion, really, it's hard to listen and work on problems at the same time in class, so if there are important announcements/lecture bits, make them clearly demarcated or do it before handing out the problem sets so students know their work time is not being reduced when they listen etc. - some lecture videos were too long
- I really enjoyed the structure of the course with at-home lectures and in-class worksheets. I also really enjoyed the group work. Dr. Bill was great at relaying the course material and showed his enthusiasm in class.
- Prof. Ashmanskas was extremely helpful in this course. I think it would be beneficial to not try to give information while the class is doing group work because of how loud it gets. Other than that, I love how he ran the class this semester.
- I have absolutely loved taking PHYS008. Professor Ashmanskas was always prompt in answering questions and explained concepts very well so that they could be understood by students with varying levels of physics backgrounds. I believe this course to be an excellent example of what the Sectors in the college should be and how a flipped classroom should work. The class is small enough that you get to know your peers and Professor well, and the subject is both exciting and specific enough to attract students interested in the topic and a professor who buoys teaching it. I have on several occasions recommended it to anyone who will listen, and spoke about the class efficacy in student government meetings as an example of a successful stem class. As a flipped classroom, Professor Ashmanskas does a wonderful job of balancing online lectures and in person problem solving. He provided lectures where he explained concepts and worked out problems which directly tied to the material we would work on in class in groups of 3, with another group of three. This system of working in groups of 3-6 people to solve problems, and have Professor Ashmanskas and our TA there to answer questions (which he always happily and thoroughly explained). I learned so much from this class and I truly believe it is the epitome of what STEM classes at Penn should look like.
- I really enjoyed this course. We did a flipped classroom, which was actually really nice. I didn't think I would like learning on my own, but I became used to that during covid, so this structure actually really worked for me. Professor Bill was also amazing. He is one of the nicest and most caring professors I have had at Penn.
- Overall, Physics for Architects was an enjoyable course. I wish Dr. Bill did more in class lectures, because sometimes it was difficult to essentially teach yourself the curriculum. I enjoyed the group work we did, I just wish it was complimented with in class lectures.

- Professor Bill was always concerned about not only our grasp of the material, but also our personal well-being, and this is reflected in his course policies which were very understanding. He was incredibly patient if we struggled to understand something. Melina was a great TA who would never fail to bring clarity to a problem that I struggled with.
- I really enjoyed it, I just didn t live the 3 hour long video assignments for homework I would rather have had more lecture time in class.
- This course covered a lot of material in a very short amount of time. That being said I think it should be limited to the types of material taught so that there can be a more in depth understanding. Further more as a student that did not take AP Physics in high school made this class challenging, it might be worth considering giving this course certain prerequisites OR providing a time for students to reinforce the material presented. I also wish this course involved more architecture concepts. I personally did not enjoy the layout of a flipped classroom and would have preferred for the content to be taught in class/live.

Physics 9, fall 2020

Here are all of the student comments, unredacted, unedited, from **Physics 9** (this course) in fall 2020, which was taught online. This fall's topics and content closely resemble that from fall 2020, but this fall's format much more closely resembles Physics 8 from fall 2021. Note that I'm working harder this year to edit videos down to manageable length!

- Nicest and most accommodative instructor
- Professor Bill is very kind and was willing to meet with students outside of class if they needed help with material. He made every effort to ensure that students understood the material, which is what every teacher should do. I enjoyed my time in his class.
- Didn't translate well to the online environment. Most work was learning the material on your own from the textbook.
- Highly enjoyable and interesting course. Work load was appropriate for allowing interest in subject to be priority over rigorous mathematical work.
- THANK YOU SO MUCH, PROF. ASHMANSKAS! Very informative, professors and TAs were all very attentive and ready to answer any questions on not only course material but also tangential concerns. The videos that Bill put out as well as the time and energy he spent crafting lesson plans really shined.