Physics 9 : Physics for Architects II

University of Pennsylvania — Fall 2018

- Up-to-date version of this page can be found at http://positron.hep.upenn.edu/physics9

Contact info

Instructors

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drop in any time you see my door open (but not MWF before class!)
I'm generally on campus 9am–6pm M,T,W,F, but I work at home most Thursdays

with occasional guest lectures by
Richard Farley
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Teaching Assistant

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Handouts / PDFs

Homework PDFs, class notes, etc. can be found at http://positron.hep.upenn.edu/physics9/files

Work load

- You should expect to put in about 4–8 hours per week outside of class, in addition to attending the 3 weekly class meetings. A typical week will include
  - 1–2 hours on Sunday evening reading the textbook(s)
  - 1–2 hours on Tuesday evening reading the textbook(s)
    - Budget your reading time for each class: it is better to skim the entire reading assignment than to read only part of it.
  - about 3–4 hours on weekly homework problems due on Fridays
    - It is probably best to think about each homework problem well before the due date, so that you are prepared to discuss the problems with other students or the instructors in the evening study sessions. You can then finish up the assignment on Thursday evening.
- As long as you put in the time to do the required work each week, you should not find this course difficult.

Schedule

We meet MWF 12–1pm in DRL A6 — map at http://www.hep.upenn.edu/~ashmansk/drl_a6_map.png

Monday	Wednesday	Friday
	Aug 29 PTFP ch1: energy *first day of class*	**Aug 31** Giancoli ch4: Newton's laws ("dynamics")
Sep 3 PTFP ch3: gravity, force, and space *(no class)*	**Sep 5** Giancoli ch11: vibrations/waves	**Sep 7** Mazur ch16: 1D waves
Sep 10 PTFP ch7: waves *(late reading OK for Rosh Hashanah)*	**Sep 12** Giancoli ch12: sound	**Sep 14** homework 1
Sep 17 (architectural acoustics chapters) *add period ends*	**Sep 19** Mazur ch17: 2D/3D waves *(late reading OK for Yom Kippur)*	**Sep 21** homework 2
Sep 24 Giancoli ch23: geometric optics	**Sep 26** PTFP ch8: light	**Sep 28** homework 3
Oct 1 Giancoli ch24: wave nature of light	**Oct 3** Giancoli ch25: optical instruments	**Oct 5** *fall break*
Oct 8 Giancoli ch10: fluids *drop period ends*	**Oct 10** PTFP ch2: atoms and heat	**Oct 12** homework 4
Oct 15 PTFP ch9: invisible light	**Oct 17** Giancoli ch13: temperature and kinetic theory	**Oct 19** homework 5
Oct 22 Giancoli ch14: heat	**Oct 24** Giancoli ch15: thermodynamics	**Oct 26** homework 6
Oct 29 PTFP ch10: global warming + Muller NYT oped	**Oct 31** (something related to thermal modeling computer project)	**Nov 2** homework 7
Nov 5 Mazur ch22: electric interactions	**Nov 7** Giancoli ch16: electric charge & electric field	**Nov 9** homework 8 *last day to withdraw*
Nov 12 PTFP ch6: electricity and magnetism	**Nov 14** Giancoli ch17: electric potential	**Nov 16** homework 9
Nov 19 Giancoli ch18: electric currents	**Nov 21** optional class on coding in Processing	**Nov 23** *Thanksgiving break*
Nov 26 Giancoli ch19: DC circuits	**Nov 28** Mazur ch31: electric circuits	**Nov 30** homework 10
Dec 3 arduino programming	**Dec 5** Mazur ch27: magnetic interactions	**Dec 7** homework 11 (short assignment)
Dec 10 practice exam due (solns) *last day of class*	**Dec 12** *reading days*	
Dec 17 final exam noon		**Dec 20** (Thursday) *fall term ends*

Why you are here

- Maybe you just want to take a college-level physics course. Learning physics should be fun and interesting, so we do everything we can to make this course fun, interesting, and low-stress. Learning physics takes some effort, but the work for this course is paced out such that most students enjoy doing it. And you will learn a lot!
  - *Physics for Architects* is a fun and relatively painless way to fulfill the college's Physical World Sector requirement.
- You may be here because Physics 8/9 is strongly encouraged for the Intensive Major program in architecture at Penn.
  - … or because the design school that you plan to attend encourages you to learn physics as an undergrad, e.g. *"an understanding of mechanics, heat, light, sound, and electricity, as demonstrated e.g. by completing at least one college-level physics course."*
  - … or because eventually, to be certified as a practicing architect, you will take exams covering structures, mechanical systems, HVAC systems, electrical systems, and perhaps acoustics.
  - … or because making a detailed energy model of a building is easier once you've studied heat and light.
- But we think more generally you are here because many of you will someday design things that will exist, will be seen, and will function in the physical world that surrounds us. A better understanding of the physical world can make you a better designer. A few students have also told us that things they'd seen in physics class would occasionally inspire artistic ideas, just as some of your studio projects are inspired by examples from biology.
- So in Physics 8 we focus on mechanics, which is good preparation for the Structures course that many of you will take as seniors.
- For Physics 9, the list of topics we'll cover can be summarized as: waves, sound, light, fluids, heat, electricity. Those topics will build on what you learned in your previous physics course. If you didn't take Physics 8, the main prerequisite for Physics 9 is that you should be familiar (e.g. from high-school physics) with Newton's laws of motion — which we'll briefly review in the first week of class.
- If there is sufficient interest, we can spend a few days, at the end of the term (after we study electric circuits), learning to program little Arduino boards to blink LEDs on and off, play tones through a speaker, and respond to your turning knobs or pushing buttons. This could be handy if someday you want to make one of your studio projects interact with its environment.
- One new addition to the course will be to use a software-based "virtual environment" to model the physics in a way that goes beyond what can be done using traditional pencil-and-paper calculations. For example, you will try out the Odeon acoustical software to model the propagation of sound in an auditorium. Later, we will use different software to model the energy flow for heating or cooling a building.

Grading

The course grading policy is designed to motivate you to learn steadily week-by-week. The goal is to keep both stress and cramming to a minimum.

- 50% : weekly homework (a.k.a. "problem sets")
- 25% : final exam (Monday, December 17, 2018, noon–2pm)
- 10% : practice final exam due on Monday, December 10 (last day of class)
- 10% : completing reading assignments with online feedback
- 5% : participation in collaborative exercises in class (work/discuss with your neighbors) and "virtual environment" projects
- To avoid penalizing people who need to miss a few classes for religious, family, or extracurricular events, the in-class total will be scaled so that a score of 80% or more receives full credit.
- In addition, you can earn up to 5% extra credit: There are a few optional chapters you can read for extra credit, and most homework assignments will include several extra-credit problems.
- 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 99% or more (which is feasible if you do very well and also do some extra-credit homework problems or reading), you can earn an A+. Keep in mind that in past years, the median exam score was around 80%, while the median homework score was around 90%, so the final exam will reduce most people's total scores.
- Our grading system strives to reward consistent weekly effort, rather than your ability to do well on timed exams.

  - Each week, you have to read, come to class, and solve homework 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.

Homework

- This Equation Sheet may be helpful for the homework. I will continue to update it as the semester continues.
- There will be a homework assignment due at the start of class most Fridays, starting 9/14.
- The homework problems should take you about 3–4 hours to complete.
  - If you find yourself spending much more than 4 hours on each homework assignment, you should:
    * form a study group with one or more of your classmates; and
    * come to the Wednesday/Thursday study sessions for help.
  - In fact you should do these two things in any case, because you will gain more from the course by discussing the homework problems with Bill, Richard, Grace, and your classmates.
- The homework is worth 50% of the course grade. You cannot pass the course without doing the homework.
- See below for policy on late assignments.
- Working together on homework is strongly encouraged, but all work you turn in must be the result of your own thinking.
  - Figuring out problems together is a very good thing, but **simply copying other people's solutions is not acceptable.**
    * If you invest the time throughout the semester to give your own brain the benefit of working through the steps of each homework problem, you will have a much easier time preparing your own brain to take the final exam. You'll also learn a lot more from the course.
    * That's why we put so much weight on the weekly homework — because anything you cram into your brain just before an exam will be promptly forgotten just after the exam.
  - If you work through a problem together with a friend at the blackboard, that's great, but you should then both go and write up your own solutions separately (not just mindlessly copying line-by-line what you wrote on the board).
  - We recommend that you first try to work through each question on your own, then (if you're stuck) trade ideas with a friend, then (to check for mistakes) compare your solutions once you've both solved the problem.
  - In any case, two of the best ways to learn physics are by solving practice problems and by explaining physics to someone else. Working together on homework achieves both of these aims, as long as you do it mindfully.
- Explain your reasoning in English — equations alone will not get full credit except in the simplest cases.
  - For instance, you might begin another problem by writing, "Because the two ends of the guitar string are held fixed, the wave amplitude must be zero at x=0 and x=L." This demonstrates that you are thinking about what you are doing, rather than mindlessly writing down equations.
  - Writing out your reasoning in English also helps your mind to focus on the *physics*, rather than the equations. I want to deepen your understanding of the world that your future creations will occupy, not to train you to manipulate algebraic symbols.
- In lieu of the traditional discussion section or office hours, we have reserved classrooms at the following times so that you can work with Grace, with me, or with each other if you wish:
  - Bill will be in **DRL 4C6 on Wednesdays from 4–6pm** (starting 9/12)
  - Grace will be in **DRL 2C8 on Thursdays from 6:30–8:30pm** (starting 9/13)
  - Even if you don't have questions, you can show up just to work with your classmates.
  - You're also welcome to contact me any time by email and to stop by my office any time the door is open. On MWF, any time after class is fine, but not before class. On Tuesdays, any time I'm around is fine. I am usually on campus approximately 9am to 6pm (but I usually work at home on Thursdays).

Late assignments

- It is important to us that you keep up with the course week-by-week.

  - Cramming doesn't produce good learning.
  - Your brain needs time to assimilate new knowledge.
  - Many topics in physics build upon one another.
  - If you fall behind, you will benefit much less from our class meeting time, and your classmates will miss out on opportunities to have informed discussion with you about the physics you are learning.
  - Cramming is stressful. Reading, discussing, and gradually assimilating can be quite enjoyable.
- We want to hand back graded work promptly so that you can learn from your mistakes before you forget what you were thinking when you made them.
- Therefore, late work will be given reduced credit as follows:
  - By "day" we mean class meeting day — Monday, Wednesday, or Friday.
  - 1 day late: 10% penalty
  - 2 days late: 25% penalty
  - a week or more late: 40% penalty
- We recognize that your life is busy, and does not revolve completely around physics. For that reason:
  - You can ask me once per term for an extension, as long as you contact me by email before the deadline. You can tell me the reason if you wish, but it is not necessary for you to do so.
  - To be fair to people who turn in the work on time, we will only waive the late penalty on one assignment per term.

Textbooks

- We will use two main textbooks for this course.
- The first book is *Physics and Technology for Future Presidents* by Richard Muller.
  - We will read 8 of this book's 13 chapters. You can, if you wish, read the other 5 chapters for extra credit.
  - This book contains a lot of interesting information and fun stories, but very few equations. So it is a nice complement to a traditional physics textbook like Giancoli.
  - You can buy it on Amazon for about $50 (or rent for about $15).
  - Or if you are a Scribd subscriber, you can read it online, thanks to a licensing agreement between Scribd and the publisher. But one **serious drawback** of the online version is that many of the figures are blanked out, so I strongly recommend that you buy a printed copy of this book.
  - Again, we have put PDFs of the first chapters we'll read up on Canvas, to give you time to buy your own copy of the book.
  - **Don't confuse** this book with *Physics for Future Presidents* by the same author! They are two different books, by the same author, with very similar titles! **(Egads!)**
- The second book is *Physics: Principles with Applications* by D. Giancoli. Either 5th or 6th edition is OK: the 5th edition is much less expensive, but the 6th edition includes some updated worked examples.
  - We will read about 15 chapers of this book.
  - You can find it on Amazon (new or used), or you can buy one of my used copies for $10. (To save you the hassle, I bought about 30 copies last month, at an average cost of $11.)
  - I have put PDFs of the first chapters we'll read up on Canvas, to give you time to buy your own copy of the book.
  - If you do buy one of my $10 copies, you are welcome to sell it back to me (for the same $10) at the end of the semester. Or you can keep it — whichever you prefer.
- If you were not in Physics 8 last year, you **do not** need to buy the Physics 8 textbooks, though if you're an ARCH major, you may find the Onouye/Kane book to be an interesting reference.
- Textbook reading will be mandatory. Usually you will read each chapter just before we begin the corresponding topic in class, and you'll answer some online questions before class to earn credit for doing the reading. Then, when we discuss an idea in class, you will not be seeing it for the first time. This will allow us to spend more of the classroom time working together to assimilate the ideas.

Class meeting format

- I want you to learn as much as possible from the time we spend together in class.
- Toward that end, I plan to make the classroom time as interactive as possible, so that you are actively thinking about and discusing physics during class time, rather than passively watching me write equations on the blackboard.

- A model for participatory physics classes that has been used successfully both at Penn and elsewhere is Peer Instruction, as described in this public radio segment.
- Here is basically how it will work:
  - Before each class (except on days when homework is due), there will be a required reading assignment, which should take you about 1–2 hours to complete.
  - Before 9am on the day of class (but preferably on the evening before), you will fill out a short online reading response form.
    * Once you have done the required reading, this form should only take you about 10–15 minutes to fill out. In filling out this form, your effort (e.g. demonstrating that you did the required reading and thought about it) counts more than the correctness of your answers.
    * The form gives you an incentive to complete the reading the night before class, and it gives me feedback on which parts of the reading were the biggest source of questions or confusion.
    * **Your answers to these questions — especially the answers turned in early — will determine what we cover in class. Please take them seriously.**
  - The class meeting will then emphasize the topics from the reading that generated the most questions, interest, or confusion.
  - For each chosen topic, I will lecture for 5–10 minutes to introduce the topic. Then I will present a few multiple-choice questions that probe your understanding of the topic.
  - For each question, you and your neighbor will spend 1–2 minutes working out an answer. Then you'll vote for your chosen answer, using a fold-up flash card.
- On days when a homework assignment is due (i.e. most Fridays), there will be no required reading. There will still be an online response form due before class, so that you can tell me which homework problems or topics from the past week were most confusing.
  - When several people tell me that they find a given topic confusing, I will give it more emphasis during class time.
  - When many people report that they are baffled by a given homework problem, we'll spend some time going over it in class.
- Your online feedback is very important to me for pacing the course and keeping the difficulty level appropriate.
  - My goal is to help you to learn as much physics as possible, in a number of hours per week that you find manageable.
- We'll also do a large number of **demonstrations** in class, to help you to visualize the concepts from each chapter. My favorite sorts of demonstrations involve your discussing and trying to convince your neighbors, just before I do an in-class experiment, what the outcome will be.
- We'll also spend some class time **solving, cooperatively, some examples of problems** that you'll encounter on the homework.
  - Typically, you'll first spend a few minutes working through a problem with your neighbor, and then I'll show you on the blackboard how I approached the same problem.
  - I think your seeing me solve a problem is only really helpful if you've first spent a few minutes thinking through how you would approach the same problem.
  - In cases where people find several ways to approach the same problem, we may have an interesting discussion about the alternative methods.

Final exam

- We will have the usual two-hour final exam (25% course weight), but no midterm exams.
  - The final exam time is Monday, December 17, at noon.
  - Most exam problems will closely resemble the weekly homework problems. So as long as you take the weekly homework seriously, the exam should not be a source of stress for you.
  - You can bring one sheet of your own hand-written notes to the exam. So there is no need to memorize, but you need to think about what will be most useful for you to write down for your own use.
- In addition, there will be a take-home "practice exam" (10% course weight) due on Monday, December 10. This is basically a "final homework assignment" to help you to prepare for the final exam.
- The final exam in this course should not be a source of stress. It is mainly a mechanism to motivate you to be sure that the weekly homework you turn in is done carefully and is the product of your own thinking and learning.