33-115 **Fall 2019**

Physics for future Presidents

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Text: Richard A. Muller **"Physics and Technology for Future Presidents"**
Princeton University Press, ISBN: 978-0-691-13504-5

What we aim for

An enormous number of important problems our society faces are intimately related to Physics. This includes such hot-button topics as energy, global warming, and terrorism. Misjudge the science, make a wrong decision. Yet, many political leaders and concerned citizens have a hard time evaluating the issues, because they have never been taught about the underlying physics. Is radioactivity good or bad? What is it in the first place? Why don't we have more battery-run cars? What actually *is* a battery? Could we run cars on solar cells, if we just build really really good solar cells? None of these questions are stupid, all of them involve physics, and their answers might change our views or how we would argue for our standpoint.

The aim of this course is to provide you with some of the essential facts and pieces of physics underlying such questions. A view of the world that includes a basic understanding of science and technology is a richer (and more satisfying) one. Knowledge is a better guide to judgment than opinions based on misunderstanding. This course will enable you to grasp many of the issues that dominate today's political discourse and to develop an informed opinion (*yours*, not mine!) for which you can rationally and quantitatively argue.

How we proceed

This course is *not* "Physics for Dummies". Not only would this be a highly condescending title; it would also badly miss the point: hardly anything that will be covered would be considered trivial by our own physics majors. In fact, you will often learn about interesting and important topics that even a typical physics major might not know. The material will be advanced, and it will require focused attention on your part, but it will *not* be difficult because the math is hard. I will skip most of the math: no calculus is required, no complex numbers, no vectors, no trigonometry. However, I expect you to know some very elementary algebra (*e.g.*, "Solve for x in the equation $a \cdot x + b = 0$") and be able to do arithmetics, even if the numbers are very large (*e.g.*, you should be able to understand that $8\times10^{7}/2\times10^{12} = 4\times10^{-5}$). I will also need you to deal with units and unit conversions, but I'll cover that at the beginning.

The aim of this course is not to enable you to do a detailed computation; you could always hire a physicist to do that, but you'd need a basis to judge under what circumstances it'd be important to know an accurate answer (and whether you should believe the answer you will be told by some expert, who was either hired by you or presented by some political opponent). To mas-

ter this skill, you need to know some key facts, understand some fundamental concepts, and be able to come up with *order of magnitude estimates* by combining the two. Hence you need to become comfortable with the use of large numbers—but you'll have ample opportunity to practice that. It matters whether you're talking about a million or a billion or a trillion—those are *not* just three very large numbers.

I will not proceed in the classical way a physics course is taught: Spelling out definitions, discovering laws, studying idealized model cases, etc. We'll jump right into the topic, at the danger of not being precise the first time, and refine our understanding later, as we learn more.

Learning objectives

You will develop an ability to discuss the science behind the technology that affects our society. You should be able to judge for yourself what all the real and would-be experts are talking about (and whether they know what they're talking about). Among the topics I'll cover are:

- Energy and Power
- Atoms and Heat
- Gravity, Forces, Space
- Radioactivity
- Chain Reactions, Nuclear Power Plants and Bombs
- Electricity and Magnetism
- Waves
- Light (visible and invisible)
- Climate Change

In each topic area, a major goal will be to connect basic scientific concepts with their real-world incarnations (e.g. in technology), and you will be expected to understand and articulate these connections. A sign that you are successfully mastering this course is that you can demonstrate knowledge of the basic facts associated with each topic as well as the ability to use both qualitative and quantitative reasoning in a discussion. The exams and assignments will give you a chance to show that you 1) have acquired the appropriate *knowledge base* for each topic, 2) can perform *simple quantitative calculations* including unit conversion and estimations, and 3) can write *concise* and *technically informed* essays on the scientific component of many issues faced by today's society. You will also use your knowledge and skills to participate in a group research project, which will be evaluated when your group presents its project during one of the weekly recitation sections during the second half of the course.

Other objectives

I am also planning to have some fun. Don't expect every minute of the course to be devoted to the learning objectives stated above.

In class

Full-class lecture/discussions are MWF. Smaller-group recitation sections are held on Thursdays. The lectures will introduce new material and highlight important concepts. You will be responsible for all the material specified in the weekly course schedule, which may include material not explicitly covered in lecture. Your recitation instructor will help you by reviewing the material and discussing a limited number of assigned problems. However, physics skills and

knowledge cannot be developed by passive listening. The majority of your recitation time will be spent either working in groups or participating in discussions.

In-class activities and responsibilities:

- You are responsible for attending all classes and attendance will count toward your grade.
- Bring the textbook to your recitation classes.
- MWF classes will usually be devoted to lectures, discussions, and demonstrations.
- The Thursday recitations will usually be devoted to discussions.
- If you miss class, it is your responsibility to find out what you missed. Handouts that offer further information on some issues will normally be posted to the course website.

Outside Class

Weekly details and assignments will be found on the course website. You are responsible for the following outside class:

- Read the assignments carefully, study the assigned textbook sections, and turn in homework problems
- Homework must include a complete, legible explanations of your work.
- **Important:** This is a 9 unit course. Expect to spend about **5 hours per week outside of class** studying for this course.

Homework Problems

Homework problems will be graded and will count toward the final course grade. Homework is due at the start of the specified class; it may receive half-credit if handed in by the start of class on the following day; it may not be graded at all if handed in later without a valid excuse. Homework must be legible, clearly organized, and stapled (if multiple pages), so that the grader can easily follow your reasoning, or it will be returned ungraded.

Concept Tests and Classroom Response Clickers

Concepts Tests are short questions given during lecture. They are usually conceptual in nature. This teaching methodology has been proven to be beneficial in large lecture classes. It will give you a chance to think about new material as it is introduced and break up the 50 minute lectures. I will discuss the solutions as part of the lecture. In some cases, you will be allowed or even encouraged to discuss the questions with your fellow students before answering.

We will be using the i>Clicker Response System. All students must purchase a device called a "clicker" at the start of the semester, or alternatively download the smartphone app "iClicker Reef" (which exists for both Android and iOS). With the clicker or the phone app, you will communicate your answers to concept questions to a classroom receiver. Your individual response will be known to the instructor but remain confidential to the class; however, the class will be able to view the percentage of students who give the correct answer and the lecture discussions will be guided by the results.

The Concept Test grading is designed to give you credit for participation in lecture without being penalized for wrong answers. You will get full credit for participation in a day's lecture if

you get at least 50% of the answers correct. In general, the questions will be designed so that this is easy to achieve. Bringing someone else's clicker to class and answering for them, as if they were actually there, is cheating and, if I find out about it, I will deal with it according to the University's rules on cheating and plagiarism.

Clickers or the phone app must be *registered*. Here is how that works:

Mobile App Users:

- Download the iClicker app for either Android or iOS (depending on your phone). The name of the app is "iClicker Reef"
- Register the app using your CMU email address (@andrew.cmu.edu)
- Search for our class using the course title Physics for Future Presidents

Please note, there is a $14.99 subscription fee to use the app for 6 months but this will cover all courses you use iClicker with this Fall.

Physical Clicker Users:
iClickers can be purchased through the CMU bookstore. Once you have purchased the clicker:

- Go to https://www.iclicker.com/remote-registration-form-for-classic
- Enter your first name, last name, Andrew ID, and clicker ID (found beneath the bar code on the back of your clicker)
- Follow instructions on the website to enter the verification word
- Click Enter
- Look over your information to verify that it is correct
- Click Submit

Please complete the registration procedure before the beginning g0f the first class.

Assignments and grading:

The course assignments will include work to be performed both individually and in small groups. Much of the work will involve short essays. Some assignments will require you to utilize current newspapers and technical magazines in addition to web-based resources. There will be two midterm exams and a final exam.

Grades

The final grades will be determined on the following basis:

- 25% Final Exam over the whole course
- 30% Two one-hour exams
- 25% Assignments
- 10% Quizzes
- 5% Group Project Presentation
- 5% Attendance and participation

Grades are based on an absolute basis: A 89-100%, B 75-88%, C 60-74%, D 50-59%, R 0-49%. There is no *grading on the curve* (grade as rank in class). The grade boundaries will not be raised but they may be lowered by the instructor. If they entire class earns 89% or above, the en-

tire class will receive an A. While this is not likely to happen, note that helping your fellow students *will not* harm your own grade. *We are all on the same team*.

Collaborative Work

Scientists and engineers normally work in groups, and social interactions are critical to their work. Most good ideas grow out of discussions with colleagues. In this course, I want you to work with others as much as possible. Study together, help your partners to get over confusions, ask each other questions, and critique each others' homework write-ups. Teach each other! You can learn a great deal by teaching. But do turn in your own assignments. While collaboration is the rule in technical work, evaluations of individuals also play an important role in science and engineering. Exams and quizzes are to be done without help from others. Cheating will not be tolerated and we will penalize it in accord with university regulations noted below.

Officer Hours, Course Center, and Additional Help

You should ask lots of questions in class. I encourage you to drop in on our *course center* if you have additional questions; the *course center* is a room open and staffed for one evening per week. Feel free to stop in just to work on your assignments with your fellow students. You can also meet with the course instructors during their office hours or by making an appointment. Check the course website for the *course center* and office hours schedules. Finally, if you fall behind for any reason, please let me know as soon as possible. The sooner I know about these situations, the better I can help you to catch up. I will do what I can to help you complete the course satisfactorily, but an incomplete grade cannot be given simply because you fell behind. Ask your TA for help if needed. Don't worry that others will know that you don't know something; chances are they don't know either.

University Policy on Cheating and Plagiarism

Students at Carnegie Mellon are engaged in preparation for professional activity of the highest standards. Each profession constrains its members with both ethical responsibilities and disciplinary limits. To assure the validity of the learning experience a university establishes clear standards for student work.

In any presentation, creative, artistic, or research, it is the ethical responsibility of each student to identify the conceptual sources of the work submitted. Failure to do so is dishonest and is the basis for a charge of cheating or plagiarism, which is subject to disciplinary action.

Cheating includes but is not necessarily limited to:

1. Plagiarism, explained below.
2. Submission of work that is not your own for papers, assignments or exams.
3. Submission or use of falsified data.
4. Theft of or unauthorized access to an exam.
5. Use of an alternate, stand-in or proxy during any kind of examination.
6. Using the clicker of somebody who is not attending class, *e.g.* during a quiz.
7. Use of unauthorized material in the preparation of an assignment or during an examination. Depending on the situation, this can for instance include textbooks, notes, computer programs, and your smartphone.

8. Supplying or communicating in any way unauthorized information to another student for the preparation of an assignment or during an examination.
9. Collaboration in the preparation of an assignment. Unless specifically permitted or required by the instructor, collaboration will usually be viewed by the university as cheating. Each student, therefore, is responsible for understanding the policies of the department offering any course as they refer to the amount of help and collaboration permitted in preparation of assignments.
10. Submission of the same work for credit in two courses without obtaining the permission of the instructors beforehand.

Plagiarism includes, but is not limited to, failure to indicate the source with quotation marks or footnotes where appropriate if any of the following are reproduced in the work submitted by a student:

1. A phrase, written or musical.
2. A graphic element.
3. A proof.
4. Specific language.
5. An idea derived from the work, published or unpublished, of another person

Accommodations for Students with Disabilities

If you have a disability and are registered with the Office of Disability Resources, I encourage you to use their online system to notify me of your accommodations and discuss your needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu.

And finally…

Please take care of yourself! *Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep, and taking some time to relax. This will help you achieve your goals and cope with stress.*
All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at

http://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:

CaPS: 412-268-2922
Re:solve Crisis Network: 888-796-8226
If the situation is life threatening, call the police:
On campus: CMU Police: 412-268-2323
Off campus: 911

If you have questions about this, or your coursework, please let me know.