Physical Sciences 12a

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Class meetings: Lecture MWF 9-10:15 AM in Science Center Hall D
Laboratory W 6-8 PM or Th 3-5 PM or F 3-5 PM in Science Center 301

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Course Goals: This is the first term of a two-semester introductory course in physics. The focus is on quantitative scientific reasoning, with the first term exploring Newtonian mechanics. Topics include kinematics, linear and rotational motion, forces, energy, momentum, collisions, gravitation, oscillations, and fluids, with a brief introduction to statistical physics. Examples are drawn from across the physical sciences and engineering.

Students will gain competence in both analytic (pencil and paper) and computational tools (programming in Python) used by scientists to model simple physical systems and analyze experimental data, including problem solving, basic programming, measurement of physical quantities, and chi squared model testing and curve fitting.

The course is aimed at first year students who have an interest in pursuing a concentration in the sciences or engineering. The course includes lecture, laboratory, and discussion components.

TLDR: This course aims to give you the tools to answer questions that you care about in a quantitative and meaningful way.

Prerequisites: We assume students are experienced with algebra and trigonometry and have a basic understanding of single variable derivatives and integrals. If you're not sure if you're mathematically prepared for 12a, please come talk to us! This course is taught under the assumption that students have no prior experience with either physics, statistics, or programming. If you've taken physics before (especially AP physics) and you're looking for a more advanced physics course, you may want to check out Physics 15a.

Textbooks:

We'll use OpenStax's free online textbook as our main resource, but we expect you to be able to use other resources when you want more clarification or a different perspective. Here are a few we recommend, available either online or through Harvard's libraries:

- OpenStax's free online textbook, *University Physics Volume 1*
- *Introduction to Classical Mechanics, With Problems and Solutions*, by David Morin
- *Physics*, by Young and Freedman
- *A Student's Guide to Python for Physical Modeling: Second Edition*, by Kinder and Nelson

Problem Sets:

This course has approximately one problem set per week (except during exam weeks). The problem sets come in two parts:

Part 1: Subskills
Subskills provide deliberate practice using the basic skills acquired that week and should be completed **before** you begin Part 2. You'll be able to check your answers via Canvas to see if you're on track, and then adjust if not. Subskills are designed to be done very quickly if you already understand the concept, and they prepare you for Part 2.

Part 2: Synthesis
This is probably what you expect your homework to look like. You should only start part 2 AFTER you you've completed Part 1. You will submit written solutions to these problems via Canvas/Gradescope. In order to receive full credit for a problem, your solution must be correct, neat, and thoroughly explained so that someone else can understand why you're doing what you're doing. We will be providing a detailed document on writing up homework with problem set 1. At least one of the problems in Part 2 will depend on measurements and analysis you performed in the laboratory (see Lab section below).

Late Policy:

We understand that things come up over the semester that limit the time you can devote to your homework, so we've built in some flexibility:

Lowest problem set score dropped: Your lowest problem set score for the semester will be dropped, meaning that the lowest score you receive on a problem set will not count toward your final grade. This is intended to give you some flexibility and allow you to focus on other assignments or commitments if needed.

Three late days: Additionally, you are allowed to use up to three late days over the course of the semester. These late days can be used to turn in assignments after the deadline without penalty. You don't need to do anything special to use a late day, simply submit your assignment as usual. You may not use more than two late days on the same assignment, and no work will be accepted 48 hours after the deadline.

Extenuating circumstances: If you're dealing with more extenuating circumstances, please reach out to us so we can develop a plan to best support you.

Participation:

Participation will be graded based on three types of assignments. (1) Short prelecture material will be delivered via Canvas and due before each class meeting. (2) Each lecture will end with in-class questions, which you will turn in at the end of class and which will be graded for submission only. (3) Participation credit may also be attached to ungraded surveys throughout the semester. We use the results of these surveys to assess and improve the course.
A final score of 90% or better on participation will be adjusted to 100%, and scores below that will be prorated accordingly. This is designed to provide flexibility for issues like occasional mild illness, travel, and needed rest. If you have extenuating circumstances that prevent you from attending class, please reach out as soon as possible so we can find a way to best support you.

Lab:

The laboratory component of the course will be slightly different from a traditional lab. You will attend one two-hour section of lab each week, where you will perform measurements and data analysis that will form the basis of a problem on the following week's homework. You will receive feedback on your laboratory work (measurements and analysis) before completing the associated homework problem. Much of the data analysis will be done using Python. No prior coding experience is required. Some of the Friday class meetings will be devoted to learning the coding skills needed to analyze and visualize data. If you're unable to attend your regular lab section due to illness or other extenuating circumstances, please email your lab TF as soon as possible.

Help room and office hours:

Courses are meant to challenge you, so we don't expect you to be able to complete and understand everything in this class by yourself. Physics is a collaborative science and we expect you to work with other students and the course staff; in fact, we ***want*** you to talk to us! We will hold numerous office hours and help rooms throughout the week. These are informal meetings where you can come to ask questions of the course staff or work together with other students on the problem sets. You do not need to have a specific question to attend, or even any question. You're welcome to just come and sit and work, and if a question comes up we (and your peers) are here to help. See the course calendar for times and locations.

Collaboration: You are encouraged to work together on problem sets, but all work you submit must be your own. Be careful not to rely too much on your classmates, because you will need to fully understand the problems for the assessments. We recommend the following workflow to maximize learning:

1. Work on the problem sets alone, making a list of places where you're getting stuck
2. Work with others in help room or office hours on the issues in your list
3. Finish things up alone where you can collect your thoughts without distraction (or better yet, start the problems from scratch without looking at your previous work)

If you skip the first and third of these, it will show on the exams.
Note: Please remember to be courteous and supportive of your collaborators. Be careful not to dominate the discussion and check in to make sure everyone else is getting the help they need and an opportunity to contribute.

Course correspondence: All course announcements will be communicated via Canvas. Please make sure you're getting email notifications from Canvas so you don't miss anything.

Assessments: Assessments are a good learning opportunity, and they provide you with a way to monitor your progress as you learn. Traditional exams can be stressful, and once you stop going to school, most of you won't see them much anymore. Our exams will be graded based on proficiency, and you'll have two opportunities to retest on each proficiency target, known as "stars". Our goal is for all of you to make progress, but we don't need all of you to do it on the same timeline.
Each question on an exam will target a particular "star" from our list of objectives for the semester. Your work will be graded based on the following rubric:

- Proficient - Your work is clear and demonstrates a completely correct understanding of the target competency.
- Growing - Your work demonstrates partial understanding of the target competency but has gaps or needs revision.
- Not yet - Your work demonstrates little or no proficiency of the target competency.

When grades are computed at the end of semester, any scores of "Not yet" cancel with scores of "Proficient." If you've achieved a total score of Proficient on more than 90 percent of the competencies, you'll receive full credit for the assessment component of the course, and scores below 90 will be prorated accordingly.
Assessments will be held during class times on Fridays. Details about retesting on specific competencies will be given after the first assessment which will tentatively be held on February 10.

Course grading: Final grades in the course are calculated via the table below. See details on each component in their relevant sections.

Problem Sets	40%
Competencies	40%
Lab attendance	10%
Participation	
Pre-Lecture	4%
Lecture Questions	4%
Surveys	2%

Accesibility: Harvard University values inclusive excellence and providing equal educational opportunities for all students. Our goal is to remove barriers for disabled students related to inaccessible elements of instruction or design in this course. If reasonable accommodations are necessary to provide access, please contact the Disability Access Office (DAO). Accommodations do not alter fundamental requirements of the course and are not retroactive. Students should request accommodations as early as possible, since they may take time to implement. Students should notify DAO at any time during the semester if adjustments to their communicated accommodation plan are needed.

Artificial Intelligence:

AI is here. You can ask it to write papers, code, and emails. It will try to solve physics problems, too. Sometimes the answers are good, sometimes they aren't.

We are not restricting you from using AI, but keep in mind that it's not a substitute for learning yourself. Think of it as another tool you can use to help you learn. There's a big discussion to be had about the implication of AI, but the bottom line is that you won't get to use it on exams this semester.

This means developing your own critical thinking skills are more important than ever.
If you need further convincing that we shouldn't be relying on this robot, we asked ChatGPT to write a song about using AI on your homework, and it came up with this:

Verse 1:
I'm just a tool, a way to find some answers
But I can't do the work for you, I'm not a dancer
You gotta put in the effort, put in the time
Don't rely on me, that's a crime

Chorus:
Don't rely on me for your schoolwork
Gotta take control, gotta take the reins
Don't rely on me for your schoolwork
Gotta do the work, gotta break the chains

Verse 2:
I'm here to help, but I'm not a crutch
You gotta stand on your own, gotta learn to strut
Don't just copy and paste, that's not the way
Gotta think for yourself, gotta have your say

Chorus:
Don't rely on me for your schoolwork
Gotta take control, gotta take the reins
Don't rely on me for your schoolwork
Gotta do the work, gotta break the chains

Bridge:
I'm just a resource, a way to get ahead
But I can't do the work for you, that's not what I'm for
Gotta put in the effort, gotta be proactive
Gotta take charge of your own education, gotta be active

Chorus:
Don't rely on me for your schoolwork
Gotta take control, gotta take the reins
Don't rely on me for your schoolwork
Gotta do the work, gotta break the chains

Need we say more? This semester is about *your* learning, not *machine* learning.