PHYS 121: How Things Work!

Fall 2020

Professor:	Daniel Sussman
Email:	daniel.m.sussman@emory.edu
Synchronous sessions: (M or W: 8:00am – 9:15am)	Zoom link (password = 507711)
Office hours: (Fri, 11:00am – 12:30pm)	Zoom link (password = 795419)
Recommended textbook:	*How things work*, Louis A Bloomfield, 5th Ed.

Weclome! I like to think that *physics*, at its heart, is the idea that the world around us is understandable, and so in PHYS 121 we'll be spending time trying to understand a little bit about how things work. We'll discuss the science behind everyday things – motion, music, materials, and much more – and see how amazing complex behavior can follow from just a few simple, general ideas.

But that's not the *goal* of this course. I want you to come away from this class knowing what it means to think like a physicist. No matter what your background or your major is, a central value of a liberal arts education is being able to think from many different perspectives. An artist (for example) and a physicist might approach the same question in very different ways, and even if ultimately a physicist's approach doesn't resonate with you, I hope you'll walk away with an enriched perspective for understanding another way of seeing the world.

So, in a nutshell, what *does* it mean to think like a physicist? As we'll see over the coming months, it means thinking that Nature is organized by *symmetry* and *scale*; it means thinking about what aspects of a system are *conserved*; and, importantly, it means combining *qualitative* with *quantitative* arguments to try to estimate how something will behave. I'm excited to convey how beautiful I think this way of looking at the world is, and I hope you're excited, too!

Recommended textbook: This course will largely follow, both in content and structure, Louis Bloomfield's *How things work: The physics of everyday life*. I am, frankly, uncomfortable at the price of modern textbooks, so while I recommend this book, I do not require you to purchase it. If you have it the book will provide additional context and, quite valuably, a slightly different way of going through many of the things I will teach. I will, however, post video lectures on canvas as well as a comprehensive set of lecture notes; I fully expect that by using those notes, engaging with the material, and participating in class, your grade can be completely independent of whether you buy the text or not.

Course organization: All class content will be organized in modules on Canvas. These modules will include video lectures, demonstrations, homework problems, and both daily and weekly activities associated with the course. Every week we will have *one synchronous class session*, typically on Wednesdays, during which we will have discussions, work in small groups, and engage with the material at hand. I will provide lectures for you to view and study on your own time; coming to class having engaged with this material ahead of time is vital to making this a productive experience.

1. I expect you to attend class meetings. Please contact the Office of undergraduate education for excused absences.

2. During Zoom sessions (class meetings, office hours, etc.) I ask that you keep your camera on. If there are circumstances that would make this uncomfortable for you, please contact me directly so we can discuss.

3. Engaging with a course and building a community through a computer screen is hard enough; please come to these sessions prepared, ready to focus, and ready to participate.

A note about this being an online class: This class is being conducted entirely via online platforms. We'll be making heavy use of short videos, discussion boards, and other online communication tools, and through active participation from everyone I hope we'll be able to forge a positive community of physics-thinkers. I expect that, as this course draws from all class years and majors across campus, many of you will have never met each other, so take this opportunity to get to know more of the many different walks of life and ways of thinking present at Emory.

Office Hours: Every week we will have a synchronous class during either the Monday or Wednesday morning time slot. I will hold office hours (at the same Zoom link as the class meetings) on the other day, and I will also stay online after each synchronous class to meet with any students who would like.

Additionally, I will hold office hours on Fridays from 11:00am - 12:30pm (which should hopefully be easier on those of you on the west coast!), using a different zoom link. If you would like to schedule a time to meet with me outside these times, please just send me an email.

Weekly homework: As in any other physics class that I teach, I think homework assignments are a vital part of this course; I simply do not believe you can learn physics just from sitting through lectures. In this way, the need to *practice* physics makes the subject no different from most pursuits in life.

So, there will be weekly homework problems which are due before each synchronous class meeting. Part of our synchronous sessions will include reviewing the homework and assessing each others' solutions in small groups. Grading of homework will be based on both the successful completion of them before class *and* active participation in these small group sessions.

Late assignments will not be accepted. However, the lowest two homework scores for everyone will be dropped, so missing an assignment for any reason will not lower your course grade unless you miss more than two.

Bi-weekly questions and observations: Physics is as much about *asking questions about the world around us* as it is about answering those questions. Every two weeks you will submit either a short question or observation about the physical world. I will post some examples on the relevant Canvas discussion board, but I want to emphasize that no questions are stupid. Indeed, some of the most childlike questions – Why does water boil? Why is the sky blue? – quickly take us to the edge of known science! Be curious, be observant, and really think about things you've always wanted to know. Thinking like a physicist means always looking at the world with an eye towards simple things we don't actually completely understand, and I'm excited to see what questions we come up with. Every week I'll select a question from those submitted and include my response to it in a (roughly) five-minute video. These videos will serve as a model for part of your final project (see below).

Midterm exams: There will be two midterms during the semester; these exams will be multiple choice, and will be largely qualitative in nature: I will ask you to apply the ideas we learn about in class to predict what will happen in various situations, analyze how or why something works the way it does, and evaluate what concepts are most important in a given physical problem. Some

quantitative manipulations may be required, but no mathematics beyond high school algebra will be needed.

Final paper / project: In lieu of a final exam, this class will have a final paper and video project. Details of this final assignment will be posted on Canvas, but the essence is that I will ask you to synthesize the approach we learn about in class together with the sorts of questions you submit during your bi-weekly assignments. You will write a paper describing something you observe about the natural or technological world, your efforts to understand it, and you will prepare a short video presentation analyzing and evaluating that observation.

Grading

Weekly homework and in-class discussions	35%
Bi-weekly questions	5%
Midterm 1	20%
Midterm 2	20%
Final paper	20%

Communications: Due to the unusual nature of the semester, communication is important. I commit to responding to emails within 48 hours of receipt, and my intention to respond faster than that most of the time. I will likely be slower on weekends. Likewise, if your situation changes regarding health, housing, or in any other regard with respect to your ability to participate in the class, please contact the appropriate Emory student support organization first and then me as soon as feasible. It is easier for me to address your needs if I know about them as soon as they arise.This does not mean I can successfully respond to every request for consideration, but I emphasize that my goal is to treat you all equitably and do what I can to help you succeed in this course.

Most of our class will be organized through Canvas. For short communications *I prefer that you contact me via email with "PHYS121" at the beginning of the subject line so that I see it.*

Additionally, I will be actively seeking feedback from you during the semester, but if you have any suggestions or comments about the class I'd love to hear them. If you prefer to send anonymous feedback, feel free to use a temporary, disposable email address; just include "PHYS121" in the subject line so that it won't get caught in my spam filter.

Forms of address: I tend to be a fairly informal (and non-hierarchical) person when I communicate, both over email and in person. My preference is that you simply address me as "Daniel." If you are uncomfortable with this informal form of address, "Professor," "Prof. Sussman," or "Dr. Sussman" are all fine.

Similarly, I will by default address you by your full first name. If you have any other preference, or if I'm mispronouncing your name, just let me know! I believe people have the right to be called and addressed as they'd like; it seems like a pretty basic and straightforward type of respect to show to each other. Oh, speaking of: if you're wondering, my pronouns are he/him/his.

Academic Honesty: I expect you to exhibit the level of integrity and honesty that being a productive member of the physics research community requires. During the course of my own work I draw inspiration, evidence, and ideas from the work of others, I argue and counter-argue with them, and I believe the scientific product that results is the better for this type of engagement.

I expect you to mirror this level of engagement with the material in this class. In practical terms, I encourage you to **collaborate, form study groups, and discuss** homework with each other, but

you must write up solutions yourself, and those solutions must reflect your own understanding of the problem and not that of one of your peers. Just like I would never dream of using or discussing someone else's work in a paper without citing them, *if discussions with your classmates helped you with a problem set you should acknowledge that fact.*

You also **must not** simply seek out and use solutions to textbook problems (if they are assigned) from the internet, which would be a serious honor code violation.

Disability statement: As the instructor of this course I endeavor to provide an inclusive learning environment. I want every student to succeed. The Department of Accessibility Services (DAS) works with students who have disabilities to provide reasonable accommodations. It is your responsibility to request accommodations. In order to receive consideration for reasonable accommodations, you must register with the DAS. Accommodations cannot be retroactively applied so you need to contact DAS as early as possible and contact me as early as possible in the semester to discuss the plan for implementation of your accommodations.

For additional information about accessibility and accommodations, please contact the Department of Accessibility Services at (404) 727-9877 or accessibility@emory.edu.

Equal opportunity/non-discrimination statement: As the instructor of this class, I am committed to upholding Emory's principles and policies regarding equal opportunity and nondiscrimination. Emory University is dedicated to providing equal opportunities to all individuals regardless of race, color, religion, ethnic or national origin, gender, genetic information, age, disability, sexual orientation, gender identity, gender expression, and veteran's status. Please contact me with any questions or concerns related to these policies, which can be found here: http://policies.emory.edu/1.3

Class session recording: Our class sessions on Zoom / our in-person class sessions *may* be audio visually recorded for students in the class to refer back to the information, and for enrolled students who are unable to attend live – this is something we will discuss during the first class.

Lectures and other classroom presentations presented through video conferencing and other materials posted on Canvas are for the sole purpose of educating the students enrolled in the course. The release of such information (including but not limited to directly sharing, screen capturing, or recording content) is strictly prohibited, unless the instructor states otherwise. Doing so without the permission of the instructor will be considered an Honor Code violation and may also be a violation of other state and federal laws, such as the Copyright Act.

Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image.

Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live.

Please read the Rules of Zoom Engagement for further advice on participating in our Zoom class sessions.

Course Outline:

The following timetable provides a tentative estimate of the material we will be covering throughout the course:

Dates	Content
Aug. 19-21	**Welcome to physics!** How do we estimate things? Why does thinking about units help so much? What are these things called "Fermi problems"?
Aug. 24-28	**Chapter 1: The laws of motion (part 1)** What are the "laws of motion"? What "language of physics" will we be using in the course?
Aug. 31 - Sept. 4	**Chapter 2: The laws of motion (part 2)** How do rotating and colliding objects fit into the framework from last week? What new conserved quantities can we understand and use?
Sept. 7- 11	**Chapter 3: Mechanical Objects (part 1)** What does it mean to be in mechanical equilibrium? How do we transfer energy between objects? Why are roller-coasters fun?
Sept. 14- 18	**Chapter 4: Mechanical Objects (part 2)** More people should ride bicycles (or at least know how they work). How do rocket ships escape the Earth?
Sept. 21- 25	**Review and 1st midterm exam**
Sept. 28 - Oct. 2	**Chapter 5: Fluids** What kind of thinking do we need for materials that aren't solid? Why do hot air balloons stay aloft?
Oct. 5 - 9	**Chapter 6: Fluids and motion:** What can we explain with fluids in motion? Or objects moving through fluids?
Oct. 12 - 16	**Chapter 7: Heat and Phase Transitions:** Wait, what *is* heat? And how does the same set of atoms change from one phase to another?
Oct. 19 - 23	**Chapter 8: Thermodynamics** What powered the Industrial Age? And how are those ideas applied to *basically every branch of science*?
Oct. 26 - 30	**Review and 2nd midterm exam** content
Nov. 2-13	**Chapter 9: Resonance and mechanical waves** What is an ocean wave? How do musical instruments work?
Nov. 16-20	**Chapter 13: Light** Why is the sky blue? Can you tell how deep you've dived just by looking at the color of a nearby lobster?
Nov. 23-24	**Review of the course:** What have we learned, and where can we go from here?