PHYS1425: General Physics I - Mechanics and Thermodynamics

October 12, 2022 **Final**

(Course Calendar Lecture notes)

Lecture Sessions:	Monday, Wednesday and Friday 12:00-12:50pm
Lecture Location:	Wilson Hall 325 (Directions)
Instructor:	Xiaochao Zheng (xz5y)
In-Class TAs/grader:	Jacob Koenemann (bxy3zr), Troy Meink (ked6na), Shrinidhi Nadgouda (dmx7ug), Lara Ojha (ssa3yw)
Grader:	Bianca Pitt (yrp8rd)
Office Hours:	See OH Google Form

Before You Enroll

This is a calculus-based physics course, but we use only a limited amount of calculus knowledge (not as much as PHYS2415). On the other hand, you must have a solid foundation of trigonometry, and be ready for a challenging science course with 3 (4) assignments due each week. While typical work load is 4-6 hours per week outside lecture time, some people do spend significantly more (>10 hours).

Course Goals & Objectives

Why is the highest degree in physics called “Doctor of Philosophy”, not “Doctor of Physics”? Will learning physics really change how you view the world? As a researcher, teacher, and continuing learner, I truly believe learning physics will change how you view and treat the world. Physics is a science that describes everything around us at the most fundamental level: Why does the sun shine? Why is sky blue? What is heat and what causes it? Can time flow backwards? Physics provides answers to all these questions, and many others you may have about the physical universe. Knowing there is a reason behind everything will help you to face your life differently, because

Nothing in life is to be feared, it is only to be understood

– Marie Curie

This course will get you started in physics, the most difficult subject in science. We will cover mechanics and thermodynamics, that underlie many of the basic phenomena in everyday life: forces and motion, rotation, equilibrium, energy conservation, oscillations, wave and sound, heat, and entropy. You will learn how to apply concepts and physical laws to solve problems. And you will develop problem solving skills that will serve as a foundation for your science, engineering or other career direction and your place as a rational, positive, and courageous member of our world.

By the end of the course, you will...

- Build a fundamental framework of concepts including forces and motion, energy, motion of solid and fluid, wave and sound, and heat and thermodynamics.
- Develop basic ability of solving problems by combining physical laws with math tools.
- Recognize one can use different methods to solve the same problem.
- Be able to check own solutions using estimation, common-sense check, dimensional analysis, limit checks, and using different physical laws.

More important, I hope you will (eventually):

- When presented with a challenge, be it a physics problem, an engineering project, or a life crisis, be able to analyze the problem objectively, apply learned knowledge, prioritize, and solve the problem or develop a path to move forward.
- Look at the world around you and realize that there are laws behind every phenomenon. Realize how grand, yet simple Nature can be. Accept as human beings we are part of this beautiful universe, and be able to draw strength from it no matter what we face.

Course Organization

This course will follow a 2-to-1 ratio of lecturing vs. active learning**.** Note that because of midterm exams and fall breaks, the **M/W/F** sequence described below can vary from month to month or week to week, so check the Course Calendar and the week-by-week schedule on Collab carefully. *The following description is for weeks when Mondays and Wednesdays are lecturing and Friday is the "third/final day of learning" (HW due before class and quizzes held in class) of that week.* The M/W/F will be shown **in blue** hereafter in this section to indicate that they will vary from week to week, action items (assignments) and/or other important facts are shown **in bold**.

Each week, I will post on Collab the material to be covered in the following week in the form of reading assignments from the textbook and lecture notes (link TBP) that contain important concepts, examples, problem-solving skills, and (sometimes) short videos for demos and example solutions. You must **complete the reading** and then submit a "**Chapter Summary**" assignment on GradeScope by 2am on **Wednesday**. Grading of these Chapter Summaries will be based on completion (provided your submission has enough content). Ideally, you only need this Chapter Summary to complete the homework and the quiz of that week rather than flipping through the textbook. Keep your Chapter Summaries organized, as these will form an important part of your learning portfolio. With the Chapter Summary done, you will be more prepared for the Wednesday lecture and the homework/quiz that follows.

Weekly **MasteringPhysics (MP) homework assignments** are due by 2am **Friday**. While this is an online platform, you are required to submit your written **"show your work" (SYW) solution on GradeScope** for specific problems to demonstrate how you approach the problem (which physical law is used), derivations, and numerical calculations when applicable. Grading of SYW assignments will be based mostly on completion (again, provided that your submission has enough content and makes sense).

Our **Friday lecture time** will be devoted to **weekly quizzes:** the first 10 minutes will be individual "thinking time", followed by 30 minutes of group work, and we wrap up by asking volunteer presenters to outline the solutions so that all groups will be on the same page when we leave the room. The weekly quiz ideally should be submitted on GradeScope by the end of class, but the due time is set to 9pm (same day) in case you need more time to write the full solution. You can continue working with your group members after the lecture time, but you must write your solution independently.

Your in-class group assignment will be random and partially based on the **Pre-semester survey**, and I'd like to finalize the group assignment by the Add/Drop deadline and keep it fixed throughout the semester if possible. The same group(s) can be considered as your "go to resources" when you continue studying course material and doing homework assignments. You will not grade or evaluate your group members (wouldn't that take the fun out of group activities?). I hope this means everyone will only gain, and never lose, from group discussions.

We will have **three exams (two midterms and a non-cumulative final)**. During the week of the midterms there will be no HW due, but you should review your chapter summaries. The

exam will be **close-book and a formula sheet will be provided in advance**. The exams will be held in-class and solutions submitted both on paper and on Gradescope, will be pledged work and no collaboration and/or outside help will be allowed. Those requiring extra time for SDAC accommodation should reserve a seat with the SDAC as early as possible.

Textbook and Other Study Material

The **reference textbook** we will use is **Giancoli's Physics for Scientists and Engineers, 5th edition, with Modifed MasteringPhysics** for completing homework assignments online. For Fall 2022 semester, this book will be offered through UVA BookStore's "Inclusive Access" program. ALL students enrolled in the class will have immediate access to your digital course materials through UVA Collab for the first 2 weeks of class—for free – starting one week prior to semester start. **After the Add/Drop deadline, your student account will be charged ~$70**. If you choose to drop the course, there will be no charge to your account. This inclusive access program is optional but if you choose to acquire your textbook elsewhere, you must opt out by the Add/Drop deadline to avoid being charged and you will lose online access after you opt out. Due to the special pricing, no refunds can be processed. This program aims to offer all students accessibility and affordability. If you have any questions regarding the program, please email UVAInclusiveAccess@virginia.edu

We will use **Modified Mastering Physics** to administrate the online portion of the homework assignments.

Learning portfolio: Your own weekly chapter summarizes should form the foundation of your learning portfolio. After completing the homework and the quiz, go back to your chapter summaries and summarize strategically what type of problems you solved and how. Before each exam, put all 4 summaries together to use as your own study guide. By the end of the semester, you should ideally have condensed all 20 chapters into a comprehensive yet concise study guide that should be sufficient for preparing for the final exam.

Course material: All lecture notes and solutions (homework, quiz, exams) will be posted on Collab under Resources. Use lecture time to listen and think, rather than speed-writing notes unless that's what you enjoy.

Assessments and Grading

The **final grade** for this course will be determined from: 30% Weekly homework assignments (that include the Chapter Summaries, MP assignments with the SYW), 20% Weekly quizzes, and 50% total from the three exams that includes 15% each for the two midterms and 20% for the final exam.

***Chapter-Summary Assignments**:* These will be posted as assignments on GradeScope on Collab and are due by 2am on the second learning day of the week. I would assume most people will do this in writing to save time, but typed summaries are also fine. These chapter summaries will be graded based on completion.

Weekly MasteringPhysics Assignments: These are administered on MasteringPhysics (MP) and consists of 7-8 problems. Some of the problems will require written work – see SYW assignments below.

Weekly Show Your Work (SYW) Assignments: Each week, I will post an outline of MasteringPhysics assignment problems on GradeScope and indicate which problems require written work. You must submit your written work through GradeScope to receive the SYW portion of the grades. While these technically do not add on to your MP assignment,

some found it time consuming because writing down work requires thorough thinking of how you solved the problem. On the other hand, this is exactly why SYW is required as it helps to solidify concepts and problem solving skills.

On Weekly Quizzes: These are typically 1-2 written problems (per quiz) that are based on the material you have learned in the previous and the current week, and have practiced on by doing the homework assignments on MasteringPhysics. The quiz problems will likely be challenging, and working in groups will help. The quiz will be given through GradeScope and will be graded "by hand" by me or the grader.

On the two Midterm Exams*:* These will be **close-book exams and a formula sheet will be provided beforehand (for review) and along with the exam**. All exams will be held in-class. Printed exam will be handed out, and solutions should be submitted through GradeScope by the end of the exam time. You should also submit your exam paper in case the electronic submission had an error. You must pledge that you have not received or given aid on these exams.

On the Final Exam*:* The final exam will be in a similar form as the midterms. The final exam is not cumulative, i.e., it will not test on material that appeared on the two midterms. However, the final exam will be longer and will focus more on your problem solving skills than memorization, thus will be counted more towards your final grade. Please also bear in mind that knowledge itself is cumulative, and thus implicit use of earlier material in the final exam may not be avoidable.

Because your written work will be graded by human beings (myself, TAs and graders), neat handwriting will be greatly appreciated. Label your problems clearly as "Problem 1", "Problem 2", etc, and box around your final answers. Use of a black or blue colored pen (or use a pencil) is preferred. Please avoid red color except for Chapter Summaries.

Academic Integrity: Posting assignment and/or exam problems from this course to online "study helper" websites is a violation of the honor policy. **Such posting will be tracked and possibly resulting in the whole class receiving zero for the corresponding problem.**

Course Policy

Attendance Policy

There is no strict attendance policy, though missing in-person classes may cause loss of learning (and possibly some fun).

By the end of the semester, those of you who fill out the course evaluation will have the lowest HW grade exempt from the final grade. Additionally, each of you will receive a "free pass" on quizzes which means one of the weekly quizzes is exempt. This should take care of occasional illness or other unexpected "bad week" reasons for missing the HW or quiz. Please note that Chapter Summaries are not excused, and you should still submit the Chapter Summary for the week where your HW or quiz is exempt.

Late Work Policy

This course has a packed schedule. Keeping up your course work – completing your reading, HW and quizzes, for example – on time is really important. For this reason, late work will be graded with a penalty unless an extension has been granted by the instructor PRIOR to the due date. Please email your instructor (me) in advance if you anticipate difficulties or delays due to official travel, unexpected illness, and family emergencies. Such

extension requests are typically granted, all you need is to ask in advance. On the other hand, extension requests based on arguments such as "having too many projects due this week" will be reviewed more carefully on an individual basis, as such challenges are considered typical for college learning (and life in general).

COVID/Illness Policy

We will follow strictly UVA Policy regarding COVID mitigation in the classroom and during in-person office hours. Should you test positive or have symptoms, please do not come to the classroom or in-person OH. All assignments can be done outside the classroom (including weekly quizzes). See below for more on remote learning.

Strategy for remote learning:

– Obtain Zoom link from your instructor (or check on Collab)

– Call in to Zoom during lecture time or watch Zoom recording after the lecture

– Follow weekly schedule closely and complete all assignments

– Know your group (via self-organized communication channel such as group-chat). This way, you will have access to group discussions and peer-assistance for completing the quizzes and homework assignments

– If needed, check out TA OH schedule (see page 1 of this document) and email the TA to request for Zoom access. They may be able to hold OH both in-person and on Zoom at the same time

Equity and Inclusiveness Policy

This course provides an inclusive space and all people are welcome regardless of their race, age, nationality, gender, and gender identity. Since we will be interacting with each other in class, we must show respect and exhibit courteous and collegial behavior throughout all class experiences. For more information, the Code of Conduct of the Physics Department can be found at http://www.phys.virginia.edu/DEI/CodeOfConduct/

Honor/Academic Integrity Policy

I trust every student in this course to fully comply with all of the provisions of UVA's Honor Code. By enrolling in this course, you have agreed to abide by and uphold the Honor System of the University of Virginia, as well as the following policies specific to this course:

– You may collaborate on the weekly homework assignments, but each one of you must submit your solution independently. Copying solutions from online "study helper (=cheater)" websites is a violation of the honor policy.

– Posting assignment and/or exam problems from this course to online "study helper" websites is a violation of the honor policy. **Such posting will be tracked and possibly resulting in the whole class receiving zero for the corresponding problem.**

– You will work in groups on the weekly quizzes, but each of you must write and submit your solution independently. Copying others' solutions is a violation of the honor policy.

– You must complete your Chapter Summaries independently.

– You must not give or receive any help on the midterm and the final exams.

If achieving knowledge through honest work is not your goal, please do not take this course.

Our Team

My experience as an experimental physicist tells me that being good as an individual is important, but it only gets you to 80% of your potential. The rest comes from team work, and sometimes, a bit of luck. Our class will be diverse, some of you have not taken any physics class, while some may have taken both Physics 1 and 2 classes but still have to be here. I believe everyone has their own place. If you are comfortable with physics and problem solving, please lead the discussion within your group and/or volunteer to present the quiz solution outline in class. This course will be challenging for sure, but should not be boring nor tormenting (I hope not, at least).

You may not realize, but most of our TAs are recruited from previous terms' classes and they will be on your side every week: They will help to explain your homework problems, guide your quiz discussion, answer your questions during office hours, and help monitoring online Piazza chat room after-hours. **In turn, if you enjoy the course, please consider working as a TA in a future term (email me, please).**

Accessibility

There are plenty of opportunities should you wish to discuss course material or other matters with me: Office hours are offered mostly in-person, email inquires are always replied within 24 hours on weekdays and often more promptly (within reasonable hours) if it's about an assignment that is due soon. In summary, I wish I can be there whenever you need me, and please let me know how I can help.

Special Accommodations

Students with disabilities may wish to work with the Student Disability Access Center (SDAC) to discuss a range of options to remove barriers of learning, including official accommodations. Please visit their website for information on this process and to apply for services online: sdac.studenthealth.virginia.edu. If you have already been approved for accommodations through SDAC, you will be contacted by email (from me) and we will develop an implementation plan together. If you are in the process of evaluation, please let me know as well. Our goal is to accommodate everyone's needs as much as possible without lowering learning standard.

Words from a future you (well almost a future you)

From Spring 2022 class, one of the End-of-Semester survey question is "Looking back, what would you like to be told regarding this course, in particular during the first 6-8 weeks of the semester?". I copied some of the answers below, un-edited, and I hope you find them useful. At the minimum, use the next 4 pages to practice the skill of "skimming".

Stay ahead, do the homework early, go to office hours, and always come to class and participate!

I would've liked to be told that: it's okay to not have a perfect understanding right away, because intuitive understanding of physics takes consistent practice, and that it will be a while before I can easily apply the common sense check and immediately understand why it makes sense. My biggest advice is to never give up or throw away a concept just because you don't understand it. If there's a difficult concept in Physics, keep thinking

about it! Don't shy away from the confusion or the challenge. Eventually, everything you learn will come together as long as you keep connecting the dots.

It would have been nice to know the shear amount of material that was to be covered. It was a bit overwhelming to cover this material along with the chapter summaries, Mastering Physics, and the weekly quizzes. It took some time to get used to, but it has definitely helped in the long run.

I wish I took the advice of reading the chapters in the textbook instead of only reading the summaries provided by the professor. The textbook material provides more information and in-depth examples.

I was very very overwhelmed when I first received this class's syllabus over winter break, and that feeling persisted for the first couple weeks of class. It took me a little bit to get into the groove of this course and learn how to manage the work, but once you figure it out it is very very manageable as long as you stay on top of everything. Now that I know what I'm doing, this is my most stress-free class and I think it's the class where it is most possible to do well.

Study the material and do practice problems in advance. Physics is an extremely hard topic to cram for and it is much better to understand the unit as the course progresses.

I liked the advice for future physics students. That was very helpful coming into the course so that I knew what the expectations for the class were. Also, the syllabus and course calendar are helpful because then I could read ahead and refresh before the semester started.

Make sure you carve out a time commitment to prepare for class and to have time to do your homework and study to understand the material as best you can. The last couple weeks, especially during midterm season, come fast and the course content gets harder and harder, so be prepared to put in enough time and effort to succeed.

Time management will help you survive.

This class is not nearly as bad as you've heard

The due dates shift over the course of the semester and it can really mess you up. Make sure you are aware when the weekly due dates change and try and reorganize your schedule accordingly.

Finish homework early, show up to class and pay attention

Go to class

Attend the lectures and take notes, and then study them after class to make sure you understand everything for the homework, quizzes, and tests. If you wait until the last minute to try and understand everything, you will fail. Everything builds on each other, so being a proactive learner will help you be successful.

Write down all the important formulas to help with the homework. Pay attention to the units. Try to get started on the homework ahead of time in case you have questions, so you can attend office hours on a later day.

Make sure you home your skills with creating a free body diagram, it will help you immensely with visualizing problems.

This course has very consistent deadlines, and if you want to succeed you need to stay on top of those, or else the inclement exams and whatnot will kill you.

I would've tried to figure out a routine right away. If I missed lecture, I would've make sure to read the lecture notes and watch the zoom recording immediately; READING LECTURE NOTES IS A MUST EVEN IF YOU MISS LECTURE. DON'T FALL BEHIND!

Make group chats with your group mates! It really helps making friends in the class, especially to get help if you ever get stuck.

This class gives you the tools to be successful (unlike other courses), but you have to take advantage of those tools and put in the work.

The homework can be challenging at times, but there is opportunities such as office hours to seek help. The concepts in this course are not simple; however, attending lectures, asking questions, and collaborating with your group contributes to one's understanding. Create good relations with your group members. You will be working with them throughout the semester and good relationships will be helpful if you are having difficulty understanding a concept. If you do not understand a topic, one of your group members may understand it and they might be able to explain it in a way you understand.

Earn as many of the easy points as possible, like homework and chapter summary because you will need them if you don't do as well on individual tests.

Physics requires a different approach from any other content I've ever learned. If you're new to it, it will either click right away or will take some time. Don't be discouraged if it doesn't happen right away. Just keep trying and asking questions and it should eventually click. Make sure to take good notes and try to do the examples in the notes before they are done in class. Use the book whenever something doesn't make sense. Don't be afraid to ask your group for help on the quizzes and try to make sure everyone understands at least where to start before leaving for the day. If you ever feel stuck on a homework, quiz question, or exam question, try to think of what content that question is on; what equations apply. You'll always have the tools you need to solve it on the equation sheet. Don't overthink it and always try to common sense check your answers.

I would have liked to know that the tests are most similar to the quizzes, because many people had trouble deciding what to study when preparing for the first test.

You learn through trial, so reading over notes won't be good review. Redoing mastering physics problems or in-class examples is a much better study method.

This moves very fast, so it's important to pay careful attention during lectures. The examples are your friend! If you need help, please go to office hours.

Just put in the work - I promise your grade will thank you.

That it is very important to go over the examples on the lecture notes. If you are able to solve those, then you will be prepared for the midterm as long as you have a pretty good understanding of the underlying concepts.

Try your best to actively pay attention during lecture, even when it's tempting to zone out. Also, start the homework early so you can go to office hours if you need help. The TAs are very helpful at explaining the material in terms you can understand. Also, do the homework with a friend if you can because it helps you understand the material better to talk it out.

Stay on top of your work. By itself, Physics 1 should not be a difficult course especially given our math and science backgrounds, but it gets difficult when you have to balance it with other courses, some much more rigorous and time consuming.

It's okay to mess up!!! Focus on correcting your mistakes and truly understanding the material and concepts, and your time in this course will be much simpler.

Actually do the work (all of it). The layers of assignments (readings, homework, lectures) really meld together to bolster your understanding. I think if you, at the very least, just do everything as it's assigned, you can succeed quite easily in this course.

I wish I knew that I could speak up in class more often; the awkward silence of no one answering a question is arguably worse than just putting yourself out there.

Professor Zheng is very approachable and is gifted in teaching students in a one on one setting. Take advantage of her office hours and don't be afraid to ask questions. In addition, the TAs are all similar in their approachability so just know you don't have to do all this work solo.

Go to office hours. The professor and the TAs want you to do well and are really nice! Skim the readings and take notes before lecture, and work on the homework in manageable chunks. You'll be fine- don't worry too much.

I would want to be told that office hours are a life-saver and grade-saver for the homeworks, and to get started on everything early because this class is a lot of work.

DO NOT wait until the last minute to complete the homework assignments. They require diligent thought and effort to be put into them not only to complete, but also to understand the material altogether.

Stay on top of the chapter summaries and mastering homework. The first 4-6 weeks of the semester is not bad, but the course will pick up after the first midterm so just stay focused and be ready to work hard.

1. Stay on top of the work, the assignments are very difficult to get done in one night especially if you need help

2. Try to get to know and work with your group outside of the weekly quizzes because I think they could be a really useful tool when studying for exams or doing homework problems

I wish I was less shy and I asked my table mates for help more often early on in the semester.

To stay onto of your work because it can catch up to you if you wait until the last minute.

Make sure you do the examples in class and pay attention to how they are changed for quizzes and homework, because test questions often mimic those problems.

Read the lecture notes and textbook side by side if a topic still doesn't make sense. Use office hours to your advantage. The TA's are always willing to help.

This course will demand a lot of work outside of class in order to effectively understand the material. Make sure to stay on top of weekly homework assignments, as they are time consuming and sometimes tedious.

Something I would like to be told is to do every assignment the moment you get a chance to. If you have 15 minutes, that's enough time to finish at least part of a mastering physics problem.

I would like to be told that I can be successful in this course if I make sure I understand the content and can apply it to solve problems each week. The homeworks are very helpful for understanding the material and for developing problem solving skills. The

quizzes test you and are on the challenging side but are helpful for solving more difficult problems. The TAs can be immensely helpful during these if you run into any problems or are having trouble starting. Utilize your group for the assignments if you are stuck, they may be able to help you figure it out. For the chapter summaries, focus on the most important content. Try to do the reading before the lecture, so that you already have an understanding of the concepts and examples that will be discussed. If an example in the lecture notes isn't covered in class, when reviewing for the exam watch the video solutions and make sure you know how to solve that problem. The material at the beginning of the course is essential to understanding everything else, so make sure you build a strong foundation. Figure out what makes you understand the material the most and then use that throughout the rest of the course. Make sure you stay on top of all the material and assignments. This class is ultimately very rewarding if you put in the work each week. You will come away having a deeper understanding of how things work and be able to find solutions to difficult problems.

DO NOT SKIP CLASS. Not only is this a slippery slope, but it is extremely hard to hear over the zoom. It makes more sense when you're actually in class taking the notes, and it's easier to ask Professor Zheng questions. It's a little bit intimidating with a group that knows what's going on when you don't, but it doesn't hurt to ask them to explain something to you as well. Apart from this, make sure to do the chapter summaries (meaning reading the pre-lecture notes as well as the textbook) a few days before we go over the subject in class, as it's all going to click better than doing the summary the night before and not really having processed the material.

build good habits early because the class gets harder

The first few weeks seem easy, but it picks up really fast after the first Midterm. So, don't skip

I personally liked reading the textbook because I felt like it gave me a wider variety of formulas that I ended up needing to apply later (especially with homework assignments). I would highly recommend going to office hours. It worked out really well for me since Prof. Zheng had office hours right after class so I could ask her about anything that came up during the lecture. Prof. Zheng will definitely sit down with you and talk out the entire problem with you. Try to space out the homework assignments too, I know towards the end of the semester I couldn't keep doing that, but it was really helpful when I did.

COME TO CLASS!!!! I would have done so much better if I attended more classes and spent more time reviewing throughout, instead of couple days before the midterms/tests. The tests were not impossible.

It takes a very long time to do the show your work homework's. Do not do not do not wait till one or two days before the deadline to start or you will be unnecessarily stressed.

I wish I were told to put much less time into reading the textbook and more into trying to understand the quizzes and the examples during the lecture time.

I would like to have been told that the class is not as hard as you think if you make an understanding of the material.

Do not be afraid to ask questions.

Study a little more out of class.

Really take notes on the chapter summaries, it'll be useful for homeworks and studying.