

Physics I: Mechanics



PHYS 131-02 and PHYS 131-03

Physics I: Mechanics

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General Course Information

This is the first course in a two-semester introductory sequence in physics for students who plan to major in the physical sciences or to enter an engineering program. In this first semester, we will focus primarily on classical mechanics – the study of Newton's laws of motion and how they can be applied to describe and predict how everyday objects (and also some not-so-everyday objects) move and interact with each other. Over the course of the semester, we will be introduced some of the most fundamental concepts in physics – concepts such as energy, momentum, force, and power – and examine the relationships between them. The material that we cover in this course forms the foundation of not only physics, but of chemistry, biology, geology, and every other field of natural science or engineering.

The understanding that you take away from this course will therefore provide you with a deeper understanding and appreciation of how the things we observe in nature and in our daily lives work at the most basic level. In the process of coming to that understanding, you'll get a chance to hone some of the universal skills that are crucial in practically *any* science or engineering field – skills such as setting up an experiment, thinking critically about what you

observe, reasoning through problems, and communicating your own knowledge to others. Indeed, by the end of the semester, you can look forward to being able to do all of the following.

- You'll be able to understand and apply the fundamental principles of mechanics – and especially **Newton's laws of motion** – in a variety of physical situations.
- You'll be able to identify conserved quantities in a physical system and apply the corresponding **conservation laws** in order to extract information about that system.
- You'll be able to **describe natural phenomena using the language of mathematics** – including calculus concepts and vector quantities.
- You'll be able to apply both qualitative- and quantitative-reasoning skills toward solving concrete problems, but also to communicate the reasoning behind your solutions to others.
- You'll be able to **perform experimental measurements** relevant for testing a hypothesis and to evaluate whether your data supports, motivates the revision of, or refutes that hypothesis.
- You'll be able to interpret, create, and describe **graphical representations of data**.

The prerequisites for this include an understanding of calculus at the level of Math 161, as well as basic algebra and geometry. You should be aware that calculus is an integral part of this course (no pun intended), and that a solid grasp of these mathematical prerequisites is assumed. Understanding this background material will be your responsibility, and if you don't feel comfortable with this material, it's up to you to seek help from the instructors or from elsewhere.

I ask that you join this course with a will to think, to ask questions, to make mistakes, and to try out ideas. Be careful not to confuse understanding with having memorized a lot of facts and formulas. I feel that the former is important while the latter is not – and the former will be far more useful to you in the long run.

Components of the Course

The course will consist of class meetings, reading assignments in the text, homework questions and problems, comprehension quizzes, some laboratory experience, two mid-term exams, and a final exam. These are described more fully below.

Class Meetings:

Class meetings will be held **in Hugel 100 from 9:30 – 10:20 AM** (if you're in Sect. 02) **or from 10:35 – 11:25 AM** (if you're in Sect. 03) each Monday, Wednesday, and Friday during the semester. A schedule of the topics we'll be discussing at each class meeting, along with the corresponding reading assignments, can be found on the course web page. These class meetings are there to help clarify things that you might be confused about after exerting your best efforts at understanding them on your own. However, I emphasize that **not everything can be covered in class; you are responsible for understanding much of the material on your own** by synthesizing what you've learned from your readings, problem sets, lab experiments, exams, and other class activities. It is therefore important that you come to class prepared to ask questions.

There are no “dumb” ones. If you don't understand something, chances are there are others who don't understand either or who don't even realize they are missing something.

Class meetings aren't only about lectures either: on most days, we will also have other class activities that are meant to help you understand the material. For example, during class meetings, you will often be working collaboratively in teams of two or three people to come up with solutions to more open-ended problems, such as evaluating a set of proposals for a hydroelectric plant or optimizing the design for a circuit. These kinds of activities are designed provide you with an opportunity to apply what you're learning in ways that more authentically mirror how practicing scientists and engineers actually work. Moreover, it is not unusual for test questions to be based on these activities, so make sure you understand them. For all of these reasons, **regular attendance in class is expected**. You are responsible for knowing anything covered in class, even if you have to miss class for any reason.

Readings and the Mastering Physics Platform:

The textbook we will be using for this course is

- Hugh D. Young and Roger A Freedman, *University Physics with Modern Physics with Mastering Physics*, 15th Ed. (Pearson, 2019).

Access to both this textbook and to Pearson's Mastering Physics platform (which we will be using for a large fraction of the homework problems this semester) have been made available to you in digital format through a link on the course Moodle for the duration of the semester. You can access these materials from the “Course Materials” link within the course Moodle. The cost of access to these materials was added to the overall cost for this course at the time you registered.

If you wish to purchase the materials another way, you have the option to opt out of this digital content. This option will be available until the last day of the drop/add period. To opt out, select the large green “Opt Out” button when accessing the book through the “Course Materials” link on the course Moodle. If you opt out, you will be credited after the drop/add period for classes. If you choose to acquire the textbook in another way, you may need to purchase an access code online from Pearson Publishing at <https://mlm.pearson.com>. The Pearson course ID for both Sect. 02 and Sect. 03 of PHYS 131 is thomas51800.

Readings from the textbook will be assigned for each class meeting, and it is important to do the assigned reading before class. You can't speed-read this stuff; you should go through it with pencil and paper at hand, checking it out as you go.

Homework Assignments:

Homework assignments for this course will include both online exercises from Mastering Physics and problem sets that you are to submit on paper. A list of the problems included in each homework assignment will be accessible from the course web page. **All problems are due at 4:00 PM on the day (typically a Wednesday) indicated on the course schedule** on that same web page. In order to ensure that your scores on the online portion of the homework are imported correctly into Moodle, you should **always access Mastering Physics through the Course Materials portal** on the course Moodle page rather than directly through Pearson's site. I will accept late paper-and-pencil exercises for half credit up until 48 hours after the time it is due; whereas the credit given for Mastering-Physics exercises will gradually decrease to zero

over a 48 hour period beginning at the time it is due. Late homework will not be accepted beyond that point without a Dean's Excuse. Your lowest homework grade will be dropped at the end of the semester.

Working through problems accomplishes a lot of different things: it gives you practice using the physical principles you're studying, which helps you learn them in a way simple memorization doesn't; it can show you some further interesting consequences of the fundamental ideas; it will teach you how to approach problems; and it will help you discover how well you really understand what you have read. It is essential that you read the relevant sections of the textbook and review your lecture notes thoroughly *before* attempting the homework problems.

Almost all the physics in a problem comes at the beginning, in the process of setting up the problem – you need to understand the physical principles that apply prior to solving the problem. This means you need to think about the physics, not search for the “right equation” – often there *is* no “right equation.” The important thing is *not* getting the same numerical answer as in the back of the book, but understanding the physical concepts and how to apply them! In fact, many times, it is a good idea to try and answer the question *qualitatively* prior to plugging numbers into equations. It is also a good idea, once you think you've solved a particular problem, to ask whether your solution seems reasonable – if you have no idea, it probably means that you haven't really understood the problem.

You are encouraged to work on homework problems with other students in the class. This can be a very productive way to study, and working with other people to solve problems is a big part of how science and engineering are really done. However, your written work should reflect your own understanding and not be a copy of another person's efforts.

Course Reflections and Comprehension Quizzes:

What's the best way to learn physics? That's a tricky question. In fact, there's a whole subfield of physics called Physics Education Research (PER), which is devoted to studying how people learn physics. The best way to learn differs from person to person, but there are some strategies that research has shown in general to be a lot more effective than others. The important thing is to experiment with different strategies, and to take time to reflect on what works for you and what doesn't. To sweeten the deal, I'll be providing you with a number of opportunities to make up for points lost on homework assignments or comprehension quizzes by engaging in some of the activities that research has shown to be particularly effective. In the same spirit, roughly once every two weeks, at the beginning of class, you'll be asked to reflect on what you've learned in this course, identify any concepts you still feel you're struggling with, and articulate a concrete plan for how you'll improve your understanding of those concepts going forward. These written **course reflections** will contribute to your course grade, so it's important to treat them seriously. The dates of these course reflections won't be announced beforehand, so make sure you arrive promptly at the beginning of class each day.

Furthermore, roughly once a week, at the beginning of class, there will also be a **short comprehension quiz** on some of the recent material we've been covering in class and on homework assignments. These quizzes are intended both to help you to check your own understanding of that material and to alert me if there are any concepts with which a lot of the class is struggling so I can better address them. The dates of these quizzes won't be announced beforehand, so make sure that you arrive in class each day prepared. Each quiz will begin **promptly at 9:30 AM** (for Sect. 02) **or 10:35 AM** (for Sect. 03) and **you'll only have until 9:40 AM** (for Sect. 02) **or 10:45 AM** (for Sect. 03) **to complete it** no matter when you start taking it,

so make sure you arrive in class on time. Your lowest quiz grade will be dropped at the end of the semester.

Mid-Term Tests and Final Exam:

There will be two mid-term exams given during the course: **one on Friday, Feb. 27th and one on Monday, Apr. 13th**. These exams are designed give you the opportunity to demonstrate how well you understand the material. The mid-term exams will focus primarily on material covered since the previous exam (or in the case of the first exam, since the beginning of the course); however, each new topic introduced in this course builds incrementally upon the material we'll have studied previously. In addition, there will also be a final exam at a date and time to be determined by the Registrar.

Laboratory:

You will be performing a variety of laboratory experiments over the course of the semester. These labs are an integral part of this course. Physics is an experimental science and did not really get started in its modern form until people began to do careful, quantitative experiments. The physics lab is a place to test and develop your understanding of the physics you learn in the classroom. Not only is it a chance to see if the ideas being presented are actually true, but it also gives a nice glimpse of how scientific information – and confidence in that information – is acquired.

Further information about the laboratory portion of this course will be provided by your laboratory instructor during your first lab meeting.

Grading

Course Grade:

Your grade in the course will be determined by the following criteria:

Homework	20%
Comprehension Quizzes and Course Reflections	10%
Labs	20%
Mid-term Exam 1	15%
Mid-term Exam 2	15%
Final Exam	20%

Instructor Drop-In Hours (a.k.a. “Office Hours”):

My official instructor drop-in hours this semester will be held on **Mondays from 3:00 – 4:00 PM**, on **Tuesdays from 3:00 – 4:00 PM**, on **Wednesdays from 3:00 – 4:00 PM**, and on **Fridays from 1:00 – 2:00 PM** unless otherwise noted on the course web page. These drop-in hours (sometimes called “office hours,” but in this case, that’s a misnomer, since they will not take place in my office) will be held in Hugel 125. If you and other students in the course have the same question, you are welcome – and in fact encouraged – to meet with me during my drop-in hours as a group.

The default assumption is that my drop-in hours will take place in person. However, if the need arises for you to attend drop-in hours virtually at any point during the semester (e.g.,

because of a winter-weather emergency or an illness), please email me in advance to schedule a virtual drop-in-hours meeting. Such meetings will take place over my drop-in-hours Zoom link, which is

- <https://lafayette.zoom.us/j/89137906511>

The password is provided on the course Moodle.

If you are unable to make it to these official drop-in hours either virtually or in person, you may also email me to make an appointment to meet at some other time. However, I recommend that you do this as far in advance as possible in order to ensure that we can find a time to meet.

Intellectual Honesty:

All exams and quizzes in this class are closed-book. Calculators are permitted, including graphing calculators (e.g., calculators similar to the Texas Instruments TI-84), but the use of cell phones and cell-phone-based calculator-emulator apps is not permitted on exams or quizzes. You will also be provided with a sheet of useful equations and fundamental constants at the start of each exam. However, the use of any other resources is not permitted. When studying, working in the laboratory, or working on homework problems, I encourage you to work with other students. However, you may not consult a solutions manual or any other source for answers to the problems, and the write-up that you submit to me for each problem should be your own work.

As always, you are expected to abide by the principles of intellectual honesty and academic integrity outlined in the Lafayette Student Handbook, which can be found at

- <https://conduct.lafayette.edu/student-handbook/>

Other Useful Information

Mentored Study Groups:

A number of Mentored Study Group (MSG) leaders have been appointed for different sections of this course. Throughout the course, the MSG leaders will lead regular study and help sessions for students in this course. **You are strongly encouraged to take advantage of this free resource.** Since the order in which topics are covered in different sections of PHYS 131 are slightly different, you are strongly encouraged to attend the sessions run by the MSG leaders for my two sections of this course (Sect. 02 and Sect. 03). However, if you are unable to attend any of those sessions due to scheduling conflicts, you are welcome to attend the MSG sessions led by the MSG leaders for **other sections** as well. The schedule for all MSG sessions will be made accessible both on the course web page and on the course Moodle page.

Student Academic Resources Site:

This is a centralized website for Lafayette students which contains resources related to college-transition support, accessibility services, tutoring, health and well-being, advising and registration, technology help, library services, student funds, and more. A link to the site is provided below

<https://spaces.lafayette.edu/enrol/index.php?id=1276>

You are encouraged to self-enroll in this site and to bookmark it for future reference.

Accessibility Services:

In compliance with Lafayette College policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require as a student with a disability. If you are requesting accommodations, **you must follow the procedures specified by the Accessibility Services Office** (administered by the Academic Resource Hub) for disability verification and for the determination of reasonable academic accommodations. I cannot provide accommodations until the Accessibility Services Office has received the necessary documents and has provided me with an official letter stating what accommodations are to be provided. Requests for academic accommodations must be made within the first two weeks of the semester, except in unusual circumstances, so that suitable arrangements can be made in a timely manner.

Informal Surveys:

Over the course of the semester, I want to hear from you how you feel the course is going, what you like, what you don't like, what your concerns are, and how you think the course could be improved. Therefore, at regular intervals throughout the semester, you'll have the opportunity to fill out a short, informal course evaluation so that we can get feedback from you.

Course Communication:

This syllabus, a list of assigned readings and problem sets, and other course materials will be posted on the **course web page** for this course. This web page, which is common to both Sect. 02 and Sect. 03 of PHYS 131, can be found at

- <https://workbench.lafayette.edu/~thomasbd/Phys131-IntroPhysicsMechanics-Spring-2026/Phys131-IntroPhysicsMechanics-Spring-2026.html>

In addition to the course web page, there is also a **Moodle page** for this course which I will frequently use in distributing course materials, communicating with the class, etc. This Moodle page, which is also common to both Sect. 02 and Sect. 03 of PHYS 131, can be found at

- <https://moodle.lafayette.edu/course/view.php?id=32507>

Occasionally, it may be necessary for me to communicate additional information (scheduling changes, clarifications about homework problems, etc.) to the class as a whole. When I do so, I will use your official Lafayette email addresses for all course-related correspondence, so make sure to **check your Lafayette email regularly**.

Other Sections:

There are five sections of PHYS 131 being taught this semester by three different professors. The coverage of topics will be similar. However, exams will differ between sections, homework assignments (while they will be quite similar) may differ slightly, and

course policies and teaching styles may vary. Nevertheless, those of us teaching the course will work hard to ensure that grading and workload are equitable across all five sections. If you need to switch lecture sections, you should do so as soon as possible. In order to do this, you will need to contact the other PHYS 131 instructor. If you do this during the drop/add period, you will need that instructor's approval to change sections. Changes can only be made for compelling reasons (e.g., a conflict with another class or other college activity). If you need to switch lab sections, contact Physics Lab Coordinator Scott Shelley at shelleys@lafayette.edu.

Common Course of Study Outcomes Statement:

This course (and particularly the lab component) will promote the following outcomes for Natural Sciences (NS) within the Lafayette Common Course of Study:

- NS1: Employ the fundamental elements of the scientific method in the physical and natural world by identifying and evaluating a testable scientific hypothesis.
- NS2: Create and evaluate descriptions and representations of scientific data via equations, graphs, tables, and/or models.

Health Protocols:

At the moment, masking is not required during class meetings or during my office hours under normal circumstances, though I encourage you to wear a mask if it makes you feel more comfortable. However, this policy may change at any point during the semester if circumstances change. In any event, if you are experiencing symptoms (cough, chills, fever, sore throat, etc.) typically associated with communicable respiratory illnesses, you are required to wear a mask while your symptoms persist, even if those symptoms are mild. If you do not feel well enough to attend class meeting, inform me of the situation by email and do not come to class. You are of course also required to abide by all campus-wide health protocols established by Lafayette College while they remain in effect. Health protocols for the lab portion of this class will be established separately by your lab instructor.

Contingency Procedures for Virtual Class Meetings:

The default expectation is that all class meetings this semester will be held in person in Hugel 017. However, under certain circumstances (e.g., the campus closes due to a winter-weather emergency) we may temporarily be compelled to move those meetings online. If this should occur, the Zoom link that we will use for these class meetings is

- <https://lafayette.zoom.us/j/89310175144>

The password is provided on the course Moodle. I will notify all members of the class by email as far in advance as possible if we need to switch to a virtual classroom environment at any point during the semester. The assumption is that if this should even happen, we will return to an in-person learning environment as soon as circumstances permit.

If we are ever temporarily forced to move to a virtual format, I would like us to be able to simulate the atmosphere of a physical classroom to whatever extent we can. For this reason, I would like to ask that you have your camera on during any virtual class meetings we end up having and to use the “gallery view” option on Zoom so that we can all see each other and

respond to each other's visual cues. I will do the same. That said, if there are extenuating circumstances which would make having your camera on an issue for you, please reach out to me and we will work out an equitable solution. Please mute yourself when you are not speaking in order to reduce background noise. Please raise your actual hand in order to take part in the discussion. If I do not see your actual hand, please raise your "digital hand."

Privacy Statement Concerning Course Materials and Classroom Recordings:

At Lafayette College, all course materials are proprietary and for class purposes only. This includes posted recordings of lectures, worksheets, discussion prompts, and other course items. Reposting such materials or distributing them through any means is prohibited. Such materials should not be reposted or distributed through any means. You must request my permission prior to creating your own recordings of class materials, and any recordings are not to be shared or posted online even when permission is granted to record. Permission will be granted only when sanctioned as an academic accommodation in an official letter from the Accessibility Services Office. If you have any questions about proper usage of course materials please ask me. Please also be in contact with me if you have any concerns with being recorded during the course.

Online discussions in Moodle occurring during synchronous class sessions should also remain private and not be shared outside of the course. Courses using Moodle will make student information visible to other students in this class. Student information in courses is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure of student information to unauthorized parties violates federal privacy laws and it must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Mandatory Credit-Hour Statement:

The student work in this course is in full compliance with the federal definition of a four-credit-hour course. The full policy and practice statement can be found on the Registrar's Office website at

- <https://registrar.lafayette.edu/wp-content/uploads/sites/193/2022/07/Federal-Credit-Hour-Policy-Web-Statement.pdf>

Winter-Weather Emergencies:

You should assume that class meetings will occur as usual, despite any weather-related issues (including power outages), even if campus offices open late or close early. In the rare event that class must be canceled, I will notify the class by email, and by leaving a voicemail message on my office phone, the number for which is (610) 330-5207.

In Closing

If you have any questions about this syllabus, or about any aspect of the course, please don't hesitate to contact me. By the end of this semester, you can look forward to having both a better understanding of *why* things in the natural world behave the way they do and a practical grasp of *how* to apply fundamental physics principles toward solving the kinds of problems that scientists and engineers grapple with every day of their lives.

Course Schedule

The full, up-to-date schedule for the course, including due date for all assignments is available on the [course web page](#).

Week	Topics and Readings	Due Dates
Week 1 1/26 – 1/30	Units and Vectors Young & Freedman: 1.1 – 1.10	HW1 (Due 1/30)
Week 2 2/2 – 2/6	Motion in One Dimension Young & Freedman: 2.1 – 2.6	HW2 (Due 2/4)
Week 3 2/9 – 2/13	Motion in Two and Three Dimensions Young & Freedman: 3.1 – 3.3, 4.1 – 4.2	HW3 (Due 2/11)
Week 4 2/16 – 2/20	Forces and Newton's Laws Young & Freedman: 4.3 – 4.6, 5.1 – 5.3, 6.3	HW 4 (Due 2/18)
Week 5 2/23 – 2/27	Circular Motion Young & Freedman: 3.4, 5.4, 13.1 – 12.2	HW5 (Due 2/25) Midterm I (2/27)
Week 6 3/2 – 3/6	Work and Energy Young & Freedman: 6.1 – 6.3, 7.1	HW 6 (Due 3/4)
Week 7 3/9 – 3/13	Conservative Forces and Potential Energy Young & Freedman: 7.1 – 7.4, 13.3 – 13.4	HW7 (Due 3/11)
Week 8 3/16 – 3/20	Spring Break (No classes)	
Week 9 3/23 – 3/27	Momentum Young & Freedman: 6.4, 8.1 – 8.3	HW 8 (3/25)
Week 10 3/30 – 4/3	Collisions and Center of Mass Young & Freedman: 8.4 – 8.6, 9.1	HW 9 (Due 4/1)
Week 11 4/6 – 4/10	Rotational Motion Young & Freedman: 9.2 – 9.4	HW 10 (Due 4/8)
Week 12 4/13 – 4/17	Torque and Angular Dynamics Young & Freedman: 9.5 – 9.6, 10.1 – 10.3	Midterm II (4/13) HW 11 (Due 4/15)
Week 13 4/20 – 4/24	Angular Momentum Young & Freedman: 10.4 – 10.7, 14.1 – 14.3	HW 12 (Due 4/22)
Week 14 4/27 – 5/1	Oscillations and Waves Young & Freedman: 14.4 – 14.6, 15.1 – 15.4	HW 13 (Due 4/29)
Week 15 5/4 – 5/8	Wave Motion Young & Freedman: 15.5 – 15.8	HW 14 (Due 5/8)
Final Exam Week		Final (TBA)