Physics 131 - Physics I: Mechanics
Lafayette College, Spring 2021

Class meeting times

Lecture section 03: M W F 10:00-10:50am

Lecture Zoom link: `https://lafayette.zoom.us/j/97297383765` You must be logged in to Zoom through your Lafayette account to access the Zoom meeting!

Lab: Nine sections of lab, taught by different instructors, meet remotely throughout the week. Your lab instructor should distribute a Zoom link.

Professor

Zoe Boekelheide

email: `boekelhz@lafayette.edu` (the best way to reach me)

Office hours: M T W Th 11am-noon. Please drop in!

Office hours Zoom link: `https://lafayette.zoom.us/my/boekelhz`

Mentored Study Group

In Mentored Study Group (MSG) sessions, students can work together on assignments or review material with an advanced student (mentor) to assist. All MSG sessions are held via Zoom for this class.

MSG leader: Evan Braasch

email: braasche@lafayette.edu

MSG sessions: M T 8-10pm. Drop-ins welcome!

MSG Zoom link: `https://lafayette.zoom.us/j/99386766578`

About this course

Physics 131 is the first course in an introductory physics two-semester sequence: Physics 131-133. This course focuses on classical mechanics - that is, we will study how and why objects move the way they do. Many of the physical situations we will look at in this course may be familiar from your everyday life, and we will build on your existing physical intuition (and perhaps contradict it occasionally!) as we formally and mathematically analyze these situations. The model of mechanics we will study in this course is considered "classical" because it came before some more modern breakthroughs in physics such as quantum mechanics (which is important at very small length scales) and relativity (which is important at very high speeds). Nevertheless, classical mechanics is a very successful model which accurately describes motion for the vast majority of situations we encounter in daily life. (If you are intrigued by quantum mechanics or relativity, come chat with me!) This course also has some broader goals beyond the specific content of classical mechanics. We will work on building intuition about the physical world, expressing physical concepts using mathematical and English language, and problem solving.

The course-catalog version of the description of Physics 131 is: "A rigorous introduction to the study of physics for science and engineering majors; a foundation on which an understanding of physics, physical chemistry, or engineering can be built. Kinematics and dynamics with emphasis on conservation laws for linear momentum, angular momentum, and energy. A calculus-based course satisfying degree requirements in all B.S. or A.B. degree programs."

Prerequisites

Math 161 or 165 (Calculus I) is a prerequisite of this course. It can be waived by permission of the instructor. Physics 131 is a prerequisite for Physics 133.

Other introductory physics courses

Everyone is welcome in Physics 131. However, you should be aware of other introductory physics courses.

Physics 111-112: Pre-med, pre-dental, and pre-vet students may wish to consider Physics 111 and 112, which cover more topics with less depth than Physics 131-133.

Physics 151-152: Students with strong previous background in physics may wish to consider Physics 151 and 152, which proceed at a more rapid pace than Physics 131-133.

This semester, Physics 151 is offered M W F 10:00-10:50am (in-person) with a Tuesday 1:10-4:00pm lab (remote).

Physics 130: Students with a particular interest in physics may enjoy Physics 130, which presents contemporary physics topics (special relativity and some particle physics) at level appropriate for first or second-year STEM majors. For physics majors, Physics 130 is a required course. For other majors, it may satisfy a science elective. Physics 130 will be offered in the fall.

Other sections of Physics 131

There are five sections of Physics 131 taught this semester, taught by three different professors. Topic coverage and homework sets will be similar. Midterm exams will be different, and course policies and teaching styles may vary between sections. Those of us teaching this course work hard to ensure that grading and workload are equitable across all sections.

Due to space limitations, the registrar may have placed you in a lab section other than the one you requested. If you need to switch lecture sections, you should do so as soon as possible. Speak to me or send me an email if you are not sure how to do this. If you need to switch lab sections, contact lab coordinator Scott Shelley (`shelleys@lafayette.edu`).

Expectations

Workload

The student work in this course is in full compliance with the federal definition of a four credit hour course. The federal course credit rule requires a total of 180 hours (12 hours/week) of student work over an approximately 15-week semester for a full unit (four credit hour) course. See the Registrar's Office web site for the full policy and practice statement (`https://registrar.lafayette.edu/wp-content/uploads/sites/193/2013/04/Federal-Credit-Hour-Policy-Web-Statement.doc`).

You should therefore expect to spend about 12 hours/week on this course: 3 hours in lecture, 3 hours in lab, and 6 hours spread throughout the week on homework and studying. Homework and studying may take place on your own, with classmates, meeting with me during my office hours, or at Mentored Study Group sessions; preferably some combination of these formats. One big difference between a high school course and a college course is that in a college course there is less time in class and more time working independently outside of class. (For example, a typical AP Physics C/M high school course covers the same material as this class but with about 180 hours of class time; we have 42). Note that "independent" is not the same as working alone or without any help! Reaching out to a classmate to study together, or attending a Mentored Study Group meeting or my office hours are great academic skills and show that you are being proactive

in your learning.

Expectations for class

Attend every class meeting. You should be prepared with a pencil/pen and notebook for taking notes and a calculator. I do expect you to participate in class - ask a question if something is not clear, and work with your classmates on assigned in-class questions/problems as appropriate. Please keep your video on if you can, as it helps foster community in the class. This is especially valuable during any work in small groups.

Previous preparation

Students enter this class with a wide range of preparation. This course has no physics prerequisties, but it does have math prerequisites. It starts at the very beginning of physics, but assumes students have mastered certain math skills (algebra, trigonometry, and some parts of calculus). Here is some advice for students coming into this course with different backgrounds:

If you have never taken physics before: Some students may feel intimidated because some other classmates might have previous experience with physics from high school. Do not despair! This course is designed to start at the beginning and you need not have taken physics previously. You may find yourself studying harder than some of your classmates, especially in the first few weeks, but please know that most students in your position find success in this course AND find that the study habits they develop are helpful throughout college.

If you have taken a lot of physics before: If you are wondering whether this is the correct course for you, please look through the chapters of the textbook we cover (Ch. 1-10, 13-15) and course schedule at our topic coverage. If you have already covered everything or nearly everything in this course, at a calculus-based level, please speak to me. If you have not covered everything but would prefer a more challenging pace, you might consider switching to Physics 151, which meets all the same requirements as this class, but proceeds more rapidly. Otherwise, many students find that the first few weeks of this course are familiar to them, but that the material gets progressively more challenging and new as the semester goes on. Please be aware of this and do not let your study habits slide!

If you are worried about your math skills: In this course, algebra, trigonometry, and some introductory calculus skills are critical. If you are concerned that your math skills will hinder your success in this course, please see me so we can develop a plan.

Course materials

For this course, you are required to obtain the following:

- **Textbook:** The textbook for the course is University Physics with Modern Physics, by Young and Freedman, 14th edition. You will need a copy of the textbook to study from. There are various editions of the textbook (13th edition, 14th edition, 15th edition, international editions, eText, etc.) The content and presentation of the material is

extremely similar between editions, so it does not matter which edition you purchase. Personally, I prefer a physical copy of the book, but some students prefer the eText; it's up to you.

- **MasteringPhysics:** MasteringPhysics is the online homework system associated with the book. You can purchase a bundle that includes the textbook (new) and MasteringPhysics access code, but it is very expensive, so we have opted not to list the bundle in the Lafayette bookstore this year. You can purchase access to MasteringPhysics through Pearson's website. If you input the course ID (`boekelheide32809`), the website should direct you to the correct edition. It will also offer to sell/rent you an eText at that time. There are other ways to purchase access to MasteringPhysics (for example buying an "access card"); these work as well but students usually find it easiest to just purchase access through the website directly. (`https://mlm.pearson.com/northamerica/masteringphysics/`)

  *Note: If you will be taking Physics 133 at Lafayette next semester, you will need the same textbook and MasteringPhysics. Keep this in mind as you look at textbook buying/renting options.

- **Calculator:** You should have a calculator (not the one on your phone) which has scientific functions such as sin, cos, etc. This could be a graphing calculator or a regular scientific calculator, it's up to you. It is important that you have a regular calculator and do not rely on the one on your smartphone. A smartphone is not an allowed resource during exams; it is a distraction at best.

Course Website

I will use Moodle to post course materials: `http://moodle.lafayette.edu`.

Learning Outcomes

By the end of this semester...

- You will 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 will 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 will be able to describe natural phenomena using the language of mathematics including calculus concepts and vector quantities.
- You will 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 will 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 will be able to interpret, create, and describe graphical representations of data.

In addition to the outcomes listed above, this course (particularly the lab component) will promote the following outcomes from the Natural Sciences section of the 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.

Grades

Grades on various assignments serve multiple purposes:

- To provide feedback on your performance on given assessments (e.g. exams, quizzes). Your performance on such assessments should reflect your understanding of the material, i.e. the degree to which you have met learning outcomes.
- To provide more immediate incentives for certain behaviors which are beneficial to your learning (e.g. studying or completing homework) or to the class as a whole (e.g. participating in class).

Thus, your final course grade should be related to both how well you understand the material and how well you complete required tasks. Your final course grade does NOT indicate your value as a person, and also does not determine your future success in physics or in life.

Your final course grade will be determined as follows:

Homework	20%
Participation	10%
Lab	15%
Midterm Exam #1 (1 unit)	13.75%*
Midterm Exam #2 (1 unit)	13.75%*
Midterm Exam #3 (1 unit)	13.75%*
Final exam (2 units)	27.50%*

*Lowest exam "unit" will be dropped.

Each midterm exam counts as an equally weighted "unit" with the final exam counting as two "units." I will drop the lowest "unit" in calculating your final grade. Example 1: if

Exam 2 is your lowest exam grade, it will be dropped from your final grade as though it never happened. Example 2: if your final exam was your lowest exam grade, then it will only count for 1/2 credit (one of the two "units" was dropped).

Detailed description of course components

Homeworks

There will be weekly homework assignments. Working on problems is essential to your learning in this course. Solving problems forces you to check your conceptual understanding of the physics we are learning and then apply it in a quantitative way. Solving problems also usually requires some creativity - putting together concepts in different ways than you might have seen them in class. The problems you will encounter in Physics 131 may be different or more challenging than problems you have encountered in previous courses. This is a good thing! Students and faculty regularly state that one of the most valuable things learned in physics classes is not any particular law of physics, but problem-solving skills.

Of the time you spend on this course outside of class, expect homework assignments to make up the bulk of it. Set aside about 2-6 hours per week for your physics homework. Begin the homework several days in advance so that if you get stuck, you have a chance to get un-stuck. How do you get un-stuck when you are stuck on a physics problem? Take a break and then come back to the problem. Do you have a new idea to try? Or maybe you realized you were stuck because there is a key concept you do not understand. Try asking a friend, coming to my office hours, going to a Mentored Study Group session, or re-reading that part of the textbook. Encountering obstacles while solving a problem is normal and learning how to deal with these obstacles is just as important as the physics you are learning.

Weekly homework assignments will be posted on MasteringPhysics. Homework will generally be due on Wednesdays at the beginning of class unless otherwise noted. Each problem will be equally weighted in your homework grade unless stated otherwise. Late homework generally receives no credit; if you have a legitimate excuse, please contact me for an extension.

Online homework submission through MasteringPhysics comes with pros and cons. Many students enjoy receiving the instant feedback to gauge their understanding. On the other hand, it can can be easy to fall into bad problem-solving habits if you don't write down your problem-solving steps as you work. To make sure you are developing good problem-solving skills, which are important for both your learning and for demonstrating your learning on exams, here is my advice: As you work on a homework problem in MasteringPhysics, write out all of your work in a notebook as if you were planning to turn it in. This will be helpful if you want to share your work with other students as you work on homework together, with me during office hours, or during a Mentored Study Group meeting. It is also good practice for exams. See the section on Exams for specific advice on how I would like to see you write out problems on exams.

Participation

You are expected to attend class, arrive on time, and participate in class discussions and group problem solving or other activities.

Labs

There are 9 lab sections for Physics 131 this semester. Lab will generally meet every week, as noted on the schedule. All assigned experiments must be completed and you must pass the lab portion of the course in order to pass the course as a whole. Please see your lab instructor for further details.

Exams

There will be three exams and a final:

- *Midterm Exam #1* will be on Friday, March 12. It will be an approximately 50 minute exam during class time.
- *Midterm Exam #2* will be on Friday, April 9. It will be an approximately 50 minute exam during class time.
- *Midterm Exam #3* will be on Friday, May 7. It will be an approximately 50 minute exam during class time.
- The *Final Exam* will be an approximately three hour exam during finals week at a time determined by the Registrar. It will be cumulative.

Exam problems will be a similar style to problems worked on homework and discussed in class. Exam problems will be designed to be completed within the time period provided, and will be designed to test understanding of concepts and competence in skills learned in the preceding weeks.

Exams will be posted on Moodle at the beginning of the class period; you will work the problems on paper, scan them to pdf (you can use a phone app such as GeniusScan or CamScanner), and submit them on Moodle.

Here is advice on how to write up a good problem solution:

- Start each problem on a new page. It will be easier to make nice pdfs, and it will be much easier for you if you need to go back and change something on a long problem solution.
- Clearly indicate the problem number on your page.
- Draw and use pictures/diagrams generously.

- Clearly work out the problem, commenting your work as you go. Problem solutions should never contain just math; use words to describe what you are doing. Reference important concepts or equations and why they are relevant. (e.g. "Used Pythagorean theorem here" or "Energy is conserved" – a few words go a long way.)
- When using an important equation, write out the equation in variables first before plugging in numbers specific to the problem. (e.g. "F = m a" followed by "1.0 N = (2.0 kg) a" followed by "a = 1.0 N / 2.0 kg = 0.5 m/s^2".)
- Remember to keep track of units by writing them out with all your calculations. This is just generally good practice - it's something professionals do - but it also will help you spot errors in your work. (If, for example, your solution for a distance turns out to have units of m/s^2, you will know you have made an error).
- Box your final solution. This makes it easier to grade and also tells me that you know what the problem was asking for and know whether you got to the end or not. You may wish to underline, star, or otherwise highlight other major milestones as you do the problem.
- Comment on the significance of your answer. (Does it make sense? Is it what you expected? Why or why not?)

Intellectual honesty

You are expected to abide by the principles of academic integrity outlined in the Lafayette Student Handbook (available from `https://conduct.lafayette.edu/student-handbook/`). Breaches of academic integrity are typically referred to the Dean's Office and can carry penalties ranging from a zero on the assignment to suspension or expulsion from the College.

Perhaps more important than avoiding external consequences are the personal benefits of maintaining the principles of academic integrity. Performing and submitting your own academic work is critical for your learning and for the healthy development of your sense of self.

Here are some guidelines specific to this course:

Homework - collaboration

Learning is a collaborative process. Discussion and collaboration on homework in this course is strongly encouraged. "Collaboration" does not mean "copying." You should understand and calculate your answer to each homework problem yourself.

Homework - resources You may use classmates, MSG leaders, my office hours, and the textbook as resources. **Do not seek out solutions to homework problems on the internet; this is considered a breach of academic integrity.** Finding solutions to homework problems on sites such as (but not limited to) Chegg, Slader, or Bartleby is not allowed.

Exams

Exams must be done on your own, using only materials specifically allowed. **Do not share information with classmates about exam problems or seek out solutions to exam problems on the internet; this is considered a breach of academic integrity.** It is important that you have a regular calculator and do not rely on the one on your smartphone. A smartphone is not an allowed resource during exams; at best it is a distraction, at worst it is a temptation.

Inclusion statement

In Physics 131, all students are welcome. Students and professors bring diverse identities to class, and it is my intention that all students feel included in the intellectual community of the classroom. Unfortunately, the history of science is full of exclusion, so it's important to be explicit about inclusion.

Please contact me if you feel your identity is not being honored in class, if you have a preferred name or pronouns that I am not aware of, you observe religious holidays which conflict with coursework, or if there is something else that I can or need to address. I am still learning, too, and your feedback is important to me.

Accommodation

It is important to me that nothing impedes your ability to do well in this course. If you have any disabilities which you feel may interfere with your ability to succeed and prosper in this class, please contact me to discuss ways of accommodating them.

Mandatory statement for any Lafayette course with a disability policy. 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. Requests for academic accommodations need to be made during the first two weeks of the semester, except for unusual circumstances, so arrangements can be made. Students must register with the Office of the Dean of the College for disability verification and for determination of reasonable academic accommodations.

Mandatory Moodle privacy statement

Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's

Office.

Schedule for Lafayette Spring 2021 PHYS131 course

*subject to change

Wk	Lec #	Date	Topic	Relevant Sections	Lab (Mon-Thurs)
1	1	8-Feb	Introduction	1.1-1.2	
	2	10-Feb	Units, velocity	1.3-1.6	Intro meeting
	3	12-Feb	Working with vectors	1.7-1.10	
2	4	15-Feb	Position, velocity and acceleration	2.1-2.3	
	5	17-Feb	Constant acceleration (1D)	2.4	Pendulum home e
	6	19-Feb	Constant acceleration (2D)	2.5-2.6	
3	7	22-Feb	Acceleration in 2D	3.1-3.2	
	8	24-Feb	Acceleration in 2D cont.	3.3, 3.5	Free fall video
	9	26-Feb	Newton's Laws	4.1-4.5	
4	10	1-Mar	Free-body diagrams	4.6, 5.1	
	11	3-Mar	Friction	5.2-5.3	Measuring the spri
	12	5-Mar	Spring force	4.5, 6.3	
5	13	8-Mar	Circular motion	3.4, 5.4	
	14	10-Mar	Work and kinetic energy	6.1-6.3	Modified atwood's
	15	12-Mar	**Exam 1**		
6	16	15-Mar	Potential energy	7.1	
	17	17-Mar	Energy problems	7.1-7.2	Measuring coeffic
	18	19-Mar	Energy problems (cont)	7.1-7.2	
7	19	22-Mar	Conservative forces and potential energy	7.3-7.4	
	20	24-Mar	Power	6.4	Exploring forces i
	21	26-Mar	Momentum conservation	8.1-8.2	
8	22	29-Mar	Collisions in 1D	8.3-8.4	
		31-Mar	**Spring break**		NO LAB
	23	2-Apr	Collisions in 2D	8.3-8.4	
9	24	5-Apr	Center of mass	8.5	
	25	7-Apr	Introduction to rotation	9.1-9.2	Momentum and er
	26	9-Apr	**Exam 2**		
10	27	12-Apr	Rotational kinematics	9.2-9.3	
	28	14-Apr	Moment of inertia	9.5-9.6	NO LAB
	29	16-Apr	Torque	10.1-10.2	
11	30	19-Apr	Angular momentum	10.3-10.5	
	31	21-Apr	Angular momentum vector	10.6-10.7	Wheels accelerate
	32	23-Apr	Gravitational force	13.1-13.2	
12	33	26-Apr	Gravitational potential energy	13.3-13.4	
	34	28-Apr	Simple harmonic motion	14.1-14.3	Wheels accelerate
	35	30-Apr	Simple harmonic motion	14.4-14.6	
13	36	3-May	Damped, driven harmonic motion	14.7-14.8	
	37	5-May	Wave properties	15.1-15.2	NO LAB
	38	7-May	**Exam 3**		
14	39	10-May	Wave properties	15.3-15.4	
	40	12-May	Standing waves	15.6-15.8	Pendulum investig
	41	14-May	Wave power and intensity	15.5, 16.4	
15		17-May	**Non-instructional day**		
	42	19-May	Wave superposition	16.4, 16.6	NO LAB
		21-May			
		TBD	**Final exam**	Cumulative (Ch. 1-10, 13-15)	