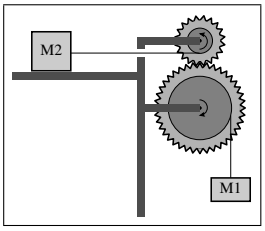
Physics 151
Accelerated Physics I: Mechanics and Thermodynamics
Lafayette College
Spring 2020



Instructors

Class: Prof. David Nice
Hugel Science Center 030
niced@lafayette.edu
http://sites.lafayette.edu/niced

Lab: Prof. Andrew Dougherty
Hugel Science Center 031
doughera@lafayette.edu
http://workbench.lafayette.edu/~doughera

Locations and Times

Class: Hugel Science Center 142
Monday, Wednesday, Friday; 10:00-10:50

Lab: Hugel Science Center 119
Tuesday 1:10-4:00

Website

Handouts, homework assignments, etc., will be distributed on paper and posted on Moodle.

Office hours

I will have weekly office hours in Hugel 030. The schedule will be set shortly after the semester begins and will be posted on Moodle as well as on my office door.

Office hours are a great time to stop by for questions about course material, homework problems, or anything else related to the class. If you wish to meet, but have conflicts with my scheduled office hours, E-mail me to schedule an appointment, or just stop by and try your luck.

Overview

From the college catalog: An accelerated calculus-based introduction to the foundations of classical mechanics and thermodynamics, intended for students majoring in science or engineering; a foundation on which an understanding of physics, physical chemistry, or engineering can be built. Topics include dynamics; conservation laws for linear momentum, angular momentum, and energy; mechanical oscillations and waves; and thermodynamics.

Lafayette calculus-based introductory mechanics/electromagnetism courses. We have two such course sequences, Physics 131/133 and Physics 151/152. Physics 151/152 is designed for students with significant prior experience in physics and/or strong interest in the field. Physics 151/152 proceeds more rapidly than Physics 131/133, especially in the first weeks of the semester. This allows Physics 151/152 to cover material with greater depth and breadth than Physics 131/133. Both course sequences use the same textbook, and students may switch between the sequences midway through the sequence (i.e., take Physics 131 and then 152, or take 133 and then 151).

Math prerequisite

Math 161 (Calculus I) is a prerequisite of Physics 151. You should understand the fundamental ideas of calculus, and you should have a working knowledge of derivatives and integrals of polynomials, basic trigonometric functions, exponents, and logarithms.

Text

The following text is required and is available at the college bookstore:

- Young and Freedman, "University Physics with Modern Physics MasteringPhysics," 14^{th} edition. ISBN 9780321982582.

Make sure you get fourteenth edition.

While the text will serve as an important resource, classes and homework sets will be your primary guide to what you need to know in order to do well in this course. Skim through the assigned sections of the text, but read through the examples carefully. Use the text as a reference as you work homework problems and study for exams.

Homework

There will be weekly homework assignments. They are the heart of this course. You don't learn physics by reading about it, or by hearing lectures about it, or by watching someone else do it. You learn it by doing it yourself: doing real experiments in lab and doing real calculations in homework.

Homework papers will be due in class on Fridays. Late papers will be accepted for 50% credit in class on Mondays. If you cannot complete an assignment due to illness, family emergency, or similarly compelling reason, please contact me. (Also see the "Dean's excuse policy" in the Student Handbook.)

I *strongly* encourage you to work with other students on the homework. Try the problems yourself. When you get stuck, talk to someone else about them. Physics is hard. You won't get all the problems on your own. Working in groups is a powerful way to learn. It is also more fun.

I will have extensive office hours. Please come and visit if you are having difficulty on homework. I am happy to help. Often there will be other students there with questions similar to yours. I expect that most of you will take advantage of office hours sooner or later during the semester.

Exams

There will be three midterm exams:

- Midterm exam #1. Monday, February 24. In class.
- Midterm exam #2. Tuesday, March 31. In lab.
- Midterm exam #3. Tuesday, April 28. In lab.

Each midterm exam will be on the material covered in the preceding weeks of class (i.e., since the previous hour exam). Further details will be given before each exam.

There will be a comprehensive final exam during finals week covering all material in the course. The final exam will be three hours and will be scheduled by the registrar.

All exams will be closed book, with equation sheets provided. Copies of the equation sheets will be available in advance. Exam questions will resemble homework problems.

Labs

Labs are an essential part of the course. You will work on experiments that are closely correlated with the material we cover in class. You will work in groups of two. You will need a copy of the lab manual, available at the bookstore. You and your partner will need a notebook to use in lab. It may be either sewn or spiral bound. It should have lined paper but not graph paper. The college bookstore has suitable notebooks.

Grading

There must be grades. Your grade will be based on:

Homework	15%
Lab	15%
Midterm Exam #1	10%
Midterm Exam #2	15%
Midterm Exam #3	15%
Final Exam	30%

I will post homework and exam grades on Moodle. The exam grades may be re-scaled depending on the difficulty of the exam. I will use the following numerical score when setting letter grades:

A	92.500 and higher	B−	79.500−82.499	D+	66.500−69.499
A−	89.500−92.499	C+	76.500−79.499	D	62.500−66.499
B+	86.500−89.499	C	72.500−76.499	D−	59.500−62.499
B	82.500−86.499	C−	69.500−72.499	F	59.499 and below

Memorization

Knowledge of terminology and notation is an important part of a scientific education. For this course, you are required to memorize the metric prefixes listed below and to know how to use them. They will be tested on midterm exam #1 and may be used in subsequent exams.

Prefix	Abbreviation	Multiplier
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}

Prefix	Abbreviation	Multiplier
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}

The computer industry uses prefixes to represent multiples of 1024 (e.g., 1 kbyte = 1024 bytes), but in physics they always are factors of 1000 (1 km = 1000 m).

Course goals and topic coverage

The goals of this course are to teach you to *think like a physicist* and to provide a foundation for further study in physical science and engineering. We will accomplish this by introducing you to the following topics. This list may evolve as the semester progresses. Specific topic and text coverage will be given on a weekly basis on the homework assignments.

Topic	Text Chapters	Approximate number of class sessions
Units	1	1
Kinematics in one and multiple dimensions	2,3	4
Newton's laws and applications	4,5,13	4
Conservation of energy and momentum	6,7,8	8
Rotational motion	9,10	9
Oscillations	14	3
Waves	15,16	5
Thermodynamics	17,18,19,20	7

Outcomes

After completing this course, you will be able to understand, identify, and apply the fundamental principles of physics in a variety of physical situations. You will be able to use both qualitative reasoning and quantitative problem-solving skills in applying those principles. Among other things, you will be able to:

- Model static and dynamic physical situations using qualitative and quantitative models.
- Use and manipulate vector equations for solving physical problems.
- Use conservation laws for scalar and vector quantities.
- Use calculus concepts in analyzing physical situations.
- Analyze oscillatory and wave motion.
- Apply the laws of classical thermodynamics.

Within the Lafayette Common Course of Study, this course (particularly the lab component) will promote the following outcomes for Natural Sciences:

- 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.

Intellectual honesty

You are expected to abide by the principles of intellectual honesty outlined in the Lafayette Student Handbook available at http://conduct.lafayette.edu.

Learning is a collaborative process, I encourage you to discuss and collaborate with other students on homework. "Collaboration" does not mean "copying." You must understand and individually write out your answer to each problem.

Exams must be done on your own, using only materials specifically allowed.

Accommodation

My policy. It is important to me that you do well in this class. 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.

Mandatory credit hour statement

The student work in this course is in full compliance with the federal definition of a four credit hour course.

Physics 151—Accelerated Physics I: Mechanics and Thermodynamics LAB
Section 1L, Tuesday 1:10 – 4:00 p.m.
Course Description, Spring 2020

Instructor:	Andrew Dougherty
Office:	HSC 031 610-330-5212
Lab:	HSC 025 610-330-5212
E-mail:	doughera@lafayette.edu
Web Page:	`http://workbench.lafayette.edu/~doughera/` or via `http://moodle.lafayette.edu`

Office Hours: Please see the enclosed schedule. Beyond those designated office hours, I will usually be either in my office or lab during the free times indicated on my schedule. Please feel free to call, e-mail, or stop by at any time and ask a question or set up an appointment.

Classes on Snow Days and Other Emergencies: If I am unable to make it to class, I will send an email via Moodle or leave a message on my voice mail (610-330-5212).

Description: This lab is designed to accompany the Phys 151 lecture class. The primary goals of this lab are to enhance your understanding of the basic physics you will be studying, and to introduce you to the *process* of doing physics. In addition, I hope to help you learn a number of general principles and ideas that apply in many laboratory situations, such as how to determine for yourself what techniques and procedures to follow to explore a particular phenomenon, how to estimate the origin, magnitude, and importance of uncertainties in your results, how to judge whether or not to believe the results, and what to do when things go wrong.

Text: You should purchase the *Physics 151 Laboratory Manual Spring 2020* in the bookstore. Each lab **team** will also be required to keep a bound laboratory notebook (not a loose-leaf binder) for recording your work. I don't require a specific type of notebook, but you must use one that is sturdy enough that the pages don't fall out. During the semester, you will often have to refer back to previous experiments to review how to do certain tasks. A simple cheap spiral notebook is fine for Phys 151 lab.

Learning Outcomes: After completing this course, you should be able to

1. Apply the basic principles from the associated lecture class to a variety of laboratory situations.
2. Generate and use data to test theoretical predictions, including making appropriate graphs, fitting simple functions to data, and incorporating basic uncertainty analysis to assess whether the data support the theory.
3. Estimate the origin, magnitude, and importance of uncertainties in your results.
4. Summarize your results in a laboratory notebook.

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:

- NS 1 Employ the fundamental elements of the scientific method in the physical and natural world by identifying and evaluating a testable scientific hypothesis.

- NS 2 Create and evaluate descriptions and representations of scientific data via equations, graphs, tables, and/or models.

Attendance: You are responsible for completing all of the assigned experiments at the scheduled times. Make-up labs are not normally available for unexcused absences. You can't count on the equipment being available outside the scheduled times.

General Strategy:

Come to lab prepared. Students who read the lab manual *before* coming to lab are more likely to learn something from it, and much more likely to complete the lab quickly and correctly.

Ask questions. Even after you read the lab carefully, you will likely have questions. You should not expect to understand everything entirely on your own—knowing when to ask a question is also an important skill.

Don't give up easily. Most experiments are designed to work reasonably well. If your experiment is apparently not working, check with me.

Conduct of Labs: Lab should be an informal learning experience. Feel free to ask questions of me and your fellow students. Remember, however, that the purpose of the lab is to learn, so you should not simply copy what someone else does. Instead, you should make sure you understand what you need to do. Also, if you do consult anyone (besides your instructor), be sure to acknowledge that in your lab notebook.

Academic Honesty: Please consult the departmental policy on academic honesty.

Grades: Students will typically work together in teams of two. Each team will submit a single notebook that is your joint best effort. Your grade for the laboratory will be the average of the grades for the individual labs in your notebook. The basic guidelines for lab notebooks are described in the introduction to the lab manual. Here is how they specifically will apply in this section:

Grades are based on a scale of 0 to 100. A lab write-up that presents data and analysis with no major errors and barely adequate discussion will receive a grade of 80. The grade could go up or down from there. Points will be added for exemplary work and further evidence that you have fully understood what the lab was about. Points will be subtracted for mistakes, omissions, contradictions, or sloppy work. Typically, the average grade for all the labs is about 85.

Specifically, you will be rewarded for:

1. Evidence that you have identified and understood the key physical concepts involved in the experiment.

2. Quality of data taken—within the limits of the apparatus, this reflects the care with which you performed the experiment.

3. Extraordinarily good organization and clarity. Putting data **IN TABLES** often greatly enhances clarity and reduces the amount of writing you have to do.

4. Good discussion of sources of uncertainty, **especially** estimates of the size and relative importance of the uncertainties. *If you think you have made a mistake, redo the measurement or calculation.*

   Note that long lists of possible errors, without any sense of whether or not those errors were actually relevant for *your* experiment, are rarely useful. *Don't make such lists.* Instead, concentrate on those few factors which you think were most important. Refer to specific data or observations you made supporting your argument.

5. Suggestions for improving the experiment, such as suggestions to clarify the physics, improve the precision, or improve the write-up.

You will lose points for:

1. Missing or contradictory data.

2. Incomplete, unclear, or incorrect analysis.

3. Illegibility. Your notes are of no use if no one else can read or understand them. In some cases, I may return the lab notebook ungraded and require you to re-write it more clearly before I will grade it.

4. Poor writing. While I don't expect a polished final product, I do expect your writing to be in reasonably clear and correct English.

5. Any clear evidence that you do not understand what you have done in the lab.

If you have any questions or complaints about grading, please ask me. I will be happy to discuss your grade and how it is determined.

Please note that most of the experiments are designed to work, and to be easily completed well within the 3-hour lab period. You should usually have plenty of time to give careful thought to what you have done and to explain your thinking clearly. You don't have to write a lot, but what you do write should be clear.

Andrew Dougherty Spring 2020
Office: Hugel Science Center 031
Lab: Hugel Science Center 025
610-330-5212 doughera@lafayette.edu

Time	Mon.	Tues.	Wed.	Thurs.	Fri.
8:00					
8:30	*prep*		*prep*		*prep*
9:00	**Phys 218**		**Phys 218**		**Phys 218**
9:30	HSC 042		HSC 042		HSC 042
10:00					
10:30		*prep*		*prep*	
11:00		**Phys 131**		**Phys 131**	
11:30		HSC 100		HSC 100	
12:00					*Physics Club*
12:30		*prep*			
1:00		**Phys 151**		Phys 131	
1:30		**Lab**		Meeting	
2:00		HSC 119		*prep*	
2:30			*Office*	**Phys 218**	
3:00			*Hours*	**Lab**	
3:30				HSC 042	
4:00		Committee	*Physics Club*	Committee	
4:30		Meeting		Meeting	

ACADEMIC HONESTY GUIDELINES
Department of Physics

It is expected that each student taking courses in the Department of Physics is familiar with the statement "Principles of Intellectual Honesty" appearing in the Lafayette College Student Handbook. The following guidelines are intended to indicate how that statement pertains to your work in physics. Your instructor may have further guidelines for your specific course. We assume that students are honest; if you are not certain as to what is expected of you, consult your instructor before proceeding.

I. EXAMINATIONS:

1. Bring only those materials specifically authorized by your instructor. Frequently in the elementary courses, you will be permitted to bring in a formula sheet or you will be provided with one.
2. If you find that the seating arrangement is such that you can see someone else's paper, don't look! Better yet, ask if you can sit in another seat.
3. If you use a calculator, clear the answer before setting the calculator aside.
4. If you fail to hand in your paper at the end of the period you will be awarded a grade of zero for that test.

II. TAKE-HOME EXAMINATIONS: Take-home examinations are often assigned in some courses. Specific rules governing such tests will be announced by your instructor. The overriding principle, however, is that any work submitted be your own or be specifically credited to its source. There should be no discussion of the test questions with *anyone* other than the instructor.

III. HOMEWORK: You must acknowledge *all* collaborators. You are encouraged to learn from one another. You should first try to do homework problems on your own; after all you will have to do similar problems on your own in tests. However, discussion of difficult problems with others can help you to develop your own analytical skills and is encouraged, provided that, *after discussion* you write up solutions *on your own*. Do *not* borrow or lend homework papers. There is an important difference between discussing a problem with someone and copying his or her work. There have been students who have loaned papers to friends for a few minutes to "check answers", and been horrified to find themselves charged with academic dishonesty because their "friends" copied their solutions.

Please Note: The same ethical standards of academic integrity and honesty apply to the on-line homework as to the written homework, except that there is no place for you to specifically acknowledge collaboration. However, the same general rules apply.

IV. LABORATORY: Usually two or more students will work together in performing experiments and will submit reports of their work. In some courses, a single joint report may be submitted. Specific instructions will be announced by your instructor. If the words used to describe some part of the experiment are taken from some other source (such as the lab manual), then the source should be cited. (Reference to the lab manual can usually substitute for laborious copying.) If you consult with *anyone* about the experiment (e.g. students in your lab class other than your lab partner), that consultation should be acknowledged in your report. Do *not* borrow or lend a completed lab book or any portion of one.

V. PAPERS: Refer to the statement "Principles of Intellectual Honesty" in the Student Handbook.