

# Syllabus for Physics 223, spring 2020

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- prerequisites** The prerequisite is Physics 222 with a grade of C or better.
- office hours** The following office hours are in room 415-P (not my office): MTWR 8:30-9:30 I urge you to pick at least one of these office hours to come to every week as part of your habitual schedule. When you show up to my office hours for help with homework, I expect you to bring both the book and your own copy of your reading notes (see below).
- web page** [www.lightandmatter.com/area3phys221.html](http://www.lightandmatter.com/area3phys221.html)  
To e-mail me, use your Spotter account.
- required materials** The text is *Modern Physics*. You will need either a printed copy, available through print on demand from [lulu.com/spotlight/benjamin\\_crowell](http://lulu.com/spotlight/benjamin_crowell), or a PDF on a laptop, which you can download from the class's web site. Having the PDF on a cell phone will not be adequate. You'll also need a calculator, two bound lab notebooks (either  $10 \times 7\frac{3}{4}$ -inch or  $9\frac{3}{4} \times 7\frac{1}{2}$ -inch) with graph paper pages (across from the colored pens at the bookstore) a metric ruler, and a protractor. You can use a dictionary on exams, but it has to be a printed dictionary, not an electronic one.
- getting started** Here are the things you need to do by the second class meeting:

1. Get everything listed under "required materials" above. You can buy the book at the FC bookstore or download it. Download and print the lab manual. The downloads are linked to from the class's web page.
2. Read this syllabus.
3. Consult the schedule on page 5. Read the lab we're doing this week, and do the listed reading and the homework problems. Take notes on the reading, and print two copies of them.

**recommended weekly routine** The following is a typical way that you could allot your time for this course during a week in which there is one reading assignment and two homework assignments.

	hours	
Read (first pass).	1	
Read (second pass, typing notes).	0.5	
Work alone on homework (first shot).	1.5	1.5
Tutoring/office hours.	0.5	0.5
Work alone on homework (second shot).	1	1
misc. (lab writeup, ...)	1	
total	<hr/> ~ 8	

**grading** Grades will be determined as follows:

homework	123 problems @ 0.1 point each	12
reading quizzes	45 questions @ 2 point each	90
reading notes	27 @ 1 points each	27
check-off labs	8 @ 10 points each	80
lab writeups	5 @ 20 points each	100
prelabs	12 @ 2 points each	28
exams	4 @ 150 points each	600

The reason for grading the homework is to give you feedback and track your progress. To avoid giving anyone an incentive to cheat by copying solutions from online or offline sources, I've made the weight assigned to the homework too low to have any significant direct effect on your grade. However, the way you learn the material in this type of course is by practicing. Therefore most students end up with about the same grades on the exams as on the homework.

points	grade
80%	A
69%	B
58%	C
47%	D

basic literacy in calculations

The following are some common mistakes in carrying out a numerical calculation.

wrong	right	
$\frac{2(1.36)}{(0.53)^2} = 9.7$	$\frac{2(1.36 \text{ m})}{(0.53 \text{ s})^2} = 9.7 \text{ m/s}^2$	Never write numbers without units. When plugging in, check that the units work out to be what you expected.
$1.37 \text{ m} = \frac{1}{2}a(0.53 \text{ s})^2$ $1.37 \text{ m} = (0.140 \text{ s}^2)a$ $a = 9.7 \text{ m/s}^2$	$x = \frac{1}{2}at^2$ $a = \frac{2x}{t^2}$ $a = \frac{2(1.37 \text{ m})}{(0.53 \text{ s})^2}$ $a = 9.7 \text{ m/s}^2$	Finish the algebra before plugging in the numbers.
Volume of one ton of helium: $V = \frac{m}{\rho}$ $V = \frac{1000000 \text{ g}}{172 \text{ g/m}^3}$ $V = 5813.95 \text{ m}^3$	Volume of one ton of helium: $V = \frac{m}{\rho}$ $V = \frac{10^6 \text{ g}}{172 \text{ g/m}^3}$ $V = 5.81 \times 10^3 \text{ m}^3$	Use scientific notation. Put your calculator in scientific notation mode. Don't waste time writing down lots of insignificant figures.

reading notes

I'll maintain a folder for you containing your notes on the reading. These are the notes you get to use on the exams. You should do the notes on a computer (for ease of revision), and do them after you read, not while reading (so that you know what ended up being the main points). I will not accept hand-written notes.

On any date when reading is assigned, you should be prepared for an open-notes quiz, and print out an extra copy of your notes on the reading; you'll turn in the copy, and I'll add it to your folder. It has to be a copy, because you need the original for your own use in studying and problem solving. I expect you to bring your own copy of your notes to school so that, e.g., we can refer to them together if you're getting help in my office hours.

Your notes need to be entirely in your own words; stating everything in your own words is a good way to test and consolidate your own understanding. Cutting and pasting from the book would be a form of cheating on exams (because the exams are not open-book), and would also be plagiarism if the copied material wasn't properly attributed.

Shorter is better. The laws of physics are fundamentally simple. I would suggest limiting yourself to no more than quarter of a page per chapter. By the end of the semester, the simple underlying structure of the material will have become more and more obvious to you, and I think you should be able to go back over your notes and edit them down to no more than about a page *total*. It's not against the rules for your notes to be too long, but it's not smart, either; long notes usually indicate that you're not distinguishing fundamental principles from trivia, or that you're making futile efforts to write a cookbook of problem-solving techniques, which is a self-defeating way to approach problem solving. If it feels too scary to walk into an exam with short notes, I suggest making a separate long version as a security blanket, but sealing them shut with a big binder clip to remind yourself that using them is probably a mistake, indicating that you aren't working from basic principles.

Google Docs for note-taking

For note-taking, I recommend that you use Google Docs, [docs.google.com](https://docs.google.com), which makes it easy to do equations. It works in any web browser, and you don't have to install any software. To do an equation, go to the Insert menu and choose Equation. You can then type in your math. A toolbar also comes up, just above the top of the page, with symbols in it like square roots. I found the toolbar confusing when it came to doing exponents; the easiest way to do it is to enter, e.g.,  $x^2$  for x squared. Printing works, but is a little awkward and ugly. A PDF file pops up, with your equations rendered at low resolution. You then have to print the PDF file (i.e., you have to do two print commands in order to get the output to actually go to the printer).

Spotter

Spotter is computer software I've written to help you check your answers to homework problems. It can check both numerical answers and symbolic ones. Having Spotter helps you more than having answers in the back of the book, because it is programmed to give you helpful pointers. If you put in an wrong

answer that I've anticipated, it will explain why it's wrong. If your answer doesn't make sense in terms of units, it will tell you that. If you get a wrong answer, you can redo the problem and put in the right answer later for full credit.

Problems labeled as online on the homework page of the syllabus have purely mathematical answers, and are in Spotter. To get credit for an online homework problem, you need to enter a correct answer in Spotter, and also turn in your written calculations and explanations along with the rest of the homework. What I'm really trying to do here is get you to come to my office hours and get help if you can't get the right answer — Spotter helps you by letting you know whether you have the problem right *before* you turn it in.

You don't need to install the software; you just use it through a web browser. Start from the class's web page, then click on the "homework" link to the class's Spotter page. Once you're in Spotter, make sure to log in, or else you won't get credit for your work! Once you're logged in, all your answers will be recorded.

When using Spotter, you have to be careful about the notation you use for inputting mathematical expressions. Spotter is designed to allow you to use something resembling normal human mathematical notation, as opposed to the notation used in computer programs. However, human math notation is designed for humans, not computers, and you need to learn a few things about how to type your expressions in a form that Spotter will interpret correctly.

First, everything you type will be smashed down to one line of text, eliminating the superscripts and subscripts. For example, a variable name with a subscript, like  $x_1$ , is entered as `x1`. Since there are no superscripts, you have to enter exponents using the `^` symbol (shift-6), e.g.,  $x^2$  becomes `x^2`. You can enter a square root as either `sqrt(x)` or `x^.5`. There is no way to enter the times symbol,  $\times$ , without confusing the computer and making it think you meant the variable  $x$ , so in scientific notation you should simply leave a space where you would normally put the times symbol, e.g.,  $5 \times 10^6$  becomes `5 10^6`. Don't try to enter this as `5e+6`; that's what a lot of computer software would want, but Spotter is trying to interpret everything as normal human notation, so it will think you meant  $5e + 6$ , where  $e$  is a variable.

Human languages, including human math notation, are ambiguous. Use parentheses liberally to make your meaning clear. There are two main situations where you need to watch out. First, arguments to functions: `sin 2x` will be interpreted as  $(\sin 2)(x)$ ; if you intended  $\sin(2x)$ , you should have entered `sin(2x)`. Second, the bottom of fractions: `1/3c` will be interpreted as  $(1/3)c$ , so if you want  $\frac{1}{3c}$ , you need to enter `1/(3c)`.

As you type your answer, the computer will display a rendering of it into "real" human math notation so that you can see how your input is being interpreted. If you're using this feature in a browser such as Internet Explorer that has poor math support, it will be slow, especially the first time you use it on a particular computer.

**academic honesty  
policy**

In cases of serious academic dishonesty, I will assign a zero on the work, and I will also pursue action at the college level, which may result in penalties such as suspension or expulsion.

Serious academic dishonesty includes cheating on an exam, or turning in homework that is plagiarized from my solutions or from a source such as Chegg.

I will also assign a zero in cases where two students turn in homework or lab reports that contain identical or nearly identical work. A good rule of thumb is that if A is helping B, only B's paper should be out, and the pen should be in B's hand.

**labs**

Most labs have prelab questions, which you're expected to turn in on a piece of paper (not in a lab notebook) at the beginning of lab.

At the end of the first lab in the lab manual, there is information about the organization of labs.

If you miss a lab, you can only make it up in one of my other lab classes over the rest of the week, and it is still due at the same time it's due for everyone else. If you want to make up a lab, email me, and I'll coordinate with the physics

technician.

**drops** I will drop you under any of the following conditions:

- You miss any lab or lecture during the first two weeks without contacting me in advance by e-mail. If I don't receive any written work from you, I will consider that the same as an absence on that day.
- You don't turn in two consecutive homework assignments during the first two weeks. You don't need to get any problems right in order to fulfill this requirement, but you do need to show some attempt at a solution for at least some problems on each assignment. It's not enough to write "I don't know how to do this problem," but it is enough if you write, "I tried to do this problem using the equation  $v^2 = 2ax$ , but that didn't work because I couldn't figure out how to get  $x$ ."
- You miss an exam without contacting me in advance by e-mail.
- Over a period of seven consecutive days, you don't turn in any homework papers or quizzes, and don't complete all the lab work (participating in lab, and turning in written lab work when it's due).

## Schedule for Physics 223, spring 2020

		read ch.	hw	topics	lab††
Jan. 28	Tu			Time	
	Th	1*	1*		2 two-source interference
Feb. 4	Tu	2.1-5	2	Waves	
	Th	2.6-7	3		3 standing waves
11	Tu	3.1-4	4	Electromagnetic waves	
	Th	3.5-6	5		11 polarization
18	Tu	4.1-4	6	The Lorentz transformation	
	Th	4.5-6	7		10 relativity
25	Tu	5.1-6§	8	Media	
	Th	5.7	9	Review of resonance, complex numbers	4 resonances of sound
Mar. 3	Tu	6	10	Relativistic energy and momentum	
	Th	7	11	Statistics, equilibrium, energy sharing	1 absolute zero
10	Tu	8	12	Macroscopic thermodynamics	
	Th	10		Images, qualitatively	<i>Exam 1</i> †
17	Tu	11	13	Images, quantitatively	
	Th		14		5A and 6A, refraction
24	Tu	12.1-5	15	Wave optics	
	Th	12.6-8	16		7 wave optics
31	Tu	13	17	The atom and the nucleus	
	Th	14.1-2		Prob. distr., variance	<i>Exam 2</i> †
Apr. 14	Tu	14.3-5	18	...exponential decay	
	Th	15	19	Light as a particle	12 radioactivity
21	Tu		20		
	Th	16.1-4	21	Matter as a wave	9 electron diffraction
28	Tu	16.5-6	22		
	Th				<i>Exam 3</i> †
May 5	Tu	17.1-3	23	The Schrodinger equation	
	Th	17.4	24	...3 dimensions	13 photoelectric effect
12	Tu	17.5-8	25	...complex	
	Th	18.1-3	26	Angular momentum	14b, mass of the electron
19	Tu	18.4-8	27	...spin	
	Th		28	<i>Final exam</i>	

§Also watch the video on consonance and dissonance linked to from the book's web page, which is a preview of some material from sec. 6.2.

†Bring a bluebook. All exams are cumulative. Each exam will concentrate on the material that you haven't yet been tested on. The last date to add notes to your folder for use on an exam is the preceding lecture.

Exam 1 covers physics 221 and 222, plus all material in this course through ch. 5. Exam 2 is through ch. 11. Exam 3 is through ch. 15. Exam 4 covers everything.

\* Whenever reading is assigned, you should bring both copies of your notes to class. Turn in your papers showing all the work you did on the homework, including the online problems. The list of problems assigned on each homework assignment is on p. 6.

## Homework assignments

A notation like 2-5 means chapter 2, problem 5.

Problems labeled “online” are in Spotter, which is explained in the syllabus. The full statement of each problem is in the book, not in Spotter. For these problems, you have to do *both* of the following things to get credit: (1) check the answer in Spotter and get it right, and (2) show your work on the paper that you turn in. If you’re getting the wrong answer in Spotter and don’t know how to get it right, please come to my office hours for help! My office hours are listed on the front page of the syllabus.

I’d appreciate it if you would leave about an inch of empty space at the top of the front page of your homework, so I can write your scores on the problems there.

Solutions for some problems, marked with an “s” below, are given in the back of the book. Try to solve these without peeking at the solution, then use the solution to check yourself. These problems are not for credit, and you don’t need to turn in your work.

Problems labeled \* are more difficult problems that are not required and are meant for students at the top of the bell curve who don’t find the regular homework challenging. These are not for points, but if you do one and would like feedback, please write me an eye-catching note on your homework paper so I’ll know to look at it.

Note that in many of the homework problems, you need to look up data in the back of the book.

If a problem doesn’t exist in your printed copy of the book, you can get it in the latest online version of the book at [lightandmatter.com](http://lightandmatter.com).

### Homework 1

*paper only*

*online and paper*

1-1

FAQs about Spotter: (1) The full statement of the question is in the book, not in Spotter. (2) Spotter has every problem, not just the ones assigned to you.

### Homework 2

*paper only*

*online and paper*

1-2 2-1

### Homework 3

*paper only*

2-3 2-4 2-5 2-7<sub>s</sub>

*online and paper*

2-2 2-6 2-9 2-11 2-13

### Homework 4

*paper only*

2-8 2-10 2-15<sub>s</sub> 2-16 2-17

*online and paper*

2-12 2-14 3-1 3-2

### Homework 5

*paper only*

3-3

*online and paper*

2-19\*

### Homework 6

*paper only*

3-4 3-6<sub>s</sub>

*online and paper*

3-5 3-7 3-8

### Homework 7

*paper only*

3-9<sub>s</sub> 3-10\*

*online and paper*

4-1 4-2

### Homework 8

*paper only*

4-3

*online and paper*

4-4 5-4

### Homework 9

*paper only*

5-2

*online and paper*

5-1 5-5 5-9 5-19

### Homework 10

*paper only*

5-3 5-6 5-11 5-12<sub>s</sub> 5-13<sub>s</sub> 5-14<sub>s</sub> 5-21 6-4

*online and paper*

5-20

<b>Homework 11</b> <i>paper only</i> 5-8 5-10* 6-1 6-3 <sub>s</sub> 6-5 <sub>s</sub> 6-7* <sub>s</sub>	<i>online and paper</i> 5-7* 5-15 5-16 6-2 7-1 7-4
<b>Homework 12</b> <i>paper only</i> 7-5 7-6 8-1 <sub>s</sub> 8-2 <sub>s</sub>	<i>online and paper</i> 5-18* 7-2 7-7 7-8
<b>Homework 13</b> <i>paper only</i> 7-9 <sub>s</sub> 10-1 10-2 <sub>s</sub> 10-3 <sub>s</sub> 10-6 11-1 <sub>s</sub>	<i>online and paper</i> 7-10 8-3 8-4 8-5 8-6* 10-4
<b>Homework 14</b> <i>paper only</i> 5-22 <sub>s</sub> 7-3 10-5 10-7 10-8 11-3 <sub>s</sub> 11-4 11-5 <sub>s</sub> 11-17 <sub>s</sub>	<i>online and paper</i> 11-2
<b>Homework 15</b> <i>paper only</i> 11-6 <sub>s</sub> 11-7 <sub>s</sub> 11-8 11-9 <sub>s</sub> 11-10 11-11 <sub>s</sub> 11-12 11-13 <sub>s</sub> 11-14 11-15 <sub>s</sub>	<i>online and paper</i> 11-16
<b>Homework 16</b> <i>paper only</i> 11-18 <sub>s</sub> 11-19 <sub>s</sub> 12-1 12-3 12-5 <sub>s</sub>	<i>online and paper</i> 11-20 11-21 12-4
<b>Homework 17</b> <i>paper only</i> 12-2 12-6 <sub>s</sub> 12-7 12-8 <sub>s</sub> 12-9 <sub>s</sub> 12-10 12-12 <sub>s</sub> 13-1	<i>online and paper</i> 11-26* 13-2
<b>Homework 18</b> <i>paper only</i> 13-3	<i>online and paper</i> 14-3
<b>Homework 19</b> <i>paper only</i> 13-4* 14-1 14-2	<i>online and paper</i> 14-4 15-8
<b>Homework 20</b> <i>paper only</i> 15-1 15-2 15-3 15-4	<i>online and paper</i> 14-5 14-6 14-7 15-5
<b>Homework 21</b> <i>paper only</i>	<i>online and paper</i> 15-6 15-9 16-1
<b>Homework 22</b> <i>paper only</i> 15-7 16-2	<i>online and paper</i> 16-3 16-4
<b>Homework 23</b> <i>paper only</i> 16-7	<i>online and paper</i> 16-5 16-6 16-8 16-9
<b>Homework 24</b> <i>paper only</i> 17-1 17-3	<i>online and paper</i> 16-15 17-4
<b>Homework 25</b> <i>paper only</i> 16-11 17-5 17-7*	<i>online and paper</i> 16-14 17-2 17-6
<b>Homework 26</b> <i>paper only</i> 17-8 <sub>s</sub> 17-9	<i>online and paper</i> 17-10
<b>Homework 27</b> <i>paper only</i> 17-11 17-12 18-1	<i>online and paper</i>
<b>Homework 28</b> <i>paper only</i> 18-2 18-3	<i>online and paper</i> 18-4

**student learning outcomes**

I. Outcome: Upon successful completion of PHYS 223 F General Physics III, the student will be able to determine qualitative outcomes of various physics scenarios by applying deductive reasoning with the appropriate laws and principles of physics. Assessment: Common questions or problems embedded in a final. Project assessed against a department standard. Students demonstrate their ability to determine qualitative outcomes of various physics scenarios in regularly scheduled conceptual homework assignments, group projects in class, and conceptual examinations for each major topic throughout the course and in a cumulative final examination at the end of the semester.

II. Outcome: Upon successful completion of PHYS 223 F General Physics III, the student will be able to determine quantitative outcomes of various physics scenarios by applying algebra, trigonometry, geometry, and calculus with the appropriate laws and principles of physics. Assessment: Common questions or problems embedded in a final. Students demonstrate their ability to determine quantitative outcomes of various physics scenarios in regularly scheduled analytic homework

III. Outcome: Upon successful completion of PHYS 223 F General Physics III, the student will be able to investigate various physics scenarios experimentally and explain the results in terms of the appropriate laws and principles of physics. Assessment: Project assessed against a department standard. Students demonstrate their ability to investigate various physics scenarios experimentally by doing so in the laboratory under instructor supervision in regularly scheduled laboratory sessions throughout the course. They demonstrate their ability to explain the results in a written report for each laboratory session.

**students with disabilities**

Fullerton College is committed to providing educational accommodations for students with disabilities upon the timely request by the student to the instructor. Verification of the disability must also be provided. The Disability Support Services office functions as a resource for students and faculty in the determination and provision of educational accommodations. (Faculty Resource Guide at <http://staffdev.fullcoll.edu/>)