Syllabus for Physics 221, spring 2010

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prerequisites The prerequisite is Math 150A with a grade of C or better. The corequisite is Math 150B.

office hours My office hours are in the classroom (not my office), M 9:30-10:30, Tu 12-1, Tu 4:30-5:30, W 12-1, Th 4:30-5:30. I urge you to pick at least one of these office hours to come to every week as part of your habitual schedule; if none of my office hours fits your weekly schedule, please give me a copy of your schedule written out on a grid, and we'll see what we can work out.

web page `www.lightandmatter.com/area3phys221.html`
To e-mail me, use your Spotter account.

required materials The text is vol. 1 of *Simple Nature*. Printed copies are available at the bookstore, and you also have the option of downloading the book from the class's web page. You will also need to download the lab manual from the class's web page and print it out.

You will need a cheap 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 (near the calculators in the bookstore), a metric ruler, a protractor, and your own e-mail.

getting started Here's a quick summary of the things you need to do by the second class meeting:

1. Get everything listed under "required materials" above.
2. Print out the book and lab manual, or buy printed copies of them, using one of the options I described in my e-mail.
3. Read this syllabus.
4. Consult the schedule on page 4. Do the listed reading and the homework problems. Take notes on the reading, and print two copies of them.
5. If you don't already have e-mail, get an account.

grading Grades will be determined as follows:

homework	129 problems @ 1 point each	129
reading quizzes	64 questions @ 2 points each	128
reading notes	24 @ 1 points each	24
check-off labs	9 @ 6 points each	54
lab writeups	5 @ 12 points each	60
prelabs	14 @ 2 point each	28
exams	4 @ 150	600

points	grade
80%	A
70%	B
60%	C
50%	D

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).

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. I will not accept hand-written notes.

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 half 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.

OpenOffice for note-taking

For note-taking, I recommend that you use the free OpenOffice word-processor, which makes it easy to do equations. You can download it from openoffice.org. If you don't have a computer at home, you can use the ones in room 416 or 2000, which have OpenOffice installed. When you're writing equations, in most cases all you need in order to make them readable is a few superscripts. For example, suppose you want to write the equation $v^2 = 2ax$ in your notes. Just type `v2=2ax`, then select the 2 with the mouse and do Format>Character>Position>Superscript.

If you want to get fancier, you can use OpenOffice's built-in equation editor. Do Insert>Object>Formula, and an empty gray box for the equation is inserted in your document. An equation editor window pops up at the bottom of the screen, and a toolbox of mathematical symbols at the top. Although the toolbox is supposed to make it easier to find and enter the symbols you want, I found it to be more confusing; the most straightforward way to do it, in my opinion, is to type directly into the equation editor. You have to learn the codes for the things you want to type, but there are only three codes you'll typically ever need: `^` for superscripts, `_` for subscripts, and `over` for fractions. Enter a Greek letter as, e.g., `%theta `, making sure to put a space after it. As an example, to make

$$\Delta x = \frac{1}{2} a t^2 + v_\text{o} t \qquad ,$$

you would do `%DELTA x = 1 over 2 at^2 + v_o t`. Note that the spaces after DELTA, both 2's, and o are mandatory. It understands parentheses, so, e.g., `1 over (2+3)` gives $\frac{1}{(2+3)}$. For invisible parentheses use curly brackets, e.g., `1 over {2+3}` produces $\frac{1}{2+3}$.

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 that are underlined on page 5 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 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., 5×10^6 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.

Another thing to keep in mind is that 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)`.

An advantage of using Spotter in the free Firefox web browser (firefox.com) is that, unlike Internet Explorer, Firefox can display mathematical equations. As you type in the equation, it will show you, "on the fly," its interpretation of what you're typing. This makes it much easier to avoid confusion about how to enter your answers.

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.

I will also assign a zero in cases where two students turn in homework or lab reports that contain identical or nearly identical work.

labs

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

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, you should leave a note for Hanh Pham, the physics technician, in the physics stockroom in room 417T.

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 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 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 221, spring 2010

		read ch.	hw	topics	lab
Jan.18	M			*MLK Day*	*MLK Day*
	W				
25	M	0 and 1	1	conservation of mass	1 conservation laws
	W	2.1.1-5	2	conservation of energy	
Feb. 1	M	2.1.6-7	3	equilibrium and direction of motion	2 conservation of energy
	W	2.2	4	numerical techniques	
8	M	2.3	5	gravity	3 the Earth's gravitational field
	W		6		
15	M			*Presidents' Day*	*Presidents' Day*
	W	2.4	7	atomic phenomena	
22	M	2.5	8	oscillations	4 absolute zero
	W			*exam 1*†	
Mar. 1	M	3.1	9	conservation of momentum	5 interactions
	W	3.2.1-3	10	Newton's laws	
8	M	3.2.4-7	11	analysis of forces	6 conservation of momentum
	W		12	*problem solving*	
15	M	3.2.8-10	13	work	7 Newton's second law
	W	3.3.1-2	14	damped oscillations	
22	M	3.3.3	15	resonance	8 work
	W			*exam 2*†	
Apr. 5	M	3.4.1-2	16	motion in three dimensions	9 resonance
	W	3.4.3	17	vectors	
12	M	3.4.4	18	calculus with vectors; circular motion	10 the force vector
	W	3.4.5	19	the dot product	
19	M	4.1.1-3	20	conservation of angular momentum	11 the momentum vector
	W	4.1.4	21	torque	
26	M			*exam 3*†	12 torque
	W	4.1.5	22	statics	
May 3	M	4.2	23	rigid-body rotation	13 the moment of inertia
	W	4.1.6	24	elliptical orbits	
10	M	4.3.1-2	25	rotation in three dimensions	14 torque in three dimensions
	W		26		
17	M		27		
26	W			*final exam, 9-11*†	

†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 the reading through section 2.3. Exam 2 is through section 3.2, and exam 3 through 4.1.3.

Coordination with Math 150B

Math 150B is a corequisite for this course. If you're taking it concurrently with this course, here's approximately what I'm assuming you're covering at various points in the semester:

week	*math topic*	*used in*
2	linear differential equations	2.1, conservation of energy; 3.3, resonance
3	integration of disks and shells	4.2, rigid-body rotation
4	work	3.2.8-10, work
4	center of mass	3.1, center of mass
14	Taylor series	
16	area in polar coordinates	4.2, moment of inertia

This is based on the sequence of topics in Larsen, Hostetler, and Edwards, *Calculus of a Single Variable.*

Homework Assignments for Physics 221

Underlined problems are in Spotter. "Challenge" problems are more difficult problems that can be done for extra credit. If you do a challenge problem, write me an eye-catching note on the front of your homework so I'll know to grade it. Note that in many of the homework problems you need to look up data in the back of the book. Some homework problems have solutions in the back of the book. You should do them, and check yourself, but you don't need to turn them in for credit.

hw 1: Ch. 0, #10,11,26 5,14,37 Ch. 1, #1

hw 2: Ch. 0, #12,17,35 15,18 Ch. 1, #3,8,11 2

hw 3: Ch. 2, #1-6,8,12,13

hw 4: Ch. 2, #7,15,20 9-11 challenge: 14
The class at which this homework is due will be a workshop where you work on the computer methods described in section 2.2. To prepare, you should try the tutorial in appendix 1 of the book. If you have a computer at home, the most convenient way to do this is to install Python on your computer, as described at `http://www.lightandmatter.com/python.html`. Otherwise you can come in to 416T during my office hours and use one of the computers.

hw 5: Ch. 0, #43 Ch. 2, #17,41 16
Problem 41 is not in your printed book: The factorial of an integer n, written $n!$, is defined as the product of all the positive integers less than or equal to n. For example, $3! = 1 \times 2 \times 3 = 6$. Write a Python program to compute 30!. (Python computes integer results with unlimited precision, so you won't get any problems with rounding or overflows.) Problem 43 is the algebra required in order to analyze your data from lab.

hw 6: Ch. 2, #24,40 19,21

hw 7: Ch. 2, #33 18,22

hw 8: Ch. 2, #28,29 25,27

hw 9: Ch. 2, #38 32

hw 10: Ch. 2, #34,36,37 Ch. 3, #1
In problem 36, part b should say that the *period* is infinite, not the frequency.

hw 11: Ch. 2, #35 Ch. 3, #2,4,9,10,15 3,13

hw 12: Ch. 3, #5,12,16-18,30,34 14,24

hw 13: Ch. 3, #6,29,74 7,19,20,22 challenge: 8

hw 14: Ch. 3, #21,27 33,35

hw 15: Ch. 3, #23,25,28,71 32 challenge: 72

hw 16: Ch. 3, #40,41 challenge: 26

hw 17: Ch. 3, #44,48,49,54 50

hw 18: Ch. 3, #42,45 46,47,55,58

hw 19: Ch. 3, #61,62,66,67 53,57

hw 20: Ch. 3, #51,56,63 60,69

hw 21: Ch. 3, #52,64,65 68,70 Ch. 4, #7

hw 22: Ch. 3, #59 challenge: 75 Ch. 4, #12 2

hw 23: Ch. 4, #1,4,5,17 3,6,8
For problem 8, the choice of axis theorem doesn't hold because the total external force on the box is nonvanishing. If you don't choose the axis at the center of the box, then the angular momentum will not be constant, simply due to the acceleration of the box's center of mass, regardless of whether it tips.

hw 24: Ch. 4, #9,11,19,25 14,15,21,23

hw 25: Ch. 4, #13,18,26 10,22,40 challenge: 24,38

hw 26: Ch. 4, #16,29-32 20,28,34 challenge: 39

hw 27: Ch. 4, #27,33,35 challenge: 37 challenge: 36
Problem 33 can be done using polar coordinates (introduced in Math 150B). The latest version of the problem (online) walks you through some of the steps of this. You can also do it without using polar coordinates, by the technique introduced in section 4.2.5 in the calculation of the moment of inertia of a disk. To get full credit, you need to do all three parts of the online version. Problem 36 requires that you read section 4.3.3.

Errata:

If you have an old version of the book, please correct the following errata. To find out whether you have an old version, check the date on the copyright page. If it says "rev. January 30, 2009" or later, you have a new enough version that these errata have all been fixed.

In ch. 2, #36, the answer in the back of the book was incorrect, and contradicted the problem's statement of what you were supposed to prove. Refer to the new version of this problem online, which doesn't have any material in the back of the book relating to this problem. In part b, the period is supposed to be infinite, not the frequency.

In ch. 2, #40, the answer should be 0.34 ms, not 1.4 ms.

In ch. 3, #32, your answer to part a will also include v, the initial speed of the middle block.

In ch. 3, #33, the problem was missing the figure to make it clear that the girl was holding the leash in her hands rather than tying it to the sled.

In ch. 3, #52, the numerical coefficient for air friction should be 7×10^{-4}, not 5×10^{-3}.

In ch. 3, #61, the given vector should be $\mathbf{r} = b\hat{\mathbf{x}} + ct\hat{\mathbf{y}} + dt^2\hat{\mathbf{z}}$, with x, y, and z unit vectors, not x, x, and x.

In ch. 4, #35, the column of energies should be labeled $E \times 10^{14}$.

In ch. 4, problem 38-40 aren't in printed book. You can find them online.