TENTATIVE SYLLABUS for PHYSICS 70 **FALL 2016**

MONDAY	WEDNESDAY	FRIDAY	LAB (T or W)
29 NO CLASS	31 **C1** (essay: see email) Introduction to the Course The Art of Model-Building	2 **C2** (T2, T7, T13) Particles and Interactions	No Lab
5 **C3** (T1, T7, T10) Vector Mathematics	7 **C4** (T2, T6, B1) Systems and Reference Frames **C1:** M8, D1ab, R7 **C2:** M3, M6 **C3:** M2, M5	9 **C5** (T2, B4, B7) Conservation of Momentum	Video Analysis (introduction)
12 **C6** (T4, T7, B3) Conservation of Angular Momentum	14 **C8** (T3, T6, T7) Conservation of Energy **C4:** M1,M6 **C5:** M5,M6 **C6:** M6,M9,R1	16 **C9** (T3, T6, B10) Potential Energy Functions	Reference Frames & Speed of Sound
19 **R1** (T3, T7, T9) Principle of Relativity	21 **R2** (T2, T6, T12) Coordinate Time **C8:** M6,M11,R1 **C9:** M4,M7 **R1:** M4,M10	23 **R3** (T2, T4, T6) The Spacetime Interval	Speed of Light
26 **R4** (T4, T6, B2) Proper Time	28 **R5** (T1, T4, T9) Coordinate Transformations **R2:** M5,M9 **R3**: M1,M5,M7 **R4:** M4,R1ab	30 **R6** (T3, T5, T9) Lorentz Contraction	Circuits and Photovoltaics
3 **R7** (B5, T6, T8) The Cosmic Speed Limit	5 **R8** (T2, T5, T7) Four-Momentum **R5:** M3, M5 **R6:** M3, D2, R4 **R7:** M3, R1	7 **R9** (T1, T4, B9) Conservation of Four-Momentum	Video Analysis (own project)
10 **Q1** (T2, T4, T8) Wave Models	12 **Q2** (T9, T10, T14) Standing Waves & Resonance **R8:** M9,D5 **R9:** M11,M13 **Q1:** M1,M3,R1	14 **Q3** (T1, T4, B3) Interference and Diffraction	Interference and Diffraction
17 FALL BREAK	19 **Q4** (T2, T5, T10) The Particle Nature of Light **Q2:** M1, M4, R1 **Q3:** M1, M12	21 **Q5** (T2, T4, B6) The Wave Nature of Particles	No Lab
24 **Q6** (T2, T8, B1) Spin	26 **Q7** (T1, T4, T7) The Rules of QM **Q4:** M3, D1 **Q5:** M4, D1, R1 **Q6:** M2, M3	28 **1st EXAM**	Photoelectric Effect & Spectroscopy
31 **Q8** (T4, T7, T8) Quantum Weirdness	2 **Q9** (T1, T6, T9) The Wavefunction **Q7:** M3, M6, R1 **Q8:** B5, D1	4 **Q10** (T3, T7, B6) Simple Models	Spectroscopy & Quantum Dots
7 **Q11** (B2, B4, T10) Spectra	9 **Q12** (T1, T4, T7) The Schrödinger Equation **Q9:** M5,M8 **Q10:** M4,M6 **Q11:** M5,M7,R1	11 **Q13** (T2, B1, B6) Introduction to Nuclei	Coupled Oscillators
14 **Q14** (T1, T5, T10) Nuclear Stability	16 **T1** (T5, T6, T10) Temperature **Q12:** M2,D3 **Q13:** M10,D5,R1 **Q14:** B8, M4	18 **T2** (T4, T5, T6) Macrostates and Microstates	Lab Tours
21 **T3** (T1, T6, T7) Entropy and Temperature	23 **T4** (T3, T6, T11) The Boltzmann Factor **T1:** M3, M7, R2 **T2:** M2, M4 **T3:** M3, M7	25 THANKSGIVING	Lunch on Monday
28 **T5** (T3, T12, B2) The Ideal Gas	30 **T6** (B4, T6, T9) Distributions **T4:** M3, M6 **T5:** B10, M4, R1	2 **T10** (T2, B3, B6) Climate Change	Peltier Coolers & IR Spectroscopy
5 **T7** (T3, T8, T10) Gas Processes	7 Handout, **T9** (T3, T6, T9) Heat Engines **T6:** B6, M4 **T10:** M6, M8, R3 **T7:** M5, R1	9 **(Final Exam: Tuesday 12/13, 9 am)**	No Lab

Items in parentheses are pre-class problems.

PHYSICS 70 **GENERAL INFORMATION** **FALL 2016**

Instructor	Office	Phone	E-mail	Office Hours
Thomas Moore	Millikan 1153	x18726	tmoore@pomona.edu	M 1:30-2, T3:30-4:30, W1:30–3

Mentors	Place	Time
xxx & yyy	Millikan 1181	MWF 9 (xxx), MWF 10 (yyy)
zzz & aaa	Millikan 1181	Sunday evening, 7 pm
bbb & ccc	Millikan 1181	Monday evening, 7 pm

Text: Moore: *Six Ideas That Shaped Physics* (3/e) Units C, R, Q, T (Available at the campus bookstore or as an electronic book through McGraw-Hill CONNECT: loose-leaf copies of *all 6 volumes* available for an additional $60 total.) (See www.physics.pomona.edu/sixideas/ for more information about the text.

Other required supplies: (1) a **good scientific calculator** (with statistics functions, but a graphing calculator is not necessary), and (2) a **purple or green pen** (get several!). You will also be submitting initial homework by emailing PDF files. I recommend you get a scanner app for your smartphone (there are several decent free apps available). Alternatively, you can come to the physics office to get your work scanned. You will also likely find a ruler, a 3-ring binder, and a stapler handy.

Learning Objectives: This course represents a guided inquiry into the physics of electricity and magnetism. Its main goals are (1) to develop an adequately clear big-picture understanding of the topics in Unit E to allow you to explain these topics to a high-school class, (2) to enable you to apply that unit's core physics principles correctly and thoughtfully to realistic situations, and (3) to adequately prepare you for subsequent physics courses. You will also practice some specific skills, including

- How to model a physical situation by making suitable approximations.
- How to use mathematical tools, including drawing and interpreting graphs, keeping track of units, doing algebra using symbols, using calculus applied to vectors, and using and interpreting computer models.
- How to present a problem solution clearly in writing.

The focus on the model-building process (in addition to merely learning concepts) is one of the things that distinguishes a good college-level course from a high-school course, so the skills you will need to succeed in this course are thus somewhat different.

A Metaphor: Physics is more like learning to play a sport or a musical instrument than memorizing facts: there are actual skills to learn that can only be mastered through practice. This course will give you guided practice with feedback. Consider class sessions and homework to be *practice*, exams to be like *games or recitals*, and your instructor and mentors as *coaches*.

General Class Structure: Physics education research has shown that practice-oriented activities are *much* more effective than lectures at teaching both the concepts of physics and reasoning skills. We will spend most of class time doing *activities* that give you practice (with instant feedback) in using the concepts discussed in the reading. *All* activities will assume that you have read the assigned reading BEFORE coming to class: this is *crucial* for your success!

Pre-Class Exercises: Bring your answers to the pre-class problems to class each class day. We will grade these problems on a 4-point scale. Three points will be based on submitting the problem on time *and* being present in class. The last point is for answering the question correctly. The goal is for you to be prepared for class. Solutions to all pre-class problems will be posted on ProbViewer (see below) at 1:00 pm each class day.

Drawers and Sakai website: East of our classroom, you will find a cabinet with a small locked slotted mailbox (on the right) and a file drawer (on the left) labeled "Physics 70." You will turn in written work to the slotted mailbox and retrieve graded work from your folder in the drawer. Our Sakai site is `https://sakai.claremont.edu` (select PO PHYS 70 Spring 2016).

Homework Problems: Much of your *real* learning takes place when you try to do substantial assigned problems, so keeping up with the homework and writing up each problem thoughtfully and completely is imperative. A written homework assignment will be due each Wednesday (see the syllabus). *Before* class on Wednesday, email a scan of *all* pages of your homework as a single scanned PDF file attachment using the naming convention `HW<Num><LastName><FirstInitial>.pdf` to the email address `Phys70@pomona.edu`. For example, if this is the 2nd homwork set and your name is Sascha Payne your attached file name would be HW2PayneS.pdf. **Keep** your actual written homework to correct later. (If you don't have a way to scan your homework, you can go to the Physics Department office to get your work scanned.)

Seriously attempting to do the homework is important, but learning from your mistakes is even *more* valuable. After each problem set is due, you can view solutions (after 1:00 pm) to all problems due that day by running the *Six Ideas* web-app **ProbViewer** (`https://sixideasapps.pomona.edu/ProbViewer/`) and entering the password "AccioHWSn!". *You* are responsible for checking each of your solutions against those posted. If you did the problem correctly, use your green or purple pen to mark it as such. If you made a mistake, please fix it and make it right, *marking all corrections with your green or purple pen* (this will make it easy for us to differentiate the corrections from your original effort). Your corrected problem solutions (on actual paper!) are due before the beginning of the class on Friday. See the last page for how the results will be graded.

Note that if you submit a clear and *complete* initial effort with good mathematical form, a plausible result, and if you submit a complete and valid correction, you will earn a minimum of 8 out of 10 points, even if your model is completely wrong and your math is also wrong. This system mostly rewards thoughtful effort! However, incomplete solutions will significantly lower your score. Because I post solutions each Wednesday afternoon, I can't count any solutions sent after I post solutions: you should simply submit a "correction" on Friday instead.)

I recommend that you work in groups on homework, especially on the R problems, which are challenging problems designed to be done in groups. (However, any work you hand in *must be in your own words*: see **Academic Honesty** below.) You can work on problems with others on Sunday and/or Monday nights at 7:00 pm in ML 1181, where you can also get help from student mentors. However, it is crucial that you also learn how to do problems *on your own*. Do not show up at these sessions without having made a good effort on the homework. The mentors are there to assist you when you are *stuck*, not help you get started, check answers, or solve problems for you.

Indulgences: I will automatically drop your *two* (2) lowest pre-class daily scores and your *five* (5) lowest individual problem scores before computing your final grade. This is meant to give you flexibility to deal with normal illnesses, field trips, athletic trips, big papers, unexpected romances, and so on. If you are sick or out of town on a Friday, please arrange for someone to submit your corrections on your behalf (or send me legible *color* scans before class via email).

Exams: You will take a midterm on October 28, and a final exam Tuesday, December 13 at 9 am. These exams will include some conceptual problems (like the T problems in the text) and one or two essay problems (like M problems) and be short enough to complete in about an hour. The first will cover through chapter Q3. For each, you may use a "cheat sheet" covering one side of an 8 ½ x 11-inch sheet and a calculator, but no other aids. I will provide all numerical constants and conversion factors.

I would like to see if we can arrange common but longer time to take the October 28 midterm rather than be confined to the class session. I think that you would benefit from a more relaxed time period. I hope to resolve this with you via email before the first day of class.

Grading scale: All grades in this class are based on a fixed scale,: **you are not competing with each other**. You can determine your letter grade on any item by dividing what you earned by what you *could* have earned, multiplying the result by 20, rounding down to the next lower integer, and consulting the chart below:

Integer:	20	19	18	17	16	15	14	13	12	11	10	9	≤ 8
Grade:	A+	A	A–	B+	B	B–	C+	C	C–	D+	D	D–	F

If average class performance for any item is particularly low (indicating that the item was unusually difficult) I may adjust grades to be higher than this scale would indicate, but I will never adjust your grade to be lower. You can earn an A+ as your final grade if your final total score (out of 20) is above 19.65.

Grading Weights: Your final grade will be computed using the weights shown in the chart below.

Pre-class exercises	Homework	1st Test	Final	Lab	**Total**
10%	30%	15%	25%	20%	100%

Academic Honesty: While you may (and are encouraged to) collaborate on homework problems, any work that you hand must express i*n your own words* whatever approach to the solution you developed with your collaborators. In your work together, exchange *ideas*, not phrases and sentences. You should not copy a sequence of algebraic steps from someone else: work out algebra on your own. Do not modify your corrected homework to make it appear as if your *initial* effort was better than it actually was. Finally, the work that you submit on exams must be *entirely* your own, and though you can use a calculator, you may not use a smart-phone, notes, or your textbook during exams.

HOMEWORK GRADING RUBRIC

In this homework grading system, we will use the following rubric to evaluate your work on each problem solution (A sheet displaying a copy of this rubric for each problem assigned will be stapled to your homework paper):

I	C	
☐	☐	Description (Sufficient / Clear & Coherent)
☐	☐	Model (Correct Principles / Correct Application)
☐	☐	Good Notation (Symbolic Algebra / Units & Vectors)
☐	☐	Valid Math (Sufficient / Correct)
☐		Plausible (Right Units / Magnitude / Sign)
	☐	Thoughtful Correction (not too much / too little)

Deduction for Missing Parts: ______ Final Score: ☐

The "I" column represents marks for your initial effort and the "C" column represents marks for your solution after correction (the grader will distinguish corrections from original effort both by ink color on the final document and by comparing with your electronically submitted initial effort). Each box is worth one point, so you start with 10 points and will retain those points if the boxes remain unmarked. The grader's marks then indicate deductions: ⧄ = $1/2$ point off, ☒ = 1 point off. The mark ☐—☐ indicates a small issue that persisted in the correction for $1/2$ total points off (= $1/4$ point for each box). Your grader may also underline some of subcategories (the words or phrases listed in parentheses) to clarify why points were deducted.

If your solution is **missing** answers to questions or parts, the grader will mark the boxes based on what is provided, and then deduct points based on what fraction of the initial effort was missing (roughly one point for each 20% of the problem omitted). In the rare case where your *corrected* effort also is missing parts, the grader may deduct additional points. If you submitted *no* initial effort, the "I" column will instead show a vertical strike through all boxes, equivalent to a 5-point deduction.)

Note: If you submit a clear and complete initial effort with good mathematical form, and your result is plausible (see below) and you also submit a complete and valid correction, you will earn a minimum of 8 points, even if your model is completely wrong and your math is also wrong. Therefore this system mostly rewards thoughtful effort.

Here are some comments about some of the individual categories (rows in the rubric):

Description: Your solution should provide *sufficient* and *clear and coherent* information apart from your math to make your reasoning transparent to one of your peers. You can provide this information with descriptive English, lists, and/or labeled diagrams. "Clear & Coherent" solutions are legible and flow logically without self-contradiction.

Model: Correctly *applying* physical principles often includes making appropriate and clearly stated approximations. If your model description is sufficiently unclear, you can lose points in both *Description* and *Model* categories.

Good Notation: This is mathematical equivalent of good grammar. To earn full credit in this category, you should (1) do all your algebra *with symbols* (no algebra with numbers), (2) *include units* with *every* numerical quantity that has units (in definitions and/or your post-algebra calculations), and (3) use *correct vector notation*.

- Doing *all* your algebra symbolically is crucial for making your work clear and easy to follow (for both you and the grader). You may use simple unitless numbers (particularly integers and simple fractions) in addition to symbols: what you should avoid is doing algebra with *any* quantities having units and/or unitless quantities that involve more than two or three digits. ***Hint:*** *You are doing algebra with numbers if a symbol appears on the same side of an equation with a number having units*.

- *Tracking* units is useful (and *highly* recommended) but even just *including* units with every number that has units is enough. Good vector notation, among other things, involves never (1) setting a vector equal to a number or (2) dividing by a vector.

Plausible: You can avoid deductions for an implausible result if you supply a note *explicitly recognizing* its implausibility. But you can lose points in this category if you make or fail to catch an error because you defined symbols poorly (for example, used the same symbol for different quantities), did algebra with numbers, used bad vector notation, didn't track units, or the like.

Thoughtful Correction: Your correction should flag and then fix issues in your *own* initial effort (if present), not simply recopy the online solution. Plausibility issues that persist after correction can also result in points deducted in this category.