

---

# *Physics 102: Classical and Modern Physics II*

Walter F. Smith, Department of Physics, Haverford College

---

## **Overview**

Welcome to Physics 102: Classical and Modern Physics II. The syllabus, information, announcements, and downloads for this course are managed through Moodle. Please check it regularly. Guest access will be available at first if you are interested in learning more about this course before enrolling.

## **Course Description**

This course is the second half of a year-long comprehensive introduction to physics begun in Physics 101. It is complementary in approach to our Physics 105/106 sequence in that 101/102 covers more material (including topics in quantum and nuclear physics) with an emphasis on applications in the life sciences, while Physics 105/106 goes into more depth for students likely majoring in the physical sciences. Both courses include significant numbers of applications to astrophysics and other interesting areas. Calculus I is a pre-requisite for both 102 and 106; Calculus II is a pre-requisite for 106, and a co-requisite for 102.

Our goal is to help you learn some very fundamental aspects of physics, especially those which most important for understanding life. In this course, we'll teach you not only what the laws of physics are, but how to use them to analyze how life works. By covering many of the basics, we'll also provide you with the physics framework you need to build a more detailed understanding of life later. You'll practice these skills in homework and lab assignments designed to relate physics to applications in the life sciences.

This semester, we'll learn quite a substantial amount of fundamental physics of electricity and magnetism, light and optics, waves and sound, and atomic and nuclear physics--and beyond. We'll also consider how these scientific foundations give us insight into questions such as:

- How do living things sense the world around them? (Sound and light, imaging and detection.)
- How can we extend our senses? (Imaging instruments such as telescopes, microscopes and CT scanners.)
- How do electrical signals propagate within organisms? (Electric fields and potentials, electric currents and circuits, electricity and magnetism.)
- What are the fundamental origins of life? (The elements, nuclei, radiation, and the origins of these in astrophysical processes.)

## **Instructors**

Walter Smith (Lecture)

Office: KINSC L110 (610) 896-1332

Email: [wsmith@haverford.edu](mailto:wsmith@haverford.edu)

Office Hours: Office hours: M 10-11, Tu 11-12, Th 10-11, F 10-11, or by appointment

If the above hours are not convenient, feel free to email me or phone me to set up a specific meeting time. Do not hesitate to contact me, even to chat about the course or science! If you are having trouble understanding the material or solving the homework problems, come and see me. Also, please let me know if you have any concerns about the course, or ideas about how to make it better.

Scott Shelley (Lab)

Office: KINSC L207 (610) 896-1310

Email: [sshelley@haverford.edu](mailto:sshelley@haverford.edu)

Suzanne Amador Kane (Lab)

Office: KINSC L103 (just off the first floor of the Rotunda in the Link) (610) 896-1198

Email: [samador@haverford.edu](mailto:samador@haverford.edu)

Office Hours: Tues. 9:30-noon, Wed. 9:30 to 11:15am and by appointment

Joseph Ochoa (Lab)

Office: KINSC L102 (just off the first floor of the Rotunda in the Link) (610) 795-6232

Email: [jochoa@haverford.edu](mailto:jochoa@haverford.edu)

Office Hours: Thurs. 12:30-3:30pm, Fri. 1:30-3:00pm or by appointment

## Location & Times

**Lecture** meets MWF at 11:30AM-12:30 in KINSC Hilles 108.

**Laboratories** meet either Tuesday or Wednesday every other week (approximately) 1:15 to 4pm in KINSC H105. You will be assigned one of these days the first week of the semester. A schedule will be posted on Moodle the first week of the semester; see below for an approximate lab schedule.

**Recitations** Optional, location and time TBA. Because the material in 102 is less familiar than that in 101, it is helpful for us to have a little extra time together, so even if you chose not to come to recitations for 101, you should consider coming this semester. During these sessions, we will work through additional problems and discuss problem-solving strategies. We'll also discuss any questions you may have. (I certainly expect you to ask numerous questions during our regular class meetings, but it sometimes happens that you have a question about some old topic or some other question which you prefer to reserve for recitation.) We will not discuss the assigned homework problems during recitation, though we may discuss related problems. We will not meet for recitation during the first week of classes.

## Help & Resources

Please feel free to be in touch with any of your instructors if you need help in the course. The Physics Clinic, a help session staffed by friendly and experienced physics majors, will be held Wednesday and Thursday 7 to 9 pm in the Physics Lounge, KINSC H107, starting the second week of the semester. Finally, the Dean's office provides Peer Tutors at your request in all subjects, including physics.

## Textbook & Lab Manual

The required textbook for the course is *General Physics, 2<sup>nd</sup> Ed.*, by Sternheim & Kane. This is available for purchase (used and new at reasonable cost) at the bookstore and online. It is also on reserve in our science library.

Lab manual assignments will be posted on Moodle as the course progresses.

You will need a scientific calculator (but not graphing capabilities). All other supplies will be provided.

## Requirements

Regular attendance: It is essential that you come to lecture and laboratory to master the concepts and material in this course; it is strongly advised that you also come to recitation. If you are ill or expect to miss class due to an athletic event or other special circumstance, discuss this with me in person first. Absences from laboratory require the lab instructor's advanced permission. Excessive absences from either lecture or laboratory can result either in your being dropped from the course, or hurt your overall grade. You are responsible for all in-class material and announcement, including knowing the timing and dates of exams, assignments labs and course deadlines.

**You are expected to attend every lab on the schedule, on the day posted. Any exception must be discussed well in advance with the instructor, unless you have a Dean's excuse for extraordinary circumstances (such as illness or emergencies.) Making up missed labs is at the lab instructor's discretion if you do not have a Dean's excuse.** You also must come to lab thoroughly prepared every day, both to make the most of the experience as well as to complete the lab exercises in the time allocated.

You should expect this course to be very interesting and exciting, and also very challenging. The material we will cover is inherently more mathematical than that in physics 101, and most people have less well-developed intuition about it. I will rely heavily on the textbook -- be absolutely certain to keep ahead with the reading, or you will be unable to get the full value from our class meetings.

## Grades, Homework and Exams

**Homework:** There will be weekly homework assignments, to be due 4 pm each Friday. You may turn these in at classtime, or in the envelope provided on the windowsill opposite my door. You will be able to see your grades and progress in the course at all times on Moodle's Grade Center. You are expected to answer all homework questions in full, legibly and neatly. **It is never enough to just write down a numerical answer: you should show your reasoning using sentences, equations and where appropriate a sketch or graph. If you do not present your reasoning clearly, we cannot award you credit, even if your final result is correct. Units and significant figures will count in the grading.**

### Grading procedures:

- **We will use an unusual procedure for handling problem sets – please read carefully!** Please do not use blue or red ink or pencil for your problem sets (pencils, black ink, purple ink, etc. are fine). After you turn in a problem set, the grader will grade it. 50% of the grade for the homework will be based on this first grading pass.

Your paper will then be turned back to you **at your next class meeting**, along with “skeleton” solutions. (These are not complete written-out versions of the problems, but rather guidelines and waypoints to help you along.) At this point, consulting the skeleton solutions as needed **and using blue ink or blue pencil** and writing on the same paper you originally turned in, you will complete any problems which you were unable to do at first, and write out complete corrections to problems which you did incorrectly. The goals of doing the grading this way are to ensure that you understand each problem fully, and also to give you a “second chance” on problems that you muff. You will then turn in your revised problem set on the following Friday at 4 pm. **(Note that I strongly suggest that you complete your revisions ASAP after getting your assignment back; this will**

**allow you to focus entirely on the new assignment thereafter.**) The grader will check over your revisions, and assign the remaining 50% of the grade.

**To make this whole scheme work, it is essential that you leave space on your problem set to write in corrections.** You may wish to leave space at the bottom of each page, or to use the back of the preceding page.

**Exams:** There will be two midterm exams and one take-home final exam. For the two midterm exams, there will be rewrites (similar format to the homeworks); 60% of the grade is assigned to the first pass, and 40% to the second. For the rewrite, the rules are the same as for individual homework problems, i.e. you may consult your text, your own notes, and handouts (lecture summaries, etc.) that I have provided. You may not consult any other written or online materials. You may consult with me, but you may not consult with any other human.

**Late policy:** You may have two “free extensions” during the course of the semester. If you take one of these extensions on a first grading pass (rather than a rewrite), you automatically get an extension on the rewrite; this doesn’t count as a second extension. You may not use a “free” extension on a lab report, an exam, or an exam rewrite. No other extensions will be granted, except for significant illness, serious family matters, etc.; in such cases, you must obtain the extension in advance of the due date. This means that problem sets that are turned in late without using a “free extension” will receive a grade of zero, unless you have obtained an extension due to extraordinary circumstances, as described above. Labs must be done on the scheduled date unless cleared in advance by the lab instructor or department assistant.

**Email:** We expect you to read your email regularly and to pay attention to all course announcements on email and Moodle, as well of course as those made in lecture and laboratory. Submission of any coursework by email is not permitted.

### **Grading:**

The grade for the course will be based on the following weighting:

First Midterm Exam	12%
Second Midterm Exam	14%
Final exam	20%
Laboratory	22%
Assignments (homework & other)	24%
Participation (literally, class participation in all its forms: attendance in lecture & lab, participation in class, etc.)	5%
Creative project	3%

### **Advice**

You may need to improve your study habits in order to do well in this course. The following suggestions are based on the experience of previous students:

- *Review* your class notes between lectures, and come prepared to ask questions. *Annotate* your class notes as you read them.
- *Stay up to date* on the reading; preferably read the assigned material *twice*; for example, once before the relevant lecture, and once after.

- *Read with pen in hand* to work out things described only briefly in the text or lecture. Ask yourself "what is the main point of each section", and *answer* the question.
- When you take notes in class, *don't just write down equations!* Qualitative information is often essential!
- Don't spend more than 1 hour on a single homework problem. Show clearly where you're stumped and just move on. Don't feel badly if this happens occasionally, or worry about the effect on your grade. Consistency in doing the homework is more important.
- **You need to allocate about 7 hours for study and homework per week, plus class time, lab time, and the time needed to write up lab reports. This means that the total commitment for this class is at least 12 hours per week, on average.**
- Do stop in to see one of us if you have questions or suggestions.
- When studying for an exam, do NEW problems, don't just review solutions and your graded problem sets!
- When you're studying for an exam, do review the *solutions* to problems and previous exams for insights into what you may have missed.

Remember that if the material is a new or unfamiliar for you, learning will take time, just as learning a new language takes time. Try not to become discouraged if the going is rough at times, and don't prejudge your ability to master the material. Generations of students have done it before you. There is no magic method of presenting the material that we can use to make it easy.

### Honor code guidelines

The important guiding principle of academic integrity is that you must never represent the work of others as your own. The following guidelines should govern your behavior in the course; please request clarification from me, other instructors, or Honor Council if you find yourself in any ambiguous situations. Also, consult the Honor Council resources website at: <http://honorcouncil.haverford.edu/resources/>.

- For homework & other non-exam assignments: You may seek assistance from the instructor or from your fellow students in doing the weekly assigned exercises and preparing for class discussions and recitations unless the problems are labeled "Individual". "Individual" problems must be completed on your own, without any interaction with other students in the course. (You may consult with the instructor or a tutor you have been assigned through the deans office, however.) For all other problems, you first must spend at least 10 minutes working on your own; struggling by yourself with a challenging problem is an important part of the learning process. Thereafter, you may also work together with other members of the class on the problem and this is often quite beneficial. Avoid situations in which you are either contributing either too much or too little to such collaborations. Please consult me if you need guidance on negotiating this issue.
- If you need to reference work from any written source in completing an assignment, you must cite it appropriately, and you must not copy from it.
- Copying someone else's work (either another student in the course, solutions posted online or material from ANY source) is a clear Honor Code violation and will result in your being referred to Honor Council. To avoid this situation, never copy over for credit work done in a collaborative setting. Put aside or cover up any notes you have written down from group collaborations and write up your solutions separately, using what you learned from them. It

is good practice to use some clear code to label cooperative work (such as colored paper or a big C label in the top right corner. (It *is* acceptable to consult your study group's notes to get unstuck at one point in a derivation, then put them away and continue working on your own, but if you are relying on group notes to produce your entire solution, that's a violation.) *Never* copy directly from a group solution, either on paper or on a blackboard. Just writing down the names of students with whom you have worked on your homework does not make such copying acceptable behavior.

- You must not explicitly look for solutions for the homework problems using the internet. For example, you may not type in the problem number, or a key phrase from the problem, into any search engine or website in an effort to find the solution or hints on how to solve that specific problem. You may use the internet for general background information on the topics relating to the problems.
- Solutions to the homework will be made available shortly after the due date. (If you are using one of your free extensions, you must not consult the solutions until after you have turned in your assignment.) Copying the posted solutions before your work is turned in is an Honor Code violation and will result in your being reported to Honor Council.
- For exams: The exams must be entirely your own work. Detailed instructions will be given on the exams themselves and discussed in advance. No collaboration of any sort is allowed once you start an exam. You must use only the resources indicated on the exam's first page. You must complete *all* exam work (including any copying solutions over neatly that you feel is needed) within the allowed time (a single contiguous block).
- It is an Honor Code violation (and illegal!) to post online any of our copyrighted course materials, including the homework and exam problems, problem solutions, lecture notes, etc.
- I will be using some materials from previous years, including some homework questions and some exam questions. It takes a lot of time to make up good questions (ones that both probe and improve your understanding, and that present an appropriate challenge). By reusing some problems, I'm able to spend more time interacting with you one-on-one. Because I am reusing some problems, you are not allowed to look at any materials from previous years of this or other Haverford physics classes.

### **Using Mathematica, other software (Origin, Excel, etc.)**

You are always welcome to use Mathematica, Excel, Origin or other software tools on assignments. However, you should employ good judgment about this -- don't let it become a crutch that you use even for rather easy algebra and derivatives. Do use it to save time doing messy algebra and integrals. I usually use Mathematica instead of a calculator for plugging in numbers, even though I may have done the algebra by hand. I find this results in fewer errors than using a calculator, because I can see everything on the screen and see that I've entered it correctly. I do all but very lengthy and tedious algebra by hand, though. However, this is a personal preference. You are very welcome to use what works for you.

However, you should know that on exams you will not be allowed to use any software (even a calculator) to do symbolic algebra or calculus, not even to check algebra that you've done by hand. The exam questions will be designed so that you should be able to do all the algebra and calculus by hand.

**Here are the ground rules:** When working in a small group on a problem, you may jointly use

Mathematica, Excel, Origin, etc. (hereafter, Mathematica for short.) HOWEVER, I require that each of you INDIVIDUALLY re-enter the Mathematica stuff on your own, even if you are transcribing from a printout of the joint Mathematica effort. The reason I impose this requirement is that Mathematica is very picky about punctuation and other details, so I want each of you to have the experience of actually entering (NOT just cutting and pasting) the equations into Mathematica.

When you are writing up your problem set, you should include an arrow with "Mathematica" written above it to indicate when you used software to perform a calculation. Then, you MUST append a printout of the Mathematica output, annotated (either by hand or with typed comments) so to make sure I can understand your arguments.

### Accommodations

Students who think they may need accommodations in this course because of the impact of a disability are encouraged to meet with me privately early in the semester. Students should also contact Rick Webb, Coordinator, Office of Disabilities Services (rwebb@haverford.edu, 610-896-1290) to verify their eligibility for reasonable accommodations as soon as possible. Early contact will help to avoid unnecessary inconvenience and delays.

### Schedule (“PS” = “problem set due on Friday of this week”)

(The pace at which we go through the topics may vary substantially from that given here, but the dates for labs, exams, and assignments are fixed.)

Week of	Topics	Chapters	Labs/Exams/Assignments
1: Jan 16	Electricity basics: Coulomb's law, conductors and insulators, electric fields	16	no class Monday; no Lab this week
2: Jan 23	Dipoles, electric potential energy & potential (voltage)	16	Lab 1: Electric Field Mapping; PS 1
3: Jan 30	Capacitors, dielectrics, biological applications of electric potential	16	PS 2
4: Feb 6	Electric current, resistance, energy & power in circuits; DC circuits	17	Lab 2: ECG & DC Circuits Lab; PS 3
5: Feb 13	AC (time-varying) electric circuits; RC circuits, signaling, nerve cells	17 & 18	Exam 1 due Friday Feb. 17
6: Feb 20	Magnetic fields & moving charges, mass spectrometer; magnetic dipoles, magnetic sense & navigation	19	Lab 3: Electron e/m Lab; PS 4
7: Feb 27	Electromagnetic induction, Faraday's & Lenz's law, motors & generators; electrical power use; displacement current and electromagnetic waves	20	Scott gives Mon & Wed lectures (Walter away); PS 5
Mar 5	Spring break		

8: Mar 12	Waves; sound waves; resonance & standing waves	21 & 22	Lab 4: Sound Lab; PS 6
9: Mar 19	How waves add up: superposition & interference; Doppler effect	21 & 22	PSPS 7
10: Mar 26	Interference & diffraction from single and multiple sources; X-ray diffraction	23	Lab 5: DNA Crystallography; exam 2 due Friday March 30
11: Apr 2	Reflection, refraction and absorption; forming images (lenses, all kinds of eyes)	23	PS 8
12 Apr 9	Forming images: the human eye and how to improve it: glasses, telescopes and microscopes; medical imaging	24	Lab 6: Optics & Human Eye Lab; PS 9
13: Apr 16	Unstable/stable atomic nuclei, nuclear decay, beta/alpha/gamma rays, radioactivity, radioactive dating	30	PS 10
14: Apr 23	Origins of the elements & the universe; life in the cosmos, finding exoplanets & searching for life	---	Lab 7: Physics of Color Lab; PS 11 & creative projects due
Apr 27	Last day of classes		all homework, labs, and creative projects due by 5 pm
Apr 28 - May 1	Reading Period		
May 2-5	Senior Final Exam Period to 5 pm May 5		Self-scheduled Final Exam
May 2-11	First-year, Soph., Jr. Final Exam Period to noon May 11		Self-scheduled Final Exam