

Boston University CAS PY104

Physics of Health Sciences

Lectures are T/Th 11:00 AM to 12:15 PM in SCI-117.

Discussions are W 9:05 AM–9:55 AM or 10:10–11:00 AM in WED-406 (2 Silber Way, Whitlock).

Labs are F 8:00–10:45 AM or 2:30–5:15 PM in labs in the basement of SCI.

The most beautiful thing we can experience is the mysterious. It is the source of all true art and science. – Albert Einstein

Instructor:

Prof. Jacob Willig-Onwuachi

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(617) 353-8955

Office Hours: TBA and by appointment

Teaching Fellow and Learning Assistant contact information office hours will be posted on piazza

What you need to know...

Basics:

- There is no assigned textbook.
- We will use a discovery-based approach with more emphasis on learning-by-doing rather than me lecturing at you.
- This is a physics class—our focus is learning concepts from physics, but I have selected topics that are relevant to understanding various subjects related to the health sciences.
- We cannot cover all physics related to the health sciences! So, we will focus on achieving a deeper understanding of a few core ideas and concepts.
- You will have homework every week—usually due on Mondays at 5pm. Solutions will be posted online soon thereafter.
- You should have discussion and lab sections. Activities will happen in all class meetings.
- I expect you to all be respectful of one another (and me!).

How to succeed in this class:

- Motivation. How you do in this class is entirely up to you (your time and effort).
- The best (and maybe only) way to learn physics is by doing physics—working problems and discussing/engaging with the material. We will practice this type of learning in class, but success will require out-of-class time.
- Participate (come to class, ask questions) and take an active role in mastering the material.
- Come to class prepared for discussion, questions, and group work.
- Review, rework, and synthesize. Review course materials, look for connections, rework homework problems after you get them back, ask yourself questions like “why?” or “how would it change if...” etc.
- Try problems on your own first before seeking help or collaborating.
- Work together on solving problems and learning the material (not solutions). But make sure that you can do every problem on your own from scratch by exam time.
- Use your resources: LA, TFs, me, and office hours!

The Fine Print...

Welcome to Physics of Health Sciences!

Physics is the study of the underlying principles governing the world (and the universe) around us. Physicists concern themselves with interactions involving matter and energy of every form and at every scale— from the tiny world of subatomic particles to the galaxies scattered across the universe. The mathematical and conceptual models developed by physicists—and the tools and techniques developed to understand and apply these models—are used to test the limits of our knowledge of nature but also to solve more familiar human problems (e.g., the invention of transistor radios, development of faster computers, use of laser eye surgery, advances in medical imaging, etc.).

This semester we are going to focus on a selection of phenomena that are relevant to the health sciences. Topics include motion, forces, energy, waves, sound, fluid flow, circuits, electric fields, and optics. Although we will cover a limited set of physics concepts, the ideas we discuss will form the foundation for much of the rest of physics, and hopefully will help you understand applications in the health sciences. I invite you to join me on this exploration of how our world works.

General Objectives:

- Hone your naturally inquisitive nature
- Discover the fundamental principles that govern how things behave
- See how these principles can be applied to help us understand a broad range of natural phenomena and problems
- Develop skills of scientific inquiry and logical reasoning
- Develop abilities to communicate your ideas and observations to others
- Develop skills at working collaboratively with others
- Learn how to learn physics
- Learn details about particular topics, such as motion, fluids, circuits, and optics

More Specific Scientific Goals:

My goals for you are that, after completing this course, you will be able to:

- Understand the central conceptual models of classical mechanics, fluid mechanics, DC circuits, and optics at an introductory level.
- Draw correct, logical conclusions from these models through well-reasoned arguments involving the application of appropriate techniques from mathematics.
- Learn to apply these models to make quantitatively correct predictions for realistic physical systems, using computational methods as appropriate.
- Conduct experiments on course subjects, make measurements using proper devices and techniques, analyze and interpret data with appropriate theoretical and computational methods, and clearly communicate your results.

Audience and Prerequisites:

PY 104 is intended for health science majors or minors or other students wishing to learn some physics related to biology, chemistry, medicine, or other health sciences. Note that, while this course covers topics from introductory physics, it does not satisfy requirements to advance in a traditional physics curriculum.

Textbook:

There is no assigned textbook. You will receive handouts that will cover the relevant material. These handouts will come in the form of class activities, summaries of the material for your reference, and various additional materials. I recommend that you purchase a thick three-ring binder to hold these materials. In addition, there is a selection of physics texts around the department and in the libraries, as well as many online resources, that you may use, if you wish to do any additional reading. But no text is necessary if you embrace the approach of this class.

Course Format:

This course is a hands-on investigation of concepts in physics that are relevant to the health sciences. It is derived from an award-winning model developed by Prof. Priscilla Laws of Dickinson College, although most of the instructional materials we will use were developed by or borrow heavily from materials from Mark Schneider at Grinnell College and the Physics Education Research Group at UNC, including David Smith, Laurie McNeil, David Guynn, Alice Churukian, Duane Deardorff, and Colin Wallace.

Most of the course will center on your in-class work that is based on a set of hand-outs known as activity guides. These activity guides give very concrete instructions for what you do in class and include space for you to write your thoughts and results. *It is essential that you complete these activity guides and hand them in. Do not let yourself fall behind!* The activity guides are divided into conceptual pieces called units, and one day's work is called a session.

Group Work and Collaboration:

The activity guides and your in-class work are done in your working group, which is typically a group of three people. Your working group is therefore a critical component for learning in this course, so for your sake, and the sake of your partners, it is very important for you to **show up on time, work with your partners, and have a sense of commitment to the group.** Science (and life) is usually a group activity. It is important that we all learn how to work productively with a range of different people.

For both the activity guides and the problem sets, you are encouraged to work together, but what you hand in should reflect your understanding of the material. The exams and quizzes, on the other hand are to be done completely individually.

Online Material:

PY104 will use **Piazza**, an online collaborative bulletin board, for posting homework assignments, solutions, notes, additional readings, and class announcements. Piazza is also the place where you will find course guidelines, schedules, contact information, and so on.

We will use **Blackboard** Learn for keeping track of grades. Use it to check your grades (activity guides, homework, quizzes, etc.) during the semester. It will be your responsibility to check the accuracy of your grades.

Classes:

The planned topic for each meeting is listed on the course calendar (a work in progress). More up-to-date information will be provided in class or via email as the semester progresses. Because of the format of this course, lab-like group activities will happen in the assigned "lecture," "discussion," and "lab" times. In all class meetings, you will learn about the scientific process, including construction of physical models, the design of experimental measurements, the collection and presentation of data, data analysis, and collaborating effectively in groups.

I will not take attendance; however, I do expect you to attend class, and a portion of your grade is based on activity guides completed and turned in during class meetings. Also, you are responsible for the material covered during class meetings, and often useful questions or discussions

arise during class that cannot be experienced by reading the material on your own. Class time is also a good time to seek clarity or get your questions answered. I assume you are all mature and responsible adults who will take an active role in mastering the material in this course.

As a courtesy, I would appreciate it if you contact me by email if you will not be in class. It is your responsibility to ask if there are any important announcements, assignments, or other information that you missed or will miss.

Exams:

There will be three exams: two in-class midterms plus a final during the regularly scheduled final exam period. There will also be quizzes in the week or two leading up to each exam. The purpose of these quizzes is to give you some clear feedback on your knowledge of the material before the exams while there is still some time to do something about any gaps in your understanding.

Homework:

Problem sets will be posted on piazza, roughly a week before they are due. Homework sets are due as scheduled in boxes located in the ground floor of the Metcalf Science Center, next to SCI-112, generally Monday at 5 PM.

You will inevitably get stuck on certain problems and need to mull them over or consult others. You are strongly encouraged to start early and to work collaboratively on assignments. Collaboration will allow you to share ideas and approaches, as well as learn by teaching each other. However, ultimately you are responsible for understanding the material, and I expect the work you submit to be in your own words/handwriting and to reflect your own comprehension. Give credit to those with whom you worked or from whom you received help by noting their names as collaborators on your submitted work.

Your problem sets should be neat, readable, and sufficiently well organized that your approach to the problem is clear to the grader. The grading will not just be based on whether or not you wrote down the correct answer but will also depend on the documentation of your reasoning, so show your work. **BE SURE TO INCLUDE EXPLANATIONS, DIAGRAMS, EQUATIONS, ETC.** Problem solving skills will be discussed in class. Place a box around final answers so they are easy to find. The homework will be graded by the teaching assistant and will be returned during discussion section or lecture. Solutions will be posted on piazza. Late problem sets (more than one class after the due date) will be accepted with a maximum score of 50%. If you fall behind or experience something that affects your ability to make progress on the homework, please reach out to me as soon as you can. Some homework might be team-based.

Discussion and Lab Sections:

Discussion and lab sections are a required part of the course. You must have assigned discussion and lab sections. Discussion rooms are fixed. Lab meetings will move to different rooms in the basement of SCI. To determine the room in which the lab is held, see the posted card on any lab room in SCI.

Grading Summary:

A standard grading scale will be used: A (90-100%), B (80-90%), C (70-80%), D (60-70%), F (<60%), with the standard modifications for +/- . The grade scale may be curved if appropriate at the end of the course, but only in a manner that will raise your letter grade, not lower it (in other words this is not purely a competition).

15% Activity Guides/Problems of the Day/Participation
15% Homework
10% Quizzes
15% Midterm 1
15% Midterm 2
30% Final Exam

BU Hub:

Successful completion of PY 252 satisfies

- 1) **Scientific Inquiry I** - Many of the most vexing problems facing the contemporary world, from the global challenge of climate change to intimate decisions about our own health, demand the capacity to evaluate scientific claims, assess the strengths and weaknesses of prevailing theories, and discriminate between conflicting data and conclusions. These outcomes foster the ability to understand scientific ideas, as well as the skills necessary to formulate working hypotheses, design experimental tests of these hypotheses, and evaluate experimental data.
- 2) **Quantitative Reasoning I** – i) Students will demonstrate their understanding of core conceptual and theoretical tools used in quantitative reasoning, such as statistics, computing, and mathematics. ii) Students will interpret quantitative models and understand a variety of methods of communicating them, such as graphs, tables, formulae, and schematics. iii) Students will communicate quantitative information symbolically, visually, numerically, or verbally. iv) Students will recognize and articulate the capacity and limitations of quantitative methods and the risks of using them improperly.
- 3) **Intellectual Toolkit: Critical Thinking** - Critical thinking is required for just, civil society and governance, prized by employers, and essential for the growth of wisdom. Critical thinking is what most people name first when asked about the essential components of a college education. From identifying and questioning assumptions, to weighing evidence before accepting an opinion or drawing a conclusion—all BU students will actively learn the habits of mind that characterize critical thinking, develop the self-discipline it requires, and practice it often, in varied contexts, across their education.

Accommodations for Students with Disabilities:

The University will make reasonable accommodations for students with documented disabilities. If you are a student with a disability or believe you might have a disability that requires accommodations, please contact the Office for Disability Services (ODS) at (617) 353-3658 to identify and special needs. ODS is located at 25 Buick Street on the third floor.

Academic Conduct:

You are expected to be familiar with and adhere to the [College's Academic Conduct Code](#). The homework and other work you turn in must be your own, subject to reasonable collaboration with your peers in this class as discussed above. Use of solution manuals, solutions from previous years, or help from postings on the Internet is expressly forbidden. Cheating on exams, quizzes, or other course work will not be tolerated. Evidence of cheating will be reported to your college's Academic Conduct Committee.

Approximate schedule of the course material:

Week 1	Intro and Motion
Week 2	Acceleration
Week 3	Forces
Week 4	Conserved Quantities
Week 5	Circular Motion
Week 6	Oscillations
Week 7	Waves
Week 8	Sound
Week 9	Fluid Statics
Week 10	Fluid Dynamics
Week 11	Bulbs and Batteries
Week 12	DC Circuits
Week 13	Electric Fields and Forces
Week 14	Geometric Optics
Week 15	Review
Thu, Sept 26	First Exam
Tue, Nov 5	Second Exam
Tue, Dec 17	Final Exam (12:30-2:30)

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