Physics 211, Spring 2019

Syllabus

Contact Information

- Instructor: Dr. Walter Freeman, wafreema@syr.edu, Physics Building room 215
- Class meetings: Tuesdays and Thursdays, 9:30-10:50 AM or 11 AM-12:20 PM, Stolkin Auditorium
- Help sessions: Friday 9:30-11:30 AM; others TBD; held in the Physics Clinic, Physics Building room 112
- Course website: https://walterfreeman.github.io/phy211/
- Recitation TA's:
  - Ohana Benevides Rodrigues, obenevide@syr.edu, lead TA
  - Merrill Asp, masp01@syr.edu
  - Bradley Cole, bgcole@syr.edu
  - Julia Gianni, jagianni@syr.edu
  - Alexander Hartwell, arhartwe@syr.edu
  - Kesavan Manivannan, kmanivan@syr.edu
  - Emily Syracuse, ecsyracu@syr.edu
  - Xuan Zheng, xzhen101@syr.edu

Textbooks and materials

- *University Physics Volume 1* (W. Moebs, S. Ling, J. Sanny, et al.), published by OpenStax. This is an open-access textbook available to anyone under the terms of the CC-BY 4.0 license and can be downloaded for free at https://openstax.org/details/books/university-physics-volume-1. You are free to print this textbook on your own; OpenStax will sell you a printed copy if you like.

- You are encouraged to have a nonprogrammable calculator for use on exams. This calculator should be able to do trigonometry and arithmetic, but should not be capable of graphing functions or solving equations symbolically. Searching "scientific calculator" on Amazon will get you many options available for less than $10. (You may not use a graphing calculator on exams.)

Course philosophy

0. Physics is simple!

This is the simplest class you will take in your university career. It is rather accurate to say that the content of this class consists of Newton's law of motion $\vec F=m\vec a$, along with a little math (algebra, simple trigonometry, extremely simple calculus). That's it.

This class won't be easy, of course; the difficult aspect of this course will be learning to use these simple tools – the elementary principles governing forces and motion – to understand situations that vary from how to drive safely on ice, how to measure the speed of a bullet, how to throw a basketball so that it goes into the hoop, how a bicycle works, and so on.

Physics is a science of simplicity. It is the most reductionist of the sciences; the aim of physics is to reduce the world around us to its simplest parts, understand how they work, and then put them back together to understand the things they make up. Physics is difficult because understanding how these simple pieces combine to determine the behavior of larger systems requires cleverness,

ingenuity, and problem-solving skills. The most difficult aspect of this course is learning to solve problems with simple tools. It's like building things out of Legos: you're supposed to build a rocketship, or a statue of Yoda, and all you have are these little bricks!

This is very different than the life sciences, where the difficulty lies in complexity: nature has built very complicated machines called "lizard" and "tree" and "physicist", and it is up to biology to try to make sense of the complexity behind her creations. Biology is hard because you have to understand all of the different pieces that make up lizards and trees and physicists. But physics isn't like that: in this class we have only objects and forces that act on them, and from that foundation you have to build up the solution to many different situations. That's the power of physics: simple laws in combination drive everything around us.

So, if you're stuck on a problem, think simple; that's how physics works.

1. Reasoning and synthesis, not memorization

This course is emphatically not a class where you will come to lecture, sit there and listen to a presentation of some facts, and then repeat them back to me on exams. The laws of mechanics are very simple, and you could
memorize them in an hour if you wanted. The challenging aspect of this class is the *application* of those
principles to understand the motion of physical systems – to take the principles of nature and, using mathematics
as a tool, synthesize them into an understanding of how a particular system behaves.
You are not going to be learning a list of currently-accepted facts; you are going to be practicing skills and learning to see the universe as scientists see it.

2. Ask for help, early and often

Since the difficult part of the course is the problem-solving aspect, it's only natural that we are going to give you lots of help in solving problems, especially at first. Learning physics is most similar to learning to play
a sport or learning a musical instrument: it requires practice and the guidance of a coach. I do not expect that you can do all of the homework problems on your own; it is crucial that you ask for help in doing your homework. If you're stuck on a homework problem, you can:

- Come to my office hours and ask, or make an appointment, or drop by my office (room 215)
- Go by the Physics Clinic; you are likely to find a TA, other students, or me there to help you.
- Ask a question in the lecture: if you're stuck on something your peers probably are too, and will welcome your question. I *always* have time in lecture to answer questions; don't be intimidated by the size of the class.
- Ask your TA or coaches during recitation
- Ask your peers for help (and insist that they help you understand how to think about the problem, not just give you the answer)
- Ask for help on the class Slack channel
- Write me, your coaches, or your TA an email.

Again: it is **intended that you will get stuck**, just like no pianist plays a difficult piece perfectly the first time. The problem-solving skills in this course are things you have to practice, and we expect you to have to practice in order to make progress; come ask us for help, and we'll guide you as you practice.

3. Learn from your work

As you look at problems – whether you're solving them the first time or reviewing for an exam –

remember: it’s not enough to know the answer. You likely won’t see the same problems again.

It’s also not enough to know how to get the answer. Knowing how to get the answer – looking through the solution and understanding how each step follows logically from the last – is also not enough.

Instead, you should make sure you know how you know what to do to solve the problem. After you complete a problem, take just a few minutes to look back over it and ask yourself: what about this problem led me to the solution? Make sure you’re aware of what aspects of the problem make it solvable in a particular way. This will help you build a flexible toolkit of problem-solving skills, tools that will serve you well on the exams and in life.

I’ve chosen to give you only six to ten homework problems per week. I could give you more, and in fact if you want more practice problems there are more available in your textbook. This is because I intend for you to spend more time thinking about what each problem entails, and learning from them; my experience has shown that students who have to slog through 25 homework problems per week are less likely to actually think about the skills they’ve applied in each one, since homework becomes a grueling endurance challenge rather than an opportunity to learn physics. I’d much rather have you do the latter.

4. This is not a math class

In this class, you will use mathematics, but it is only a tool. Do not let yourself become a thrall to mathematics; this class is no more about mathematics than a class on Shakespeare is a class about words.

The laws of physics are written in the language of mathematics, but they describe things beyond math: the physical interactions between objects.

If you are stuck, resist the temptation to go leafing through your textbook looking for ``the right equation to use''. Physics isn’t about equations; it’s about ideas and the ability to solve problems. Instead, put your pencil down and think: what is going on here? What principles are at work in this problem? How do I expect the system to move (or not move)? What things do I know, and what other things can I figure out from them? What does my intuition tell me should happen? What forces act on the objects? If you still can’t figure out how to proceed after thinking for a while and consulting your notes on problem-solving approaches, it’s a good time to ask for help.

The mathematics you will need for this class are:

- Algebra:
  - You will need the ability to solve a system of N equations for N unknowns, using substitution
  - You will need to know how to use the quadratic formula to find the intersection of two parabolas
  - There is guaranteed to be one problem on the first exam where you will need to use the quadratic formula
- Trigonometry:
  - You will need to know how to compute the legs of a right triangle given knowledge of its hypotenuse and one of its angles
  - You will need to know how to compute the angles of a right triangle and the length of its hypotenuse given the lengths of the legs
- Calculus:
  - You need to know the concepts of “derivative” (rate of change) and “integral” (cumulative effect / area under curve). If you are just now in Calculus I, don’t worry; it is no accident that

Newton developed both mechanics and calculus, and I will teach you what you need to know. You won't have to do any difficult derivatives or integrals.

That's it.

5. This is your class, too

As part of this philosophy of inquiry and questioning, I welcome your input. If there is some aspect of physics that inspires or fascinates you, please ask; if you have feedback for me that will help you enjoy the class more, then please let me know.

Learning Objectives

After taking this class, you will be able to:

- Unit 1 (Kinematics):
  - Translate between verbal, graphical, algebraic, and numerical descriptions of an object's motion
  - Given a description of an object's acceleration, create a description of how its position and velocity change, or vice versa
  - Use vectors to describe motion in two and three dimensions, and use trigonometry to manipulate them
  - Incorporate physical units (meters, seconds, and so on) into algebraic and arithmetic statements
- Unit 2 (Forces):
  - Identify the forces that act on the objects present in a variety of physical situations
  - Describe the basic properties of the forces of tension, friction, gravity, and normal forces
  - Using Newton's second law, construct mathematical relations between those forces and the objects' motion
  - Identify constraints on those forces and on objects' motion based on Newton's third law and the geometry of the situations at hand
  - Describe the forces required to cause an object to move in uniform circular motion
  - Use the previous skills to predict how an object will move in any given situation, and the forces involved in its motion
- Unit 3 (Conservation laws)
  - Use conservation of momentum to solve problems that involve collisions and explosions
  - Use the work-energy theorem and conservation of energy to determine properties of the motion of systems to which they apply, and recognize which systems those are
- Unit 4 (Rotation)
  - Construct analogies between the properties of rotational motion and the properties of translational motion
  - Use conservation of energy to solve problems in which objects rotate as well as translate
  - Describe the relationship between the forces that act on an object and the torque they apply about any given axis
  - Describe the relationship between the torque applied to an object and its angular acceleration
  - Use both $\vec F=m\vec a$ and $\tau = I \alpha$ in tandem to predict the motion of objects that both translate and rotate

- Throughout (Process of Science)
    - Describe the basics of scientific integrity and the properties of both honest scientific arguments and dishonest pseudoscientific claims
    - Critique (pseudo)scientific claims that are made in bad faith, and describe the problems with them
    - Critically examine sound and unsound scientific claims that seek to overturn preexisting consensus. In particular:
        - Describe the primacy of empirical measurements in evaluating scientific claims
        - Critique flawed arguments that fail to address empirical data
        - Critique flawed arguments that fail to address the broader framework of physical laws of nature
        - Critique flawed arguments that focus on the identities of the people involved, rather than their data and logic

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Course Activities

Recitations

Twice a week, you will have discussion sections led by one of your TA's, assisted by a few dozen students from previous years of Physics 211. *These discussion sections are the most crucial part of this class*, since it's there that you will do the hard and crucial work of practicing the skills you learn. Physics takes practice. It's not something you only learn from a lecture; it's something you practice with a coach. In recitations, you'll practice your skills in groups of three – learning from your peers, teaching them, and asking questions of the numerous guides that are there to help you.

Recitation attendance and participation are graded. Before each in-class exam, you'll take a practice group exam in recitation with your group. These practice exams are graded as well. A further set of guidelines (incorporated into this syllabus) for recitation, and the homework you'll submit during them, may be found at https://walterfreeman.github.io/phy211/recitation-guidelines.html. (For the purposes of this PDF syllabus, this document is included at the end.)

Lectures

In the auditorium, we will alternate between presentation and practice. I will first introduce you to the new ideas we are studying, asking questions and getting your answers using colored cards. (These take the place of clickers.) If you have done the reading ahead of class, these presentations will serve as review and enrichment. Questions during the presentation are encouraged and welcome! I will also demonstrate for you the analytic processes involved in solving problems. I may also distribute short tutorials for you to work in class, or ask you to answer short questions on note cards and pass them in at the end of the class.

At any time during class, feel free to interrupt me and ask questions. If you do not understand something, ask. I don't care how many students are in the auditorium – I almost certainly have time for your question.

Quizzes

We will have a few brief quizzes in class (probably eight during the semester) that may be done in either recitation or lecture. These will also serve as a proxy for attendance if they are held during lecture. There are no makeups for the quizzes, although you may replace one quiz grade with the associated exam grade if your recitation participation average was satisfactory during that unit.

Homework

Homework in this class is designed as a tool to help you develop the problem-solving skills needed to understand physical situations on your own.

You will have an assignment due each week (more or less), which you will hand in to your recitation TA. I do not intend for you to work on these problems by yourself without help. The Physics Clinic is a great place to come to do your homework; you will likely find many of your peers there as well. You are also welcome to come to my office hours and sit and work, asking questions as they arise. Doing the homework thoughtfully and with an eye toward understanding "So how did I know what to do here?", and asking for help is the single best thing you can do to help yourself in this class.

When writing your homework solutions, you must describe what you are doing in words, even if these descriptions are brief; your solutions should not consist only of equations. Show us what you are thinking and why you are doing what you're doing; this will both help you learn and help us give you more partial credit if you understand what you're doing but mess up the math. **If you do not describe what you are doing and why, you may not get full credit for a solution, even if it is correct.**

You must submit each problem on a separate side of a page; this is to help us grade your work more easily, and will give the TA's more time to help you learn physics – which is what we'd all prefer!

Two problems from each set will be graded fully (out of ten points); the rest will be quickly graded for completeness out of two.

Labs

You are enrolled in a lab. It is a separate course. Do not ask me anything about the lab; I don't know anything about it. Ask your lab TA or Sam Sampere (smsamper@syr.edu). (You may, of course, ask me questions about the *physics* of things you do in lab, but don't ask me if there is lab this week, where your lab is held, etc.)

Help Sessions

These help sessions are opportunities for you to interact with me and the rest of the teaching team in small groups or individually. (Some folks call them "office hours".) If you have questions or suggestions, need help with your homework or with studying, or just want to chat, this is a great opportunity. They will be held in the Physics Clinic, room 112, or elsewhere as announced.

Grading and Exams

Item	Date	Points
Homework	Due throughout	25
Exam 1	5 February	15
Exam 2	7 March	15
Exam 3	9 April	15
Final Exam	6 May	30

Attendance and participation	Throughout the semester	10
Group practice exams	The Friday prior to each exam	15
Paper on the nature of science	29 April	15

The lowest of your exam grades will be dropped. If your final exam grade is lower than any of your three midterm exam grades, then the final exam will instead only count for 15 points. Note however that students with an unusually low recitation participation grade for any given unit will not be eligible to drop the corresponding exam without prior permission, at our discretion.

This will result in a total of 125 possible points. This value will then be converted to a percentage (by dividing by 1.25), and grades will be assigned as follows:

- A : >88
- A-: 80-88
- B+: 75-80
- B : 70-75
- B-: 65-70
- C+: 62-64
- C : 58-62
- C-: 55-58
- D : 50-55
- F : less than 50

Exams

There will be three exams and a final on the dates shown on the course schedule. You may bring one side of handwritten notes, a nonprogrammable calculator, and writing implements. (Calculators that graph functions or solve equations symbolically are not allowed.)

Cellphones, smartwatches, and the like may not be used during exams for any reason. Using these devices is presumptive evidence of academic dishonesty. If, due to an emergency situation, you require an exception to this, notify me or a proctor before the exam starts.

Makeup exams will not be given except in extreme circumstances involving serious disabling illness (not just a cold), family emergency, or events of singular importance to your personal life that occur on inflexible dates (e.g. your sibling is getting married). If you must miss an exam for such a reason, notify Walter or Ohana as far in advance as possible. I may ask for documentation. I may either:

- assign a time for a makeup exam, written or oral, which will likely be on the following weekend
- replace your missed exam grade with your grade on the portion of the final corresponding to the same material
- drop the grade for the missed exam

Incompletes

A grade of “incomplete” may be given to any student who is unable to complete the course material by to the end of the semester due to unavoidable problems outside his or her control. This is a “grade pending” status that allows you to finish up the course in the future and then receive a grade. In general, any student who is unable to meaningfully participate in class for a period of two weeks or more due to

- serious illness or injury, physical or mental;
- caregiving for the serious illness of a family member;
- legal involvement or proceedings;
- or international issues

is eligible to take an incomplete in the course. If you think that you may need to take an incomplete, please contact me as soon as possible.

In general, students may *only* take an incomplete if they have finished a substantial portion of the course (two units) with a grade of C+ or better.

Academic integrity

While you are encouraged to discuss your homework with your peers and collaborate with them on solving our problems, all work you submit must reflect your own understanding and be a product of your own work. Submitting any work that you do not understand and cannot explain, or that is a result of wholesale copying, will be considered academic dishonesty. Please don't let this discourage you from working on your homework with your peers. That is exactly what you *should* do! But *copying someone's work* is different than *working together with them*.

Additionally, you are not allowed to post solutions to the homework on the Internet. In particular, posting solutions to Chegg, CourseHero, or any other websites that charge students a fee or otherwise monetize access to that material is an extremely serious breach of the Academic Integrity Policy and may result in your suspension or expulsion from SU.

We reserve the right to seek a sanction of course failure for any violation of the Academic Integrity Policy.

(The following is boilerplate from the University)

Syracuse University's Academic Integrity Policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of participation in class activities. The policy also prohibits students from submitting the same work in more than one class without receiving written authorization in advance from both instructors. Under the policy, students found in violation are subject to grade sanctions determined by the course instructor and non-grade sanctions determined by the School or College where the course is offered as described in the Violation and Sanction Classification Rubric. SU students are required to read an online summary of the University's academic integrity expectations and provide an electronic signature agreeing to abide by
them twice a year during pre-term check-in on MySlice.

Students with disabilities

If you believe that you need accommodations for a disability, please contact the Office of Disability Services (ODS), located in Room 309 of 8047 University Avenue, or call (315) 443-4498, TDD: (315) 443-1371 for an appointment to discuss your needs and the process for requesting accommodations. ODS is responsible for coordinating disability-related accommodations and will issue students with documented Disabilities Accommodation Authorization Letters, as appropriate.

Since accommodations may require early planning and generally are not provided retroactively, please contact ODS as soon as possible.

More generally, if there is anything I can do to help you, whether it is related to a disability, a medical condition, or anything else, please let me know. I have an excellent working relationship with ODS and will do anything in my power to make your experience in my class a good one.

Religious observances and excused absences

(The following is common to all SU classes)

SU's religious observances notification and policy, found at http://hendricks.syr.edu/spiritual-life/index.html, recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holidays according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance provided they notify their instructors before the end of the second week of classes. An online notification process is available for students in My Slice / StudentServices / Enrollment / MyReligiousObservances / Add a Notification.

(The following is specific to Physics 211)

Events of equal solemnity to major religious observances, occurring on inflexible dates, will be given the same deference as religious observances. This includes weddings and commitment ceremonies of immediate family members, funerals, caregiving duties for sick family members, and the like. Note that I consider romantic partners and exceptionally close friends to be family.

Attendance at political demonstrations occurring on inflexible dates or in response to ongoing events of significant gravity, regardless of affiliation or cause, will also be treated as such an event.

If you need to miss class for such a reason, please notify Dr. Freeman as far in advance as practical to discuss arrangements.

Recitation guidelines, included into online syllabus by reference

General

- In order for the recitation to be useful and effective, please come to recitation prepared. Specifically, this means that you have attended lecture, looked anything up in the text you didn't understand and/or asked someone about it, and looked at homework that has been assigned recently. You will be working in groups, and if you have fallen too far behind you are hindering both yourself and your groupmates.
- To make the most of our time together in recitation, please ask any questions that you have regarding things covered in lecture, reading assignments,
  homework assignments, etc. Asking informed questions is essential to succeeding in this course; the ability to reason physically is a process of inquiry, and being able to ask good questions is, if anything, more important than knowing all of their answers.
- Out of respect for your classmates and the course as a whole, students are expected to be punctual (see section Attendance). Recitation sections will start at the time posted; if you're late, you may miss things, including being counted present.
- The use of electronic devices (computers, laptops, tablets) is in general not allowed, with the

exception that you may use them to refer to course material.

Attendance and Participation

- Attendance and participation are a component of your final grade. A sign in sheet will be passed around at the beginning of recitation. At the TA's discretion, students arriving late may not receive credit for attendance.
- You are expected to participate actively in recitation activities. These include class discussions, group work, and presentations. Your recitation grade will be based both on your attendance and on the quality of your contributions to your group and to the class.
- Before every exam, you will work on a preliminary exam in your groups. These preliminaries serve both as practice exams for the in-class test and as group examinations, and together they carry the same weight as one of the in-class exams.
- If you must miss a group exam, notify your TA in advance. If you miss a group exam for an excused reason, your in-class exam grade will replace the group exam grade.

Homework

- Homework is due at the beginning of recitation. If your TA instructs you to submit homework to their mailbox, you may do so, but do not do this without prior permission. If extenuating circumstances prevent you from turning your homework in on time, contact your TA well in advance of the due date to request an extension, which will be granted at their discretion. Late homework without prior arrangement will only be accepted in emergency situations.
- If you must be absent from recitation, contact your TA in advance to arrange to submit your homework.
- You are encoraged to collaborate with your peers on your homework. However, you must understand everything you turn in. Work that is so similar to another student's that it reflects wholesale copying, rather than collaboration, amounts to "substituting someone else's understanding for your own", and will be treated as a violation of the Code of Academic Integrity.
- Homework submissions should not consist only of algebra without accompanying diagrams and discussion. This is not a mathematics class; do not simply submit mathematics. Your solution to homework problems should be a short narrative, explaining your complete thought process leading from the problem to the solution using words, pictures, algebra, and numbers where appropriate. Words and diagrams are just as important as symbols and numbers.
- Any solution with numbers substituted for algebraic expressions prematurely will lose up to half credit. This may seem harsh, but it is considerably simpler *and far more illuminating!* to substitute in numbers only as the very last step of a problem, unless there is specific physical insight to be gained by numerically evaluating expressions sooner. In general, unless you are prepared to interpret a numerical value, rather than simply compute it, leave it as an algebraic expression. This point will be illustrated in class and further explained by your TA's.
- Any final answer bearing dimensions (a mass or a length, for instance) without units will be marked as incorrect.
- You are also expected to include units along with numerical dimensionful quantities in your calculations. This will prevent you from making certain sorts of mistakes: adding together a length and a mass, for instance. If you make this sort of mistake, and if you would have caught the mistake had you carried the units along with your numerical work, then you may lose credit for the entire problem. This may seem harsh, but this requirement is there to encourage good habits. This will be discussed further in class.
- If you have an objection to the grading of your homework, speak to your TA, as the grader, first. Any student making a grade appeal must be prepared to solve the problem, without notes, on the blackboard. If, after discussion with the TA, you still wish to appeal your grade, speak to

Walter or Ohana.

Exam grade appeals

- If you believe that your exam grade is incorrect, speak to your recitation TA first. If they agree with you, they may fix the mistake. If they disagree with you, they may direct you to consult with Walter.
- As with homework, if you are appealing the grading of an exam problem, you must be prepared to solve the problem on the blackboard.