How to study for this class.

Your study time divides into four parts: 1. Reading and studying a textbook. 2. Studying your class notes. 3. Doing problems. 4. Watching online physics videos. You should be studying two to three hours every day minimum for this class (many students need to study more than this). But how? If you spend this amount of time and still don't do as well as you want, you must learn how to study more efficiently to make it pay off.

Read and study the textbook, any text you want. You may need to read the same passage three or more times before understanding it, just like everybody else. Also, don't get too distracted reading a bunch of different texts as some students, including your instructor, like to do; the payoff isn't big enough. **15% of your study time.**

Take notes in the lecture and study them. Write down everything said aloud, and everything written on the board. Just doing that and nothing else will help you somewhat, but to maximize your learning you should study your notes outside of class. There is no meaningful learning during a lecture, that takes time; the lecture sets the stage for you to then learn on your own (if you can, by yourself), outside of class using your notes as a guide. You can maximize your learning by organizing and re-writing your notes after each lecture. **15% of your study time.**

Studying your notes is good, but to succeed in the class you need to do more. How do you study the solutions on the nebula2 server archives to maximize your learning? **This is the most important part of success in the class.** The primary test of your knowledge (and how you will be graded in this class) is your ability to solve a physics problem **you have never seen before**. The idea is to use your conceptual knowledge of the theory to step your way through the solution, starting at the beginning, without skipping steps, to the end without worrying about the final answer. If you understand the physics, then you personally don't really solve the problem (by the force of your profound intellect, let's say). Instead, your knowledge of how to apply the theory, "the physics", solves the problem for you; that's the point. So, you **never memorize a solution,** you just let the physics solve the problem for you each time you do it. You will be mostly graded on the clarity of your solutions, not your final answer. If you understand the physics, it is no problem to present a clear solution; that will happen automatically as a function of the clarity of your understanding.

Pick a problem to work on. Study its solution or just try to solve it cold. But while working the problem, never look at the already given solution. Work your solution out to the end, or as far as you can, and then look at the provided solution and find where, if anywhere, you went wrong. But you are far from done studying this problem. Giving yourself enough time to forget the solution (remember, don't memorize solutions) which could be anywhere from an hour or two to a couple of days, do the problem again from scratch (don't look at the solution!) and see how far you can get this time, not from memory, but by applying your understanding of the theory, step by step. Get as far as you can and then once again, compare your solution to the online version. If they match, maybe you learned something, but if you're like me, you still made mistakes, maybe the same mistake, maybe a new one. But that means you will have to do the problem once again; forget about it for a day or so and then try again. You might be surprised that it could take up to five repetitions of solving the same problem before you have straightened out your incorrect thinking about applying the theory. Ask questions in office hour when you get stuck; email doesn't work. Maybe the given solution is wrong (there are mistakes in the archives!) and then congratulations, you have then found a mistake in my solution! So, this means you will have to do the same problem many different times over different days practicing the correct application of the theory. And this is just for one problem! You should be doing this for three to five problems every day. Do as

many problems as you can stand. If you can't make progress on a problem, or really solve it completely, within ten or fifteen minutes, look at the solution and see where you got off track, or better yet, just move on to a different problem you can do. Don't waste time staring at a problem without writing something down. This is how you will learn, actively engaged.

Every time you solve a problem (especially the same problem you are doing again, or even several times again, to gain practice), do your best to pretend you have never seen it before, whether you have or not. As will be explained in the lectures, in setting up a solution to a problem, you do the physics first, and then do the math; so really, solutions divide into two parts: the physics part and the math part. Physics is not algebra; don't have your solution confuse the two. It mostly doesn't matter what some physics problem is asking you to find for a final answer for you to proceed with its solution; quite often what final quantity a physics problem is asking for is just a matter of solving a math equation, usually algebra, that was generated by doing the physics first. And if numbers are given in some problem (checking the archives will show you this is rare), your final answer will still be algebraic, an answer in terms of "given" variables, where you then plug in the numbers to find the final numerical answer, no numbers until the end. Your job is to thoroughly study those archive solutions; the job of the lecture is to help you understand what those solutions mean so you can incorporate it into your own problem solving. But in my own class, it makes sense to study the problems I've given to students in the past (i.e., the archive solutions). **69.99% of your study time:**

Watching physics videos on YouTube, or the equivalent, is just a lazy, passive waste of your time and only provides an illusion of learning. There is no meaningful learning in passively watching somebody else do a problem or talk about it (which is not the point of the class lectures as has already been stated). Do you think you could learn how to play the violin by watching somebody else play? You must actively engage your intellect. Watching online physics lectures or physics demonstrations will not help you solve a single non-trivial physics problem that you've never seen before. **0.01% of your study time:**

Summary: One understands physics by applying it to problem solving. If you can't do the problems, it automatically means you don't understand the physics – no exceptions; all the given problems in this course are created to be solved if you understand how to apply the physics theory. Please don't say that you understand the theory but just can't solve problems; this is a famous illusion. If you can't solve problems, that means you don't understand the theory. Every time you solve a problem you are doing the theory; all your final answers are "derived" from the physics. At our level, problem solving and the physics theory are the same.