Syllabus Physics 21, Fall Semester 2023

https://lehigh.edu/inphy21/

Lecture
Tuesday and Thursday, 10:45-11:35, LL 270.

Recitations
Wednesday and Friday, various times

Classes meet four times a week for lectures and recitations. Lecture times are at 10:45am in LL270. Check the time For your recitation section. All students attend the lectures together, on Tuesdays and Thursdays, They then meet in small groups on Wednesdays and Fridays.

Instructor

Prof. Ivan Biaggio, LL 407
phy21@lehigh.edu
Office Hours: After each lecture, Mo and Wed from 4:25pm to 5:30pm.

Recitation Leaders / Teaching Assistants

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You'll see your recitations leaders, a.k.a your teaching assistant (TA), twice a week in small groups, and they are your primary contact. If you have questions or need more help with an assignment, ask during recitations, or get a meeting with your TA. Office hours will be set independently. Your professor's office hours are given above.

How to get help: Use the homework assignments to determine the areas where you have difficulties or are in doubt, make a list of what you don't "get", and then come to office hours or tutoring meetings. Do not just ask something like "can you give me some hints about this problem?" Determine first more precisely where you have problems when trying to solve the problem, and then ask specific questions.

Initial Competences Required for this course (what you should know already)

How to describe and predict the movement of bodies in terms of the forces acting on them. Vectors and how to use them. Writing down algebraic equations and solving them. Familiarity with derivatives and integrals, and knowing what they mean and how to use them. Knowledge of what differential equations are and how to solve the simplest ones.

Course contents (what we will teach in this course)

Electric and magnetic fields, their origins, and their effects: how those fields arise, and what they do to electric charges, electric currents, and to each other. The origin of electro-magnetic waves, how they relate to light, how light propagates through systems consisting of lenses and mirrors, and how images are formed. How electric circuits work: what happens when one uses conducting wires to connect together such elements as "resistors", "capacitors", and "inductors" in various configurations, and then sends an electric current through them.

Competences expected after this course (what you will be able to do when done)

After this course, students are expected to know what happens when charges create magnetic or electric fields, or when they interact with those fields. And to know how electric and magnetic fields create each other, and give rise to electromagnetic waves and light. Students will be expected to be able to look at an electric circuit and describe its components and their main effects, and to know what the speed of light is, how light propagates in different transparent materials, and the meaning of interference, diffraction, and other optical phenomena like total internal reflection. Finally, students will be expected to know what a diffraction grating is, how mirrors and lenses work, and how lenses and mirrors are used in optical imaging systems.

But in addition to *knowing* all those things mentioned in the above paragraph, students will also be expected to be able to *use the mathematical tools of physics* to quantitatively determine what happens in all those scenarios, calculating and predicting such things as the strength and direction of an electric or magnetic field, the magnitude of currents induced by changing magnetic fields, the currents through the various elements in an electric circuit, the intensity of light and the appearance of its interference or diffraction patters, and the location and size of images in optical systems. "Calculating" here means to derive derive algebraic expressions that describe a quantity and how it depends on other things, followed by also using numbers to arrive at a numerical result.

For example, students will be expected to be able to calculate, algebraically and numerically, the magnitude and direction of a magnetic field at a certain point in space when given a certain current distributions, or the time dependence of an electric field. As another example, students should be able to design a system that uses lenses or mirrors to form the image of an object, and to determine the light intensity pattern on a screen as it is affected by diffraction or interference. Students will be able to quantitatively determine the currents and voltages that will appear over various circuit elements as voltages are applied, currents are forced through the circuits, or switches are flipped.

Challenges and motivation

The following paragraph is from the editor's blurb about a physics book (found here). I believe this description addresses an important truth and an important difficulty. I am pasting it here without any changes:

> *In typical physics classrooms, students seek to master an enormous toolbox of mathematical methods, which are necessary to do the precise calculations used in physics. Consequently, students often develop the unfortunate impression that physics consists of well-defined problems that can be solved with tightly reasoned and logical steps. Idealized textbook exercises and homework problems reinforce this erroneous impression. As a result, even the best students can find themselves completely unprepared for the challenges of doing actual research.*
>
> (I would also add that this also applies to engineering and other fields, not just physics)

This is an introductory physics class, so we cannot avoid going through the details and teaching the toolbox, or doing the standard homework assignments (via *masteringphysics*). They are necessary to practice the ability to do the calculations, which is an important skill. But what is also necessary is to first know what certain words mean, and in general "what happens" in certain circumstances. To efficiently use the mathematical toolbox, you must also understand things in terms of simple descriptions of cause and effect, without any math. And you must learn know how the descriptions are related to certain symbols and mathematical equations. This is what the paragraph above is worrying about, and this is what will give you the flexibility to actually use the skills that you learn here in future, seemingly unrelated settings.

The important skills are then: understanding of the meaning of equations, understanding a problem by using your own sketches and drawings to understand what could happen (and develop a path to a solution) before doing any calculations, develop informed guesses of how a solution should look like, which then can be used to evaluate the correctness of calculated results. And so on. The problem is that these skills cannot be taught (or learned) directly, but need to be developed through practice. Here what you should do:

- Print out the mastering physics assignments, do the work on paper (keep those papers in folder or notebook so that you can go back to them), and only at the end copy the results into the masteringphysics forms online.
- You don't need to do every single assignment you find on masteringphysics every week, but look at all of them (but do enough of them to collect your homework points). You will then go through any problem you didn't immediately do later, while reviewing and studying..
- Do not copy the solutions to homework assignments. You won't develop the skills you need if you do this.
- Do the Learning Homework (LHW) Assignments. **Always** do at least the *Narrative* part. Write questions for you TA on the paper that you hand in with your solutions. You generally don't need to solve the LHWs completely, but attempting to do as much as you can and making a list of your difficulties is important. That's what LHWs are for.
- Look at assignment early, and start by writing down a set of questions that you can ask in recitation or that guide you to a necessary review of the material that you just learned.
- Do not read only my class summaries, or only the textbook, any other additional reading about the same topic can be useful.
- Suggestions on study techniques, deliberate practice, etc., are found later in this syllabus, and on coursesite.

Exams

This is something that will surprise you, but the exams that we do in this class do not need to be solved to a 95% level or above for you to demonstrate mastery of the subject. The exams are designed to test ***how much you can do correctly***, they are not designed to test if you can do everything correctly.

Therefore, don't be surprised if you will learn that the people got an "A" in a test by answering only maybe 60% of the answers correctly. This is not because the exams are "too difficult" or because we grade on a curve. This is because the exams are designed to offer many ways for you to show that you learned the material within the time-constraints of an exam: there is no expectation for anyone to actually do everything (but still, do look at all the questions when you do an exam. You want to exploit every opportunity to show what you can do).

Lecture, Recitations, Homework

The class plan (on coursesite) will tell you more or less what topics we go through every week. Prepare before class by having a look at the textbook, so that you know what's coming and the words used in that context. Come to class to see what the most important points are and how they fit with the rest. Go to recitation to exercise with lots of examples. Do the homework because the first step towards *understanding* is to try and solve a problem. Even if you can't do it immediately, it is the act of struggling with it that will be decisive to help you learn the material.

Bottom line

This course is taken by many students with different backgrounds and interests (see page 6). Therefore the course provides a way for students who are not too interested (yet?) to do some work and get the grade that they need, but it also provides ways for more advanced or interested students to challenge themselves, sometimes via the LHW mechanism. Continue reading on the next pages for more details, and remember to contact your TA or your Professor if you have any doubts or any questions.

REQUIRED MATERIALS AND CLASS ACTIVITIES

Course website

A quick access point to all you need is at lehigh.edu/inphy21, with a summary of how this course will work, instructions on how to sign up for *masteringphysics,* and a link to this syllabus.

CourseSite

Class material is available there.

Textbook

Randall D. Knight, "Physics for Scientists and Engineers: A Strategic Approach", 3d Edition,
We will cover chapters 20 to 37, available in the paperback as *Volumes 3 and 4.*

Note that this is an older edition, allowing you to get pre-owned printed books for cheap (less than $20 via amazon or eBay, etc). We will cover the material in chapter 20 to 37, *but not in that sequence*. In addition to this textbook, there are also plenty of free resources online, see for example https://openstax.org/details/books/university-physics-volume-2 (unit 2), or https://www.feynmanlectures.caltech.edu/II_01.html.

Mastering physics

This course will use *masteringphysics* for homework, and you must specify the above textbook when signing up. Assignments must be submitted twice a week, on Tuesday night and Thursday night. For instructions on how to sign up, go to lehigh.edu/inphy21/. Note that it is also possible to sign up for access to the electronic version of the textbook.

Class Plan

On coursesite: It lists when each activity takes place, when each topic is taught, and where it is found in the textbook.

Lecture summaries

On coursesite: I'll be posting typeset summaries of each week of lectures. You **must** read them. Print them out and mark any sections that you don't understand, to serve as reminders to read more about them, ask questions, and so on. There are wide margins to allow you to add plenty of notes and comments..

Learning homework (LHW)

On coursesite: Weekly homework assignments that are meant to stimulate critical and creative thinking and to provide a different way to learn a subject, thanks to following a pattern of "*think-struggle-work-ask-understand*". This is an important complement to *masteringphysics*. Don't do the LHW because of the homework points you can collect. Do it for the training and understanding that you receive from it, and always study the solutions (see below).

Full, detailed solutions of each learning homework

On coursesite: These are *teaching solutions*, going into details of the particular problem, with additional information and explanations. You should always look at them, even if you happen to not have done the corresponding homework.

Quizzes

Every week in the Friday recitation. These are short questions on topics that have just been taught or discussed during class or past homework. These quizzes serve to check your progress and will be further discussed in recitation.

READING MATERIAL

There are several resources that you can use to help you along. The class plan posted on coursesite details what will be discussed in every lecture, and the corresponding sections in the textbook. You will also have the "lecture summaries" mentioned above. In addition, I will provide a full, detailed solution of the Learning Homework, and if there is enough request for them, I can also write some notes about the solutions to masteringphysics problems. Sometimes solutions will go beyond what was asked in the original problems, providing more explanations on related topics.

You must make sure you read the textbook, the weekly-summaries, and the homework solutions. Reading assignments are an integral part of the course

HOMEWORK ASSIGNMENTS AND QUIZZES

On-line Homework (MP)

Masteringphysics will allow you to practice and review the material as it is being taught, and it is the system that lets you collect the largest amount of points towards the final grade. A new homework assignment will be made available on masteringphysics by each Tuesday (**MPa**, due Thursday night) and each Thursday (**MPb**, due Tuesday night the next week). Every MP homework counts on average more than *8 points*, for a total of at least 16 points each week. You don't need to answer every single questions to get the maximum amount of HW points.

Have a quick look at each assignment the day *before* recitation, so that you can ask questions if you don't understand a problem. **MPa** (the Tuesday homework) must be submitted on-line *two days* later by Thursday at midnight, so that its solution can be discussed on Friday. **MPb** (the Thursday homework) must be submitted on-line *five days* later by Tuesday at midnight, the following week, and its solution will be discussed in recitation the day after. The submission deadline is strict. The system does not allow for late submissions and late submissions won't be accepted.

Learning Homework (LHW)

The purpose of the learning homework is to stimulate critical and creative thinking and to provide an additional way to learn a topic. The aim is not even necessarily to obtain a full solution. The aim is to try to solve the problem, but get stuck somewhere, maybe fail to fully solve it immediately, but then use the experience to generate more questions and more understanding. This provides an alternative to the shorter masteringphysics problems that often give the impression that there is just a recipe that one must know. Such recipes do not exist for real problems! The learning experience in the LHW is to *attempt* to solve the problems, and see how far you can go, and then come back to them later. LHW assignments will require to hand in solutions in **two steps:**

(1) A *short narrative* in English describing (a) what you see as the physical principles that are at play in the problem, and (b) the steps you intend to take towards solving the problem, but without any calculations. Both parts, (a) and (b), are required.

(2) A *final solution*, handed in a week later, with all your algebraic calculations and results.

This system is designed to develop problem-solving skills and stimulate discussions and questions. The most difficult thing about physics is integrating what one learns about "what happens" and the math that can be used to describe it, which then allows to analyze a physical situation and develop a plan for solving a problem. The *narrative* makes explicit a key problem solving step that is often neglected but is also often the largest hurdle when starting to learn physics.

For each LHW, think first about what it is asking, what are the physical effects that come into play, and put together all ideas that you think might be useful for developing a solution. This is what you do to generate the *narrative*. Start working on a solution only after you have done that.

A learning homework assignment will be posted on coursesite at the beginning of every week.

The *short narrative* must be handed in recitation on the very next Friday. This gives you a few days to think about it and ask questions. You will get your narrative back on the following Wednesday. But in the meantime you can keep working and start developing the solution. The TAs can also discuss your narrative in personal meetings during their office hours.

The *final solution*, must be handed in recitation on the Friday of the following week (one week after you handed in the narrative). Once the semester is on its way, you will regularly hand in, each Friday, both the narrative for the new LHW, and the solution for the LHW from the previous week.

Use the fact of giving your recitation leader handwritten paper to also add any written questions you might have!

The narrative and final solution will be graded on a scale from 0 to 4 points, delivering *8 extra homework points* per week that will count towards the total homework points mentioned above. Late homework will not be accepted.

Detailed solutions of each LHW will be on coursesite at the beginning of every week. LHW solutions often go beyond what was asked. Read the solutions and compare them to what you did! It is not the responsibility of the grader to go through and find all your mistakes for you. Going through the solutions yourself and comparing to what you did is obviously an important and helpful way to learn the material.

If you find somewhere somehow a solution of any homework assignment, **do not use it**. Using it robs you of the opportunity to learn what you know and don't know, and to practice essential skills. The fact is that *we learn by struggling to do something. You need to struggle to solve a problem in order to get better at it.* Do not look at any solution before you try to do this. Also, do not waste your TA time by submitting something that is not your work**.** If you are worried about homework points towards the final grade, don't. There are enough points in masteringphysics to max that out.

Note also that the homework assignments and their solutions are useful also in case you choose to not submit your work. Just go through the solutions and try to understand them. It is better than nothing and can help you study: Look up everything you need until you understand a problem and its solution. Then hide the solution somewhere, take a new sheet of paper, and try solving the problem based on what you remember.

Quizzes

There will be one short quiz every week during Friday's recitation. Of all the quizzes, only the best 70% will count towards the 75 Quiz points that contribute to the final grade. There won't be any make-up quizzes.

A TYPICAL WEEK

w i, day 1	Tuesday	Submit MPb_{i-1}	MPa_i available	LHW_i available
w i, day 2	Wednesday			Discuss LHW_{i-1}, LHW_i, and MPa_i
w i, day 3	Thursday	Submit MPa_i	MPb_i available	
w i, day 4	Friday	Hand in LHW_i narrative	Hand in LHW_{i-1}	Quiz. Discuss LHW_i and MPb_i

EXAMS

Exams are closed book, but an equation sheet will be provided for you to print out, and you can add some short notes for yourself on it. You don't need to memorize any complicated formula.

Mid-Term Hour Tests

There will be two hour-tests that should take place according to the plan issued by the Registrar's office. There won't be any make-up tests. If you miss a test because of an accident or illness documented with the office of the Dean of Students, you will be able to substitute the grade for the Hour Test you missed with the partial grade obtained in the corresponding section of the final exam.

Final Exam

There will be one comprehensive final exam. The date and time of the final exam are set by the Registrar.

COURSE GRADING

The final grade of the course will be determined from a total number of "points" collected. These points are obtained in the two hour tests, the final exam, homework, and quizzes as follows:

Exams	300	(60 each from the two hour tests, and 180 from the final exam)
Homework	150	(accumulated by adding homework points up to a maximum of 150)
Quizzes	75	(obtained from the grades of 70% of the quizzes, the ones that got the highest grade)
Total	**525**	

Additional extra-credit points that can also contribute to the above total will be given based on attendance and participation in recitation or in lecture, at the discretion of recitation leaders and lecture instructor, but they will be limited to a maximum of 50 points.

The 300 exam points, as described above, will be determined by adding the points obtained in the two hour tests and in the final exam. The two hour tests together contribute a maximum of 120 points, and the final exam contributes a maximum of 180 points, for a total of 300.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive review process. If the documentation supports a request for reasonable accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online at https://studentaffairs.lehigh.edu/disabilities.

THE PRINCIPLES OF OUR EQUITABLE COMMUNITY

Lehigh University endorses The Principles of Our Equitable Community [http://www.lehigh.edu/~inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf]. We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

A NOTE ON ACADEMIC INTEGRITY

Academic integrity applies to all we do. See the links in the top-left corner when you enter coursesite, which opens some slides/vignettes. Don't cheat on exams or quizzes, don't copy homework assignments. Taking care of academic integrity works to your advantage. When doing homework, some nice discussions among friends are always a good way to learn, but do try to also work on the assignments alone. Always relying on help from others will work against you because it will not allow you to identify the areas where you have more difficulties.

Lehigh University Undergraduate Student Senate Statement on Academic Integrity

We, the Lehigh University Student Senate, as the standing representative body of all undergraduates, reaffirm the duty and obligation of students to meet and uphold the highest principles and values of personal, moral and ethical conduct. As partners in our educational community, both students and faculty share the responsibility for promoting and helping to ensure an environment of academic integrity. As such, each student is expected to complete all academic course work in accordance to the standards set forth by the faculty and in compliance with the University's Code of Conduct.

HOW THE VARIOUS ELEMENTS FIT TOGETHER, AND OTHER GENERAL COMMENTS

What is this really about?

Many different students take this course. Some of you may be interested in physics. Some of you may have to take this course as a prerequisite and don't see the reason why. Some of you may hate the fact of having to take physics. Others may love it. Maybe you will encounter some problems (especially as part of the learning homework) that seems to be too esoteric or appear to be totally useless to you. Or you may find problems that seem too easy or boring. There may be some of you who will only be interested in their grade, or a few who don't care too much about the grade but just want to be done with this course and move on to other things. Some others will be happy to learn something about how the universe works, others won't care, and others will see value in learning the techniques.

Because of the diversity of interests in the students taking the course, we need to cover all backgrounds. What I will try to do with this course is help everyone, no matter what their aim is: *give something to the physics lovers to go beyond what's in the standard textbooks, while separating out that material so that it does not bother other students*. Provide a structure that allows to get a decent grade even if not a physics fan – *if willing to do some work and learn something*.

But most of all, the important question is what will remain after the course is over at the end of the semester.

One thing is the ability to *calculate and solve problems*. This is a valuable skill that will be useful whatever you do in the future. Such a skill is built through *practice*. It is the same as in music or in athletics. Practice is what allows you to master something, and developing problem-solving skills requires doing many problems. There is no other way. We help you to do this by providing homework assignments and discussing them with you.

Another thing that could remain is the *knowledge* of some things that happen in the universe and an *understanding* of how they work (or how one can use them to do something new). This kind of understanding and knowledge is achieved only by acquiring the ability to see how things are related to each other. Imagine that what we will learn is represented by some big photograph. It is possible to go through a course like this one and only do the equivalent of analyzing some selected clusters of pixels and their colors. But you must also learn to take a step back, see the whole picture produced by all pixels together, and how different parts relate to each other. It is important to achieve this ability to see the whole picture, while at the same time we also work on details. This is what is very difficult to achieve by just reading a textbook sequentially, and where my role in the lectures and in the design of the course comes in. I will take a spotlight and illuminate the various parts of the picture and guide you through it. While doing so I'll highlight which parts of the big textbook we must use are really important, and help you distinguish them from the parts that are just additional descriptions or examples.

The ultimate aim is not just to be able to solve problems in a test. It is to obtain some background knowledge and some work habits and strategies that will be useful later on, for those who may keep taking physics course, but also for those who will go into engineering or other fields. Basically, this course contributes to the foundations of a house that you cannot see yet, which makes it harder, but you need the foundations to build a beautiful house.

The work that needs to be done

It is important to realize that this is a fast-paced course which does require a lot of work. ***The rule of thumb is that for every credit hour you need to work three credit hours on your own***. This course is a 4 credit course, and therefore it is totally normal and expected that you work an **additional 12 hours a week** to learn all the required material and keep up with the coursework. It is critical that you digest the material presented during one week before the next week starts.

The material to be learned in this course will come from multiple sources (lectures, recitations, textbooks, homework, reading-assignments). **Lectures** will serve to introduce new concepts and as a guide to the connections between different topics. They will also highlight the most important ideas. **Recitations** will go through many examples, and they are the place where you ask questions and exercise problem-solving. Homework assignments solidify what has been introduced in lectures by allowing the students to apply the concepts and techniques they just learned.

Do not just read the textbook, do not just come to class: this course is designed for you to learn the material through a combination of all the activities described above. *In other words, the lecture and the other activities are integrated. I designed how the material that you will learn is transmitted to you via lecture, recitations, reading assignments, various kinds of homework assignments, the corresponding solutions, and the examples discussed in class.*

Therefore, to profit from this course you must do everything. Sometimes it is useful to introduce a new concept in a homework, other times this happens in a reading assignments or in class.. Sometimes we calculate through an example in class, but often you should do your own math, working through examples outside of class. Our limited class time is better used for explaining and connecting concepts instead of detailed number-crunching.

At the end of the course, **students will be expected to know the material that is exercised in the homework and that is presented in the corresponding chapters of the textbook even if it is not explicitly discussed in class**. It is worth stressing that, given the time-constraints, it is impossible for me alone to tell you everything that you need to learn in lectures, but I can guide you by highlighting the most important things.

REPEATING SOME ADVICE, AND MORE DETAILS ABOUT HOW TO LEARN

You cannot learn physics without doing lots of independent homework, in particular problem solving. It's the practice of using the concepts that makes you learn and understand them.

Practice problem solving

Getting into the habit of needing "hints" or any other initial help on a homework assignment before trying to do it yourself **is the absolute worst thing you can do**. The most difficult part of solving a problem is finding the right path to work through it. That's what you need to exercise (the *narrative* that is part of the weekly learning homework is meant to help with this).

The basic trap many people fall into because of various reasons, including former training and the way people are tested in school, is the big bear trap of thinking that knowing the material is equivalent to solving the standard problems, with the associated belief that in order to solve a problem one needs to find and use a particular formula or a specific recipe.

This doesn't work. This has never worked. This will not work in any real-world future activity you will engage in in the future. The very first thing you need to do to solve a problem is visualize it, **make a sketch** of what is going on, or what you think may happen, decide what basic principles can be used to understand the issues, set up some basic relationships, *and then, once you have an idea about what to do*, start thinking about techniques or equations. Equations are the mathematical description of a *relationship*. Don't look for formulas with the thing you are interested in on the left-hand side. Also, when solving any problem, use algebra for as long as you can. At the end you will get a formula that represents your solution, but it will be an algebraic expression that you derived yourself. Only plug-in numbers at the end.

Lecture plan and textbook

My advice is not just to read a textbook sequentially. Instead, read end-of-chapter questions or summaries, and then keep going back to the textbook over and over again to look for explanations and details. Read the questions at the end of the chapters, and then go back to look for information based on what you can answer and what you can't. In this class I will follow an optimized path through the material, described in the plan made available on coursesite. This path has been designed to highlight the relationships that may not be seen just by following the textbook sequentially. A counterintuitive advantage that follows from this is also that the reading assignments will not be necessarily sequential, which will help you access the book in an efficient way, and get a feeling of the different ways each topic or physical effect can be associated together. This will in turn be very helpful for general understanding, and will make you better at solving problems because it trains you in seeing relationships. But in addition to the textbook, do also consider any other source material that you can find, from openstax, to wikipedia to anything else that you might find useful (see the last section below).

Homework points that count towards your grade

Homework points can be collected towards the *150 homework points* that count for the final grade. Do the math: two MP assignments each week of at least 8 points each give (at least) *16 MP points per week*. Over 12 weeks this already gives 192 points. In addition, the LHW provides up to 8 points per week, that is up to 96 points over 12 weeks. So you can collect 288 points thanks to the very minimum of points made available each week from both MP and LHW homework, but you only need 150 to maximize the homework contribution to the final grade. In addition to this, the MP assignments will always have some short questions to quickly collect points, and I will also generally provide more than 8 points for each MP assignment. This means that it won't be an issue if you miss out on one homework because you are sick or because of any other problems, and it also means that you don't have to stress to do every single problem or question that is offered in each weekly homework assignment! You can look at them later. The HW is for learning.

Note that the LHW counts towards only 8 of the 24 (or more) weekly homework points you can collect. You should do it because it is promotes understanding and discussion, and will help you in the long run. So it is not a big deal if you don't solve it completely, but you must try to do as much as you can, and there will be solutions to discuss. Some LHW assignments will have some more challenging parts that are attractive to the most interested students, but they are also useful as review materials and alternative explanations for all students.

Copying

In addition to the academic integrity issues, copying your homework is a guaranteed way to *not* learn the material and to get a bad final grade. And I'd also repeat to **not go look for "hints" about solving problems. You must exercise finding your own way to the solution of a problem.** *There are no "hints" in exams on in real problems* you may face later on. If you go to tutoring ask a tutor if you need help in understanding what the homework is about, but try doing the problems alone first!! Going to a tutoring class where they give you a recipe for solving a problem that lets you skip the step of actually finding the way towards a solution will leave you with only the math to complete. Working like this defeats the purpose of homework and will work against you in the tests and in anything else.

Also, I must underline that I am not policing you trying find old versions of homework that come with solutions, or some other pre-made, pre-canned solution. But you **will** be worse off if you do it. Same story: if you copy, you will not learn problem-solving, you will miss important practice, and you will not absorb the material and skills. If somebody gives you an old version of a homework with solutions, ignore them or store them for future checks, and try to attack the problem yourself first. If you have troubles, look for info in the textbook, describe your difficulties to your TA, come ask questions.

Additional ways to help you learn

To develop a general understanding where relationships between sub-topics start to emerge, it is necessary to develop an understanding of how things "work" in general terms, of how different effects are related to each other, or can be described in a similar way, etc. This is the "learn what happens" part. I will try to give an intuitive feeling in the lecture whenever I can, but you should also look for other sources beyond our classes or the textbook. You can find lots of things just on the web. Or there are popular science descriptions that will give you a good background about what we will do without using a single equation. There are many resources like this, from newspaper or magazine articles to books. As an example, a cheap, short, well-written booklet that you can look at is Asimov's *"Understanding Physics: Volume 2: Light, Magnetism and Electricity,"* which is available for something like $5 (check on-line).

How to practice physics

In many areas, it has been shown how "deliberate practice" can be essential, and the following is what I think is a good way to implement it when studying physics. Clearly, everyone needs to find their own way, and some things may work better for you than others. But the suggestions below should still be useful.

I suggest **four activities** that all start by looking at old questions and problems. These activities can be done while studying, or in addition to anything else you normally like to do. Which one of these activities you keep doing depends on your personal needs. Here a list, ordered according to the time they require, from least time to more time:

1. Look at old questions/problems and see if you understand the question. ➡ If you don't, or if there is one word you don't understand, look up the material in the textbook and check what it is that you are missing.
2. Look at old questions/problems and see if you understand what are the physical principles that you could use. ➡ If you cannot do this, look up the material in the textbook and find out what you are missing.
3. Look at old questions/problems and see if you can plan how to solve them without actually doing so. ➡ If feel you are missing something, or you are confused about which path to take, look up the material in the textbook or elsewhere. At this stage, if you don't plan to go to try to (4), you can check the solution.
4. Look at old questions/problems and solve them. ➡ If you encounter problems along the way, go back to the textbook and other similar examples to see where the difficulty is. Once your solution is done check it against the solutions that are available. See if you did it right. Understand your mistakes, and why you made them, or what the correct way would have been. Go back to textbook or other materials to get help.

The idea is to build up from (1) to (4), but to do (1) quickly many times before doing (2), and then do (2) many times before doing (3), and so on. This method is makes efficient use of time: it is better to dedicate whatever available time you have to look at more problems as described in points (1) to (3) without calculating a full solution, when compared to the alternative of always trying to solve a problem; because the latter automatically means that you can look at fewer problems. Using this method will also ensure that you are not missing out on some important piece of knowledge or definition. To implement these steps, use the conceptual questions in the book, use any of the problems there, use the additional exercise packs, use old masteringphysics problems, or use old learning homework assignments and their solutions.

Here is what I expect to happen: at the beginning, if your knowledge of the material still needs to be built up, you will find yourself doing point (1) over and over again. Keep doing (1) until you don't need to go back to the textbook or other material anymore and then move to (2). Students with less knowledge-gaps will move quicker to (2). Keep doing (2) until you see that you don't need to go back to other material anymore. Then do (3) and see if the plan you come up with is the one that makes you confident that you can work this out, and exercise doing (4) for some problems.

Once you are further along in your studying, doing points (1) or (2) will take no time at all, and doing point (3) will also become faster.

Note that this is not about doing less problem solving (point 4). It is about doing the same amount of problem solving, but then *deliberately* building up the skills that are part of points (1) to (3) and that are often neglected when studying because standard solutions often focus too much on the math and too little on the physical understanding that allows to arrive at the correct algebra in the first place.

Important: The above only works if you try to answer those questions, and do those problems by yourself. Only after you have tried by yourself (in the variants described in points 1 to 4 above), go seek help or maybe do some of the activities with a colleague. But you can't find out about what you really do not understand if you do not exercise facing those challenges alone.

Naturally, the activities listed above also serve as a springboard to dive into the book (and any other material that helps you), which, as I am sure I already said, is much better than just reading the textbook sequentially.