How to Study Physics

Physics is ***supposed*** to be hard. But that it requires genius is a myth. It just needs a bit of talent, and a lot of work. Tough material in a physics lecture often comes rapidly. You often won't fully understand what's being said. Mark your notes with a "**?!**" to ponder later.

Physics lectures are hard to follow because ***physics is abstract.*** Items in a typical biology or economics lecture often connect more smoothly to familiar concepts. But the abstract concepts of physics don't readily associate with the everyday items in your memory. Here's advice for dealing with this abstraction. (It's solidly based on pseudo-neurology.)

Before coming to a physics lecture look over the relevant text. Ideally, study it, but if that's not in the cards, at least read it. Looking at the equations and diagrams and briefly musing on new terms is extremely worthwhile--***even if you don't quite understand.*** This vague information ricochets around in your brain entangling with memories already stored there. Later, when these concepts show up in the lecture, some synapses recognize them--and, excited by the familiarity, hold tightly.

Sometimes in physics, an explanation may follow so reasonably that you happily nod, **"Uh huh,"** at each step. At the end of a derivation or a worked example, you might think you understand it--and that you will remember it. But wait ten minutes and then try to repeat the example without looking back. Odds are 5 to 2 that you'll get stuck. Why? Because physics is abstract, you made very few mental associations with the physics concepts you read. The information may well be in your head, but you just can't access it.

Should you now look back to see how the problem was done? ***Don't!*** You'll just "uh huh" your way through the argument once again, and you'll likely not recall it the ***next*** time you need it.

Scanning your brain for a bit of lost information is not a rational search. You jump haphazardly from one memory site to another. If you're lucky, you stumble on a site associated with what you're looking for, and you can then follow that clue. But since physics is abstract, few associations form automatically—as they may in, say, biology or economics. You thus rarely stumble on a memory connected to the piece of physics information you're seeking—because there are so few of them. It would be better if that physics information were entangled with ***many*** items in your memory. Then the likelihood of stumbling on such an associated one would be high. How do you achieve that?

(Over please.)

Here's the trick: When you're stuck, ***don't*** look back at the book. Make your brain ***struggle***! Even if you ***know*** you won't find the answer. At this point, struggling is the end in itself. Your search will poke at many possibly relevant neurons. That excites them; their synapses begin to wave furiously. (It's a mildly painful experience.)

And while you're doing this, ***focus*** your search. The best way to find a needle in a haystack is to think hard about just what a needle in the hay would look like. Ask yourself: "Exactly what is it that I don't understand?" Tell yourself as precisely as you can just what you need to know. Imagine a friendly expert on the phone; what physics question would you ask?

After ***at least*** ninety seconds of such intense exertion, go ahead and look up the answer. At this point, when you see it, you won't nod "Uh huh." It will be "**Ah hah!**" And now all those random synapses you caused to wave furiously will latch onto this physics item. The correct reasoning now entangles with a vast number of your stored memories. Next time you search for this concept, just get anywhere in the neighborhood, and one of these entangled synapses will clue you towards it.

Psyche yourself up to feel a burst of pleasure with that "Ah hah!" (It should be at least as enjoyable as stopping banging your head against a wall.)

After you figure out how to solve a problem you had trouble with, try to figure out the generic nature of your difficulty. Did you not read the stated problem carefully enough? Maybe you started without a careful reading of the relevant text material or your lecture notes. Or did you not have a systematic enough approach, i.e., did you write down the relevant fundamental equations and list the known and desired quantities? If you find the same generic problem repeating itself, you will discover what in your approach needs adjusting.

You will, of course, do a lot of studying alone. But a great way to develop a clear understanding of something in physics is to explain it to someone else. In physics you often get hung up on small but crucial points, but since one person's hang-up is usually not the other's, people working ***together*** can make rapid progress. It can even be fun. Find some compatible study companions. ***And make use of discussion sections and office hours!*** Physicists at all levels do much of their work in groups. Much more so than many other disciplines. Physics is a social science.

Finally, for some unfortunate people (including me) the process of learning will always be painful. We make up for it by especially enjoying the understanding.

Four tips on studying for a physics exam

1) A good way to study for an exam (in any course) is to make up a reasonable exam yourself. It's *not easy* to select a set of problems that the hard-working good student can do well at, that are also hard enough to foil a non-working student, and that emphasize the major points of the course. Trust me! The exam you make up is very likely to be close the one you will actually get.

2) After completing a homework problem or question with the aid of the book, wait at least 20 minutes, and, on a blank sheet of paper, do it again *without* the book or your previous solution. If you need to look back at the book or your previous solution, repeat the above process.

3) Suppose you've just understood a tricky point on a homework problem or in the text, and you want to remember it. Draw a little sketch, even a meaningful doodle. Then close your eyes for at least a *full 30 seconds* and concentrate on associating the picture with the concept. It works amazingly well—in *any* subject.

4) Get a good night's sleep. Psychology experiments show that loss of sleep the previous night does not *severely* affect activities that mainly require memory. But sleep loss severely affects activities that require logic.