The Blank Page

or

How to Succeed in Physics With Only a Reasonable Amount of Trying

If you have problems in this class because you don't attend or pay attention in lectures, don't do the problem sets or labs, or otherwise don't do what you know is expected, then of course the best advice I can offer is to start doing those things. This brief essay is directed at what I expect is the vast majority of the class: those of you who are willing to put in a substantial but not a heroic amount of time, but are concerned that you will still struggle with the material.

At every level of physics I have taught, from introductory mechanics to advanced quantum field theory, I have had students come to me with some version of the following problem:

> When I'm sitting in the lecture, when I'm reading the book, and when I'm working on the problems with my friends, I understand everything perfectly. But when I get to the exams, even though I have studied for hours, I just freeze up; I don't know where to start on the problem. Once I see the solution I understand it, but I can't get going on the spot.

I call this problem the Blank Page. I'm sure it exists in the other sciences and throughout the liberal arts, but in physics it is particularly pronounced. Many students wrongly conclude that this problem indicates that they are just "no good at physics." As someone who is pretty good at physics, I can tell you this is not the case. This problem is intrinsic to the subtle process by which our brains process and understand knowledge. We all face it. It's how we're wired.

So how will you conquer the Blank Page? I offer some specific techniques below, but what they all have in common is they are *active*: they do not necessarily require putting any more time into the course, but they do require replacing time you spend passively, following along someone else doing physics, with time you spend actively, doing physics yourself. So let's go down the list:

Lectures and TA sessions: Here in a big, comfortable lecture hall it's tempting to sit back and nod along as the class goes by. It all makes sense at the time, but the next day it's gone. Clearly, the first advice is to take notes. To get the most out of those notes:

- Treat your notes as if you are going to have to use them to explain the subject to someone else. Don't just record the information, but instead explain it back to yourself.
- Express everything in your own words as much as possible. (Multilingual students often have success taking notes in a different language from the lecture!) **Don't** mechanically copy down what's on my overheads. (I make these available to you anyway.) Decide for yourself what's important and write that down.
- Take a few minutes after class to review your notes. While the lecture is still fresh in your mind you can probably fill in some details you missed.
- **Ask questions.** If you have been paying attention in lecture and find that something is confusing you — that is, you can't explain it clearly back to yourself in your own words — it is almost certainly confusing many other students as well. Many are too proud or shy to speak up. Don't be! Students who ask questions help me improve the lecture and help themselves by being engaged in the class. Being good at physics does not mean immediately understanding new concepts. It does mean actively processing those concepts and confronting the parts that are confusing. Students who ask questions and are unafraid to appear "stupid" consistently end up among the best performers in my classes.
- Taking such careful notes you will undoubtably find that you missed some parts of the lecture. This is fine — just leave a blank space and a reminder to go back and fill it in later. This is a great benefit of your active notetaking — you've already structured your study time because you've identified the parts you need to review more closely.

Readings: Students often spend far too much time "studying" the book. I don't give set reading assignments because you don't need to "do the reading" for this course. Rather, you need to draw on the book for guidance in completing problem sets and labs.

- I don't recommend that you read the book like a novel from cover to cover. Instead, read it like an encyclopedia. Formulate questions: "How do I find the electric field from the potential?" or "What is an example of the use of Gauss' law to find the electric field?" and then use the book, along with TAs and me, as a resource for finding the answer.
- One good use of the book is to help fill in those blank sections from your notes.

Problem Sets and Labs: This is the most important section, because **doing problems sets and labs is where you actually learn to do physics.**

- **If you practice taking on the Blank Page, you will get better at it.** If you treat assignments and labs like exam questions — for which you have to struggle to find a direction to get started and then move forward step by step — you will do better on the exams. Just reading over examples, problems and solutions will not build this skill. It just doesn't activate the right neurons.
- Students often say, "I looked at this problem and had no idea how to find the answer." My response is usually, "OK, but can you figure out *something* you didn't know before? Does that lead you to something else?" Very often these steps will give a solution to the problem before the student has even realized it. This approach is nothing to be ashamed of — the power of physics lies exactly in its ability to take us to a consequence we didn't anticipate by using a series of small steps, each of which we do understand.
- It's tempting to go "formula fishing," where you try to solve a problem by hunting through all the formulae in search of one that will help you. Don't do it. There are a *lot* of formulae in this course, most of which are only applicable or relevant in certain situations. Instead, first figure out the physical relationship you would like to know, and then you can see if you have a formula for it. Along the same lines, while it's fine to refer to worked examples to help you through a problem, solve each problem on its own — don't try to force it into the exact same pattern as another example, because it might genuinely require a different path of logic.
- Working in groups can be good or bad, depending how you do it. The first time you struggle with problems, discussions with others are a great way to get unstuck and build understanding. But if you are dependent on others to push you along, you are going to be lost on the exams. To get the most out of group work (and to stay on the right side of the law):

  1. Think about all the problems thoroughly on your own first, before consulting others.
  2. As in lectures, reprocess everything in your own terms and ask questions.
  3. Separate discussions from writeup. Discussions should serve to get you moving, but once you "get the idea" you should be able to produce the solution on your own. If you find you need to take down extensive notes on your discussions with your peers, you are probably too reliant on their leadership.

- When you get problem sets back, go through what you did wrong. Where you have mistakes, use the solutions to get on the right track, but then write out a corrected version of the problem without referring to the solutions.

I hope I've given you some specific strategies you can try out from the start. Not all will work for everyone, of course. But remember that learning is a very mysterious process, and even though much of what I'm suggesting might seem banal or pointless, it might just work better than you expect.