Preface

Students: if this is too long, at the very least read the last four paragraphs.

Page ID 22630

Thank you! For many years Eric Mazur's Principles and Practice of Physics was the required textbook for University Physics I at the University of Arkansas. In writing this open-source replacement I have tried to preserve some of its best features, while at the same time condensing much of the presentation, and reworking several sections that did not quite fit the needs of our curriculum: primarily, the chapters on Thermodynamics, Waves, and Work. I have also skipped entirely the chapter on the "Principle of Relativity," and instead distributed its contents among other chapters: in particular, the Galilean reference frame transformations are now introduced at the very beginning of the book, as are the law of inertia and the concept of inertial reference frames.

Over the past few decades, there has been a trend to increase the size of introductory physics textbooks, by including more and more visual aids (pictures, diagrams, boxes...), as well as lengthier and more detailed explanations, perhaps in an attempt to reach as many students as possible, and maybe even to take the place of the instructor altogether. It seems to me that the result is rather the opposite: a massive (and expensive) tome that no student could reasonably be expected to read all the way through, at a time when "TL;DR" has become a popular acronym, and visual learning aids (videotaped lectures, demonstrations, and computer simulations) are freely available everywhere.

Our approach at the University of Arkansas, developed as a result of the work of Physics Education Research experts John and Gay Stewart, is based instead on two essential facts. First, that different students learn differently: some will learn best from a textbook, others will learn best from a lecture, and most will only really learn from a hands-on approach, by working out the answers to questions themselves. Second, just about everybody will benefit from repeated presentations of the material to be learned, in different environments and even from slightly different points of view.

In keeping with this, we start by requiring the students to read the textbook material before coming to lecture, and also take an online "reading quiz" where they can check their understanding of what they have read. Then, in the lecture, they will have an opportunity to see the material presented again, as a sort of executive summary delivered by, typically, a different instructor, who will also be able to answer any questions they might have about the book's presentation. Additionally, the instructor will directly test the students' understanding by means of conceptual questions asked of the whole class, which are to be answered using clickers. This prompts the students to think harder about the material, and encourages them to discuss it on the spot with their classmates.

Immediately after each lecture, the students will have a lab activity where they will be able to verify experimentally the concepts and principles to which they have just been introduced. Finally, every week they will have an "open response" homework assignment where they get to apply the principles, mathematically, to concrete problems. For both the labs and the homework, additional assistance is provided by a group of dedicated teaching assistants, who are often able to explain the material to the students in a way that better relates to their own experience.

In all this, the textbook is expected to play an important role, but certainly not to be the students' only (nor even, necessarily, the primary) source of understanding or knowledge. Its job is to start the learning process, and to stand by to provide a reference (among possibly several others) afterwards. To fulfill this role, perhaps the most essential requirement is that it should be readable, and hence concise enough for every reading assignment to be of manageable size. This (as well as a sensible organization, clear explanations, and a minimal assortment of worked-out exercises and end-of chapter problems) is what I have primarily tried to provide here. A student who wants more information than provided in this textbook, or alternative explanations, or more worked-out examples, can certainly get these from many other sources: first, of course, the instructor and the teaching assistants, whose essential role as learning facilitators has to be recognized from the start. Then, there is a variety of alternative textbooks available: the best choice, probably, would still be Mazur's Principles and Practice of Physics, since it uses the same terminology and notation, introduces the material in almost the same sequence, and has tons of worked-out examples and self-quiz conceptual questions. That book is available on reserve in the Physics library, where it can be consulted by anybody. If a student feels the need for an alternative textbook that they can actually take home, one option is, of course, to actually buy Mazur's (which is what everybody had to do before); another option is to explore other open-source textbooks available online, which have been around longer than this one and benefit from more worked-out exercises and a more conventional presentation. One such book is University Physics I.

Finally, there are also a large number of other online resources, although I would advise the students to approach them with caution, since not all of them may be totally rigorous, and some may end up being more confusing than helpful. Some of my students have found the Khan Academy lectures and/or the “Flipping Physics” lectures helpful; I personally would recommend the lectures of Walter Lewin at MIT, if only for the wide array of cool demonstrations you can see there.

One last word, for the students who may have read this far, concerning the use of equations and “proofs” in this book. It is essential to the nature of physics to be able to cast its results in mathematical terms, and to use math to explain and predict new results; hence, equations and mathematical derivations are integral parts of any physics textbook. I have, however, tried to keep the math as simple as possible throughout, and I would not want a lengthy mathematical derivation to get in the way of your reading assignment. If you are reading the text and come upon several lines of math, skim them at first to see if they make sense, but if you get stuck do not spend too much time on them: move on to the bottom line, and keep reading from there. You can always ask your instructor or TA for help with the math later.

I would, however, encourage you to return, eventually, to any bit of math that you found challenging the first time around. Do try to go through all the algebra yourself! I have occasionally skipped intermediate steps, just to keep the math from overwhelming the text: but these are typically straightforward manipulations (multiplying or dividing both sides by something, moving something from one side of the equation to the other, multiplying out a parenthesis or, conversely, pulling out a common factor or denominator...). If you actually work out, on your own, all the missing steps, you will find it’s a great way to improve your algebra skills. This is something that will make it much easier for you to deal with the homework and the exams later on this semester—and for the rest of your career as well.