The Theoretical Minimum

Countless people are interested in learning physics on their own, but the advice they get on the internet is often poor. Many compilations of resources or advice are decades out of date, or reflect the author's idiosyncratic preferences, or worst of all, are merely a vehicle for showing off how many obscure books the author has heard of. That's a shame, because there's no secret to learning physics. You can get a deep understanding of it by working through a small set of canonical textbooks.

The Undergraduate Minimum

The following books are well-written and beloved by students. They are particularly useful for self-studying students because they are self-contained, anticipate possible misconceptions, and most importantly, contain lots of good problems. If you work through them, doing many of the problems on your own, then you'll know the core content of an undergraduate physics degree.

1. Any introductory calculus-based physics book, as listed here. They're all about equally good, so just get any one that's reasonably common.

2. *Classical Mechanics* by Taylor. The smoothest introduction to intermediate mechanics, with thorough explanations and lots of problems of varying difficulty. Can be started with only ordinary calculus background, with the required vector calculus gradually introduced.

3. *Thermal Physics* by Schroeder. An extremely clean, focused, and clear introduction. Requires exposure to multivariable calculus, e.g. the multivariable chain rule and multiple integrals.

4. *Introduction to Electrodynamics* (4th edition) by Griffiths. The best book for undergraduate electromagnetism by a huge margin. Achieves the almost impossible combo of being required for just about every course on the subject, yet still beloved by its readers. Starts with an excellent crash course on vector calculus, assuming the reader only knows ordinary calculus.

5. *Introduction to Quantum Mechanics* (3rd edition) by Griffiths and Schroeter. The most accessible introduction to quantum mechanics, assuming only ordinary calculus and introducing a little linear algebra when needed. It is built around a core of elementary exercises, meant to help the student gain intuition, and also has a rich variety of harder problems.

Upper division students often loudly complain about these books to signal that they've used more "hardcore" books, such as Landau and Lifshitz for mechanics and Shankar for quantum mechanics. These are also great books, but not as suitable for self-study because they omit context a beginner needs, lack rich practice problems, and take mathematical background for granted. Like any book, reading them will certainly enrich your understanding, but I recommend mastering the books above first. After you do, they'll be easily approachable if you want to read them.

Note that the four books I recommend above are *exactly* the same as those recommended in Susan Rigetti's excellent guide. This isn't a coincidence: there really is widespread consensus among physics students that these are great books to start from! If somebody tells you, in the 2020s, that you should avoid all of them, chances are that the author is trying to sell you something. Sometimes, it's a personal worldview, like the idea that learning should be unnecessarily hard to "count", or that others should slavishly follow the same inefficient path they took. Other times, it will be a homecooked theory of everything, which poisons your understanding of real physics.

Electives

Here are some excellent, gentle first books in several subfields of physics. None of them will get you all the way, but once you finish one, you'll have a clearer idea of what to do next. All of them should be readable after completing the undergraduate minimum.

- Astrophysics: *An Introduction to Modern Astrophysics* by Carroll and Ostlie.
- Cosmology: *Introduction to Cosmology* by Ryden.
- Condensed matter: *The Oxford Solid State Basics* by Simon.
- Continuum mechanics: *Physics of Continuous Matter* by Lautrup.
- Complexity theory: *Nonlinear Dynamics and Chaos* by Strogatz.
- Particle physics: *Introduction to Elementary Particles* by Griffiths.
- Plasma physics: *Introduction to Plasma Physics* by Chen.
- Quantum computers: *Quantum Computation and Quantum Information* by Nielsen and Chuang.
- String theory: *A First Course in String Theory* by Zwiebach.

The Graduate Minimum

A graduate degree in physics typically begins with seeing all the undergraduate material again, but at a higher level. In this context, there's a standard set of recommendations based on the books that boomers used when they went to graduate school. I think most of these "classics" have been improved upon by more modern sources, written in this century. Today's sources are simultaneously deeper, more relevant to current research, and easier to understand. My recommended list is:

6. *Modern Classical Mechanics* by Helliwell and Sahakian. (Improved version of Goldstein.)
7. *Modern Electrodynamics* by Zangwill. (Improved version of Jackson.)

   Jackson's book is excellent and thorough, and has been the standard since the 1960s. However, professional physicists have always complained that it skips a lot of steps. Moreover, I think its selection of topics is somewhat out of date. The beginning of the book covers boundary value problems in great detail, but most physicists today would just use a computer instead. The end of the book covers topics which are essentially only important to those building particle accelerators. Zangwill's new book improves on all of these aspects. It has more discussion of how equations are derived and what they mean, and replaces extended discussion of very specialized topics with glimpses into how electromagnetism is used across all of physics.
8. *Statistical Physics* (two volumes) by Kardar. (Improved version of Pathria/Huang/Reif.)
9. Quantum Mechanics lecture notes by Littlejohn. (Improved version of Sakurai.)

   In the 1980s, Sakurai's text was the most complete and modern one of its kind, causing it to become the standard in American graduate courses. But tragically, Sakurai passed away before completing even a rough draft, so the rest of the book was filled in by assistants working off his handwritten notes. This led to hundreds of "bugs" throughout, like nonsensical problems, undefined or ambiguous notation, and dubious explanations, many of which remain in the 3rd edition 35 years later. By contrast, Littlejohn's notes have been refined over decades of teaching graduate quantum mechanics at Berkeley, and every aspect of them is perfectly clear.

Further Specializations

Students often ask for a list of books to read to be totally "prepared" for research, but this is misguided: even within a subfield (such as particle physics), the answer depends entirely on the research problem you end up working on. There's too much in each subfield for any one person to learn. The right path is to master the fundamentals above, then get a research mentor who will direct you to an interesting problem, and help you figure out what you need to learn to attack it.

Alternatively, if you don't intend to do research in physics, and only want to study it for fun, then the right path forward is to figure out precisely why you're going to the trouble of doing so. Are you fascinated by the story of physics as a science? If so, you're well-prepared to read about the history of physics, either through the works of historians or directly from the primary sources. Do you enjoy the struggle of cracking tough problems? You can find many more such problems throughout the literature, or you might want to start formulating and solving your own. Do you just want to know what's going on at the research frontier? The next time you see a mindblowing but vague news article about the latest breakthrough, you'll be prepared to go right to the source and see for yourself. The "minimum" knowledge above will not be enough to understand *any* of those papers immediately, but it will be enough for you to figure out how to learn the parts you're missing in a reasonable amount of time. The foundation is set.