

For 50 years, physics students have enjoyed learning about electricity and magnetism through the first two editions of this book. The purpose of the present edition is to bring certain things up to date and to add new material, in the hopes that the trend will continue. The main changes from the second edition are (1) the conversion from Gaussian units to SI units, and (2) the addition of many solved problems and examples.

The first of these changes is due to the fact that the vast majority of courses on electricity and magnetism are now taught in SI units. The second edition fell out of print at one point, and it was hard to watch such a wonderful book fade away because it wasn't compatible with the way the subject is presently taught. Of course, there are differing opinions as to which system of units is "better" for an introductory course. But this issue is moot, given the reality of these courses.

For students interested in working with Gaussian units, or for instructors who want their students to gain exposure to both systems, I have created a number of appendices that should be helpful. Appendix A discusses the differences between the SI and Gaussian systems. Appendix C derives the conversion factors between the corresponding units in the two systems. Appendix D explains how to convert formulas from SI to Gaussian; it then lists, side by side, the SI and Gaussian expressions for every important result in the book. A little time spent looking at this appendix will make it clear how to convert formulas from one system to the other.

The second main change in the book is the addition of many solved problems, and also many new examples in the text. Each chapter ends with "problems" and "exercises." The solutions to the "problems" are located in Chapter 12. The only official difference between the problems

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and exercises is that the problems have solutions included, whereas the exercises do not. (A separate solutions manual for the exercises is available to instructors.) In practice, however, one difference is that some of the more theorem-ish results are presented in the problems, so that students can use these results in other problems/exercises.

Some advice on using the solutions to the problems: problems (and exercises) are given a (very subjective) difficulty rating from 1 star to 4 stars. If you are having trouble solving a problem, it is critical that you don't look at the solution too soon. Brood over it for a while. If you do finally look at the solution, don't just read it through. Instead, cover it up with a piece of paper and read one line at a time until you reach a hint to get you started. Then set the book aside and work things out for real. That's the only way it will sink in. It's quite astonishing how unhelpful it is simply to read a solution. You'd *think* it would do some good, but in fact it is completely ineffective in raising your understanding to the next level. Of course, a careful reading of the text, including perhaps a few problem solutions, is necessary to get the basics down. But if Level 1 is understanding the basic concepts, and Level 2 is being able to *apply* those concepts, then you can read and read until the cows come home, and you'll never get past Level 1.

The overall structure of the text is essentially the same as in the second edition, although a few new sections have been added. Section 2.7 introduces dipoles. The more formal treatment of dipoles, along with their applications, remains in place in Chapter 10. But because the fundamentals of dipoles can be understood using only the concepts developed in Chapters 1 and 2, it seems appropriate to cover this subject earlier in the book. Section 8.3 introduces the important technique of solving differential equations by forming complex solutions and then taking the real part. Section 9.6.2 deals with the Poynting vector, which opens up the door to some very cool problems.

Each chapter concludes with a list of "everyday" applications of electricity and magnetism. The discussions are brief. The main purpose of these sections is to present a list of fun topics that deserve further investigation. You can carry onward with some combination of books/internet/people/pondering. There is effectively an infinite amount of information out there (see the references at the beginning of Section 1.16 for some starting points), so my goal in these sections is simply to provide a springboard for further study.

The intertwined nature of electricity, magnetism, and relativity is discussed in detail in Chapter 5. Many students find this material highly illuminating, although some find it a bit difficult. (However, these two groups are by no means mutually exclusive!) For instructors who wish to take a less theoretical route, it is possible to skip directly from Chapter 4 to Chapter 6, with only a brief mention of the main result from Chapter 5, namely the magnetic field due to a straight current-carrying wire.

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The use of non-Cartesian coordinates (cylindrical, spherical) is more prominent in the present edition. For setups possessing certain symmetries, a wisely chosen system of coordinates can greatly simplify the calculations. Appendix F gives a review of the various vector operators in the different systems.

Compared with the second edition, the level of difficulty of the present edition is slightly higher, due to a number of hefty problems that have been added. If you are looking for an extra challenge, these problems should keep you on your toes. However, if these are ignored (which they certainly can be, in any standard course using this book), then the level of difficulty is roughly the same.

I am grateful to all the students who used a draft version of this book and provided feedback. Their input has been invaluable. I would also like to thank Jacob Barandes for many illuminating discussions of the more subtle topics in the book. Paul Horowitz helped get the project off the ground and has been an endless supplier of cool facts. It was a pleasure brainstorming with Andrew Milewski, who offered many ideas for clever new problems. Howard Georgi and Wolfgang Ruckner provided much-appreciated sounding boards and sanity checks. Takuya Kitagawa carefully read through a draft version and offered many helpful suggestions. I thank Ali Woollatt and Irene Pizzie for their professional work in producing the layout of the book and copy editing the manuscript. Other friends and colleagues whose input I am grateful for are: Lindsay Barnes, Simon Capelin, Allen Crockett, David Derbes, John Doyle, Gary Feldman, Melissa Franklin, Jerome Fung, Jene Golovchenko, Doug Goodale, Robert Hart, Tom Hayes, Peter Hedman, Jennifer Hoffman, Charlie Holbrow, Gareth Kafka, Alan Levine, Aneesh Manohar, Kirk McDonald, Masahiro Morii, Lev Okun, Joon Pahk, Dave Patterson, Mara Prentiss, Dennis Purcell, Frank Purcell, Daniel Rosenberg, Emily Russell, Roy Schwitters, Nils Sorensen, Charlotte Thomas, Josh Winn, and Amir Yacoby.

Despite careful editing, there is zero probability that this book is error free. A great deal of new material has been added, and errors have undoubtedly crept in. If anything looks amiss, please check the webpage [www.cambridge.org/Purcell-Morin](http://www.cambridge.org/Purcell-Morin) for a list of typos, updates, etc. And please let me know if you discover something that isn't already posted. Suggestions are always welcome.

**David Morin**