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A Handbook of Mathematical Methods and Problem-Solving Tools for Introductory Physics (Second Edition): Introduction

J F Whitney and H M Whitney

# A Handbook of Mathematical Methods and Problem-Solving Tools for Introductory Physics

Joshua F Whitney and Heather M Whitney

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## Chapter 1

### Introduction

The purpose of this book is to *fill in the gaps*, so to speak, that may be present after a student experiences lecture and lab on a given introductory physics topic and then tries to tackle problem solving on their own. In our experience, this independent effort of putting the pieces together is when the learning really happens, but students sometimes benefit from checking in with someone during that time. And sometimes that time comes when office hours are not available, so we wrote this short handbook with that situation in mind. It is comprised of a wide variety of insights, some big-picture, thinking-like-a-physicist kinds of ideas, and some detail-oriented, such as the best way to put in positive or negative signs. Likewise, this handbook is written with both algebra- and calculus-based introductory physics students in mind. It has coverage of ideas that will apply to all students, regardless of which type of introductory physics class you are taking, and just a few calculus-specific ideas.

Thus, the handbook is best suited as a companion text when you begin to work through the actual homework problems after lectures. Each section will focus on a deeper understanding of the equations you will be using along with problem-solving skills. Toward that end, most sections will begin with a very careful description of each equation, what every symbol means and what the equation is saying in as simple terms as possible. Remember that equations themselves are merely tools and you will be in much better shape if you know what tool you are looking for before you start looking, thereby preventing you from wasting time, energy, and frustration trying to solve a problem with a hammer when you really need a wrench.

The tone of this book is as straightforward as possible so that it can be used as a study guide. Everything is explained thoroughly but we have tried to avoid being too funny or asking rhetorical questions or all the things that can contribute to physics textbooks being 1000+ pages long. Along these lines, we have also erred on the side of fewer figures than you might expect, because we anticipate that you will want to refer to your course textbook as much as possible to reconcile what you see here with

its presentation by your instructor and textbook. Every section will contain small summaries and important points that, in all honesty, you could probably just memorize and use in that form to do reasonably well on your physics tests. But you might not really understand the physics with this approach. A much better course of action is to study these, apply them, and when you don't feel like you *need* to memorize them anymore, you're in good shape. That is to say, the summaries can be used as a test themselves in that when they feel intuitive, you have a fairly solid grasp of the material.

It's important to note this book is not exhaustive for an introductory physics course, nor is it intended to be. It is focused on the things that students usually struggle with due to, in our opinion, poor explanations. You may not find exactly the examples or explanations you are looking for, but the problem-solving techniques and conceptual explanations can be applied to almost anything in your introductory physics course. You can think of this handbook as a style manual of sorts for physics, but in a problem-solving sense. Just as with a writing handbook you would look at specific examples and then apply them more broadly as similar situations come up, you can take the ideas of this book and apply them to other problems in physics as well.

Our most significant piece of advice to students of introductory physics is that you should make time for trying problems that are new to you, without having a textbook open, and under some kind of time limit. Doing so gives you the opportunity to put together all the pieces that you are learning and make them your own. Any student we have ever had who takes this advice learns physics well.

Above all, we wrote this handbook with our students, past, present, and future, in mind. Seeing our students, especially non-physics majors, learn, understand, and enjoy physics has been a particular joy for both of us. We tried to consider the questions they have frequently had and what types of advice and suggestions from us seemed to be effective when implemented by them. We have learned much from them, anticipate learning much from them, and dedicate this book to them.