2.7.1: Introduction

You might well wonder why we start off a physics book with a chapter on mathematics. The thing is, the mathematics covered in this chapter is mathematics you are supposed to already know. The problem is that you might be a little bit rusty with it. We don't want that rust to get in the way of your learning of the physics. So, we try to knock the rust off of the mathematics that you are supposed to already know, so that you can concentrate on the physics. As much as we emphasize that this is a physics course rather than a mathematics course, there is no doubt that you will advance your mathematical knowledge if you take this course seriously. You will use mathematics as a tool, and as with any tool, the more you use it the better you get at using it.

The goal of this chapter and the next chapter is three prong: it is intended (a) to help you review content you know (b) introduce some of the topics that are needed for this course, and (c) serve as a reference resources that you can go back to whenever the content is used in the course.

Some of the mathematics in this chapter is expected to be new to you. Some will be needed right away, some will not be needed until later in the course. We will focus initially on the content that is needed for the beginning of the course.

Even though you might have taken physics and calculus before, this course will assume that you are not familiar with any of the content. If you have already taken calculus, physics, or both, then you have a well earned advantage. Don't be complacent though since we will cover the concepts more thoroughly.

Two points of emphasis regarding the mathematical component of your solutions to physics problems that have a mathematical component are in order:

1. You are required to present a clear and complete analytical solution to each problem. This means that you will be manipulating symbols (letters) rather than numbers.
2. For any physical quantity, you are required to use the symbol which is conventionally used by physicists, and/or a symbol chosen to add clarity to your solution. In other words, it is not okay to use the symbol x to represent every unknown.

Aside from the calculus, here are some of the kinds of mathematical problems you have to be able to solve: The reciprocal of $\frac{1}{x}+\frac{1}{y}$ is not $x+y$. Try it in the case of some simple numbers. Suppose $x=2$ and $y=4$. Then $\frac{1}{x}+\frac{1}{y}=\frac{1}{2}+\frac{1}{4}=\frac{2}{4}+\frac{1}{4}=\frac{3}{4}$, and the reciprocal of $\frac{4}{3}$is $\frac{3}{4}$ which is clearly not 6 (which is what you obtain if you take the reciprocal of $\frac{1}{2}+\frac{1}{4}$ to be $2+4$). So what is the reciprocal of $\frac{1}{x}+\frac{1}{y}$? The reciprocal of $\frac{1}{x}+\frac{1}{y}$ is $\frac{1}{\frac{1}{x}+\frac{1}{y}}$.

This chapter does not cover all the non-calculus mathematics you will encounter in this course. If you master the concepts in this chapter (or re-master them if you already mastered them) you will be on your way to mastering all the non-calculus mathematics you need for this course. Regarding reading it all: By the time you complete your physics course, you are supposed to have read this book from cover to cover. Reading physics material that is new to you is supposed to be slow going. By the word reading in this context, we really mean reading with understanding. Reading a physics text involves not only reading but taking the time to make sense of diagrams, taking the time to make sense of mathematical developments, and taking the time to make sense of the words themselves. It involves rereading. The method I use is to push my way through a chapter once, all the way through at a novel-reading pace, picking up as much as I can on the way but not allowing myself to slow down. Then, I really read it. On the second time through I pause and ponder, study diagrams, and ponder over phrases, looking up words in the dictionary and working through examples with pencil and paper as I go. I try not to go on to the next paragraph until I really understand what is being said in the paragraph at hand. That first read, while of little value all by itself, is of great benefit in answering the question, "Where is the author going with this?", while I am carrying out the second read.

Note

This book is a physics book, not a mathematics book. One of your goals in taking a physics course is to become more proficient at solving physics problems, both conceptual problems involving little to no math, and problems involving some mathematics. In a typical physics problem you are given a description about something that is taking place in the universe and you are supposed to figure out and write something very specific about what happens as a result of what is taking place. More importantly, you are supposed to communicate clearly, completely, and effectively, how, based on the description and basic principles of physics, you arrived at your conclusion. To solve a typical physics problem you have to: (1) form a picture based on the given description, quite often a moving picture, in your mind, (2) concoct an appropriate mathematical problem based on the picture, (3) solve the mathematical problem, and (4) interpret the solution of the mathematical problem. The physics

occurs in steps 1, 2, and 4. The mathematics occurs in step 3. It only represents about 25% of the solution to a typical physics problem.
