CHAPTER OVERVIEW

1: C1) Abstraction and Modeling

1.1: About this Text
1.2: Modeling in Physics
1.3: Units and Standards
1.4: Unit Conversion
1.5: Significant Figures

This first section is going to serve two purposes: first, introduce some of the key important concepts that we will need right from the beginning, like units and significant figures. Second, we want to open up the question: "what is physics"? Like many such open-ended questions, there are many ways to answer it. It is not going to be our intention to answer this fully in any sense - we just want to answer it enough so that as a student, you know why this book exists and what you should be getting out of it. To get right to the point: **physics is the study of the abstraction of the physical world**.

So that's a pretty obscure statement, so let's break it down a bit. When we say "abstraction", that's basically a way of replacing all the real physical objects out there that we want to understand (balls, cars, airplanes, etc...objects!) with mathematical representations of those objects. These representations are simple - sometimes they are just points, or maybe box-shaped things with wheels to represent cars, etc. The point of the abstraction is both to simplify the problem (points are easier to deal with than real life planes), and also to make it mathematically precise. "how a car moves" is actually a question far too complicated for a simple introduction to the world of physics to handle. There are literally millions (way more!) of interactions taking place in the motion of a car - things like the engine, the wheels, and the transmission - but even little things like the air molecules hitting the outside of the car and slowing it down. By replacing the entire thing with "a point" or "a box with wheels", we make the problem simple enough for us to actually perform some calculations to understand it's motion.

We should be clear what the kind of mathematical precision we are talking about here as well. We don't mean "calculating the exact value of the speed of the car to 5 decimal places" (we'll see in this chapter that kind of precision is not actually what we are after). We mean something more like "numerically well-defined". For example, if we said "The position of the car is 5 m from the end of the race", we can't actually perform any calculations with that information, because *which part of the car are we talking about*? For sure, you could say "the front", or "the back", or "30 cm from the driver", but now we might need to know even more things about the car - how big is it, or how big the seats are (to determine the position of the driver relative to the finish line). The abstraction avoids all this by the replacement of real objects with simple representations of them. If the car is represented as a point, then "5 m from the end of the race" becomes very well-defined, because it can only refer to one location! Similarly for the representation of the car as a box with wheels - more information is required (dimensions of the box and the wheels?), but it's still far less then what might be required for the real, physical car.

Now that we've covered "abstraction", what does "study of the abstraction" mean? Well, it's often said that physics is "the study of the fundamental interactions" - that's what we mean, but we mean it specifically *within the abstraction*. We aren't actually studying how the fundamental interactions of the real world influence real physical objects - we are representing the world with an abstraction, and studying the abstraction. The force of gravity is actually enormously complicated in the real world (it's everywhere, it acts between each individual molecule and each other individual molecule....you'd be calculating for your entire life!), but in our abstraction, it's just a simple force acting between two points. By proposing simple, fundamental interactions between objects we are hoping to model the real world.

Of course, we claim that physics actually is the study of the real world, but you aren't ever going to see that connection by using solely the abstraction - you have to go into the laboratory and perform experiments to verify that our abstraction is an "accurate and precise" representation of the real world. We aren't going to talk much about that in this text, since it is primarily designed to give you an introduction to the prediction and quantitative aspects of the field - hopefully, your theoretical experience with this text will be coupled with a laboratory experience as well, so that you can see how well physics actually does at describing phenomena and events in the real world.