Chapter 1: Introduction to Physics

This chapter is an overview of physics and gives a taste of what it is like to do physics. To read this chapter you need to know a few things. I assume that you have studied a little algebra, up to the fact that $x^{-1} = \frac{1}{x}$. I also assume that you have some grasp of what pressure, volume, and temperature are.

1.0 The nature of physics.

It is my opinion that physics is the most fundamental of all sciences. What is physics? It is the goal of this chapter to answer that question. To begin with I will discuss only broad structural concepts—physics as an activity.

Let's ask a slightly different question, how is physics done? We seek to think of physics as a verb. As with any science, physics begins and ends with nature. Physics takes our perceptions of nature and seeks to produce an understanding of those things we can perceive. We will begin by breaking physics into four artificial branches. All breaking of physics into branches is artificial—nature doesn't care how we carve it up for study, it simply is. We break it up to make its study easier. The branches we will consider here are experimental physics, theoretical physics, computational physics, and applied physics.

Experimental physics is the original source of data and it is the ultimate arbiter of scientific truth. We do not mean that we can gain ultimate truth from any science, we can only determine whether something is true in the sense of our understanding. We say that something is consistent with measurement. Since we are—at least at some level—measuring nature, then we could infer that something consistent with measurement is consistent with nature. That is the sort of truth that we are referring to. There are several aspects to experimental physics: It provides us with instruments to measure things, it provides the ability to measure things that we canot derive mathematically, and it provides data about nature.

Theoretical physics is the means by which experimental data is converted into an understanding of nature. Patterns in the data are perceived and studied. This study consists of applying mathematical methods (logical, algebraic, geometric, analytical, and topological) to produce results that can, hopefully, be tested in experiments. It is not pure mathematics, physical intuition needs to guide the development of theories.

Computational physics is the application of computers to the hard problems of physics. Computers acquire data from measurements, store the data, allow us to retrieve the data, and to apply methods of analysis to it in the hopes of identifying patterns. One way is the visualization of data and theories, modern graphical capabilities allow us to identify patterns more easily than ever before. Most of the comptations of traditional theoretical physics are simplified and unrealistic, computers allow us to grapple with more realistic computations than we can do by hand. This leads to the ability to simulate reality on the computer. There is a danger in this, we can be led astray by computer simulations if we put too much stock in them. We never have perfect understanding of physical relaity, and computer simulations can be very close to reality—but they are only extensions of theories and are not perfect. After a point every simulation will diverge greatly from reality due to our inability to capture nature theoretically.

Applied physics is the application of physical ideas to areas where we are either: Limited to extending physical ideas to studies where we cannot practically perform experiments (say in studies of distant stars, or in the evolution of thunderstorms, etc.), or extending those ideas to places where we cannot be certain that the necessary simplifications of physics apply (engineering, for example).