Preface

Natural Philosophy: A Survey Of Physics and Western Thought is intended for a single year-long course in high school physics or an introductory course of college physics. It presents an overview of the entire subject of physics. This book is not just another version of the standard introductory physics text; it is an entirely new approach to physics.

Some educators will find it surprising that the book leaves out, or treats in very brief fashion, several topics which typical physics books cover *ad nauseum*, such as inclined planes, springs, etc. This is done for two reasons. First, we must distinguish between two kinds of courses. One type of course answers the question, "What introductory material should an engineering or science major in college study?" The second type of course answers the question, "What should every educated person know about physics, assuming that he or she never studies physics again?" This course is designed to answer the second question. As such, it spends a large fraction of the time on *modern* physics, the types of questions that modern physicists actually think about. Why should students spend time on boring questions about inclined planes and springs when these are not the type of problems that thrill modern physicists either?

At the same time, this course will not hinder the student who wants to pursue engineering or physics. It should serve as a good road map for further study. Too often a student's experience is the following: he or she reads some interesting "popular" book that makes physics seem exciting. Then the student enrolls in an introductory physics course that spends an eternity on inclined planes, etc., drumming out any further interest. The reason for this mind-numbing approach is that these problems form the basis of all further serious study. If you really want use physics, you must understand things like springs and pendulums, because they set up the mathematics used in all sorts of calculations. If you don't plan to study it further, however, these problems have little value.

It is also my feeling that too many physicists are enamored with tricks and puzzles, and so typical textbooks, even very introductory ones, are crowded with examples which really don't have any deep meaning, except that they are tricky. Some physicists talk about the importance of problem solving skills when what this usually means is "finding the trick." Does it really matter to most people how to walk on burning coals or how to make a gyroscope float in midair? I have tried here to restrict the reader's attention to the truly important results of physics. Of course, many tricky things have importance for engineering problems; for example, the subjects of heat conduction and airplane autopilots are involved in the above examples, but this is not a course in engineering. In general, there is a consensus among educators these days that less is more. I have made a conscious effort

to remove standard tricks which are really not central to the *story* of physics.

On the other hand, some educators will find it surprising that many fairly advanced topics of philosophy are included. Is this appropriate for high school or college students? Absolutely. Why should students be experts in machinery and equations, and unlearned in philosophy? Historically, physics and philosophy have interacted strongly, under the name "Natural Philosophy," which I chose as the title. On the other hand, this material is not necessarily only for young students. If you have already studied physics but never thought about the philosophical issues involved, this book is for you. A warning: what makes philosophy interesting is the controversies. Dealing with controversial matter, however, means taking positions which some people will not like. Instead of shying away from these issues, I encourage those who disagree with my positions to study the issues further. Wisdom comes from taking the time to understand controversial issues, not avoiding them.

While some historical issues are covered, my emphasis is on the modern understanding of physics. Many physics textbooks take a historical approach, presenting topics in the way the process of discovery originally unfolded (or at least, as the commonly accepted history says they unfolded.) This has the advantage of helping the student see the way science works, but it has the drawback that too many concepts have to be unlearned, or in some cases are never unlearned, leaving the reader with various fallacies. For this reason, Einstein's theory of relativity is presented before magnetic fields, and the discussion of quantum mechanics starts with the wave nature of matter.

In my opinion, physics should precede study of chemistry. This is one of the reasons why the math in this book involves only algebra and a little geometry. By the end of the course, students should have a good feel for what makes atoms stick together and what electrons orbitals are. The lack of calculus does not mean everything is easy, however. Some of the advanced math sections have very subtle algebra arguments which will challenge the better students. In general, more emphasis is given to being able to follow a logical argument that uses algebra than to solving puzzles (which some people call "problem solving"). Even if the reader never goes on to do any more physics problem solving, being able to follow algebraic arguments is an important life skill.

Natural Philosophy: A Survey Of Physics and Western Thought is designed to be used at several different levels. On one level, a person may read only the discussion and history sections and skip the math sections. These discussions do not depend heavily on the math. At another level, students with math ability may work through the basic Math Focus and Practicum sections. At a higher level, the student may work through some or all of the Advanced Math Focus and Advanced Practicum sections. The math sections in this course assume knowledge of basic algebra, a smattering of geometry, and the metric system, but no calculus or trigonometry is assumed, even in the advanced sections (but some basic results of trigonometry and calculus are taught). This is not only to make the course easier to teach at a lower level, but because I believe that every educated person should understand algebra, while I do not believe that every educated person needs to understand calculus. Algebra is the language of science, just as Latin was the language of scholars in the Middle Ages. A philosopher, theologian, or pastor who does not understand algebra does not have a reasonable understanding of the technological world in which modern people live, and

therefore can not speak meaningfully about the issues facing many people's lives.

Some educators may want to skip the philosophy and Bible study sections and concentrate on the math. My goal, however, is to present an *integrated* curriculum in which philosophy, math, and measurements connect together. Therefore, the best learning experience will involve doing some of all the different types of sections. Try to avoid the temptation to skip all the "touchy feely philosophical stuff," at one extreme, or to skip all the "difficult math stuff," at the other extreme. Also, if you must cut some material, try to cut a fraction of each chapter instead of skipping the later chapters. For example, if you estimate that you can only do 2/3 of the material, do 2/3 of each chapter instead of only the first eight chapters. Otherwise you will miss much of the really fascinating modern physics.

Because this book includes both philosophy and physics, some educators may want to give credit for two courses, one in philosophy and one in physics. Writing assignments may be based on the thought questions at the end of many sections.

Natural Philosophy: A Survey Of Physics and Western Thought assumes that the student has access to and basic proficiency with a simple mathematical plotting program such as Microsoft Excel. The ability to plot graphs is an essential skill in the modern world and every student should learn to use this type of program. For scientific plotting, Kaleidagraph is actually better and cheaper than Microsoft Excel for scientific plotting, but Excel may be easier to find. Each chapter also contains several projects designed to not require expensive equipment, which students are encouraged to try. I agree with many modern educators that we learn best by doing, and doing projects resembles real modern science much more than memorizing terms. I encourage adult, nonstudent readers to do the hands-on practicum exercises too. Too many people seem to think that science projects are only for young students and that an adult grows out of such things. By contrast, many of the greatest minds of Western culture liked to fiddle with real devices and didn't disdain working with their hands.

This book also contains a vocabulary list for each chapter. One of the barriers to understanding physics is the large number of new words, including common words used in new ways. Unfortunately, there is no way around simply memorizing the meaning of these words. Science has its own language, and we must learn the words of the language just as we would learn any foreign language.

Some readers will be surprised to see sections on Bible study mixed in with studies of physics. I believe that the Bible is the inerrant Word of God, and science about God's world can not be separated from his Word. Readers who do not share this belief should still give attention to these sections, however. The interaction of the Bible and science has been a central ingredient of the development of natural philosophy in the Western world, and this interaction still affects the politics of the United States today. Knowing what the Bible says, and does not say, is essential for understanding the debate.

As a useful supplement to both the physics and the history, I highly recommend the video series, *The Mechanical Universe*, produced by Cal Tech. It gives a high-quality presentation without too much math, and it is relatively free from gratuitous anti-Christian bias. This video series and other teaching resources are available at from suppliers listed in Appendix B at the end of the book.