

## Preface

### Physics is the liberal arts of high tech

*Physics and Technology for Future Presidents?* Yes, that is a serious title. Energy, global warming, terrorism and counter-terrorism, health, internet, satellites, remote sensing, ICBMs and ABMs, DVDs and HDTVs -- economic and political issues increasingly have a strong high tech content. Misjudge the science, make a wrong decision. Yet many of our leaders never studied physics, and do not understand science and technology. Even my school, the University of California at Berkeley, doesn't require physics. *Physics and Technology for Future Presidents*, *PTffP* for short, is designed to address that problem. Physics is the liberal arts of high technology. Understand physics, and never again be intimidated by technological advances. *PTffP* is designed to attract students, and teach them the physics they need to know to be an effective world leader.

Is science too hard for world leaders to learn? No, it is just badly taught. Think of an analogous example: Charlemagne was only half literate. He could read but not write. Writing was a skill considered too tough even for world leaders, just as physics is today. And yet now most of the world is literate. Many children learn to read before kindergarten. Literacy in China is 84% (according to the OECD). We can, and must achieve the same level with scientific literacy, especially for our leaders.

This course is based on several decades of experience I've had presenting tough scientific issues to top leaders in government and business. My conclusion is that these people are smarter than most physics professors. They readily understand complex issues, even though they don't relax by doing integrals. (I know a physics professor who does.) *PTffP* is not Physics for Poets, Physics for Jocks, or for Physics for Dummies. It is the physics you need to know to be an effective world leader.

Can physics be taught without math? Of course! Math is a tool for computation, but it is not the essence of physics. We often cajole our advanced students, "Think physics, not math!" You can understand and even compose music without studying music theory, and you can understand light without knowing Maxwell's equations. The goal of this course is not to create mini-physicists. It is to give future world leaders the knowledge and understanding that they need to make decisions. If they need a computation, they can always hire a physicist. But the knowledge of physics will help them judge, on their own, if the physicist is right. Let me illustrate what can be taught by telling a short story that I share with my students in the first lecture. It tells them what I want from them.

### An ideal student

Liz, a former student of my class, came to my office hour, eager to share a wonderful experience she had had a few days earlier. Her family had invited a physicist over for dinner, someone who worked at the Lawrence Livermore National Laboratory. He regaled them through the dinner with his stories of controlled thermonuclear fusion, and its great future for the power needs of our country. According to Liz, the family sat in

awe of this great man describing his great work. Liz knew more about fusion than did her parents, because we had covered it in our class.

There was a period of quiet admiration at the end. Finally Liz spoke up. "Solar power has a future too," she said.

"Ha!" the physicist laughed. (He didn't mean to be patronizing, but this is a typical tone physicists affect.) "If you want enough power just for California," he continued, "you'd have to plaster the whole state with solar cells!"

Liz answered right back. "No, you're wrong," she said. "There is a gigawatt in a square kilometer of sunlight, and that's about the same as a nuclear power plant."

Stunned silence from the physicist. Liz said he frowned. Finally he said, "Hmm. Your numbers don't sound wrong. Of course, present solar cells are only 15% efficient...but that's not a huge factor. Hmm. I'll have to check my numbers."

YES!! That's what I want my students to be able to do. Not integrals, not roller-coaster calculations, not pontifications on the scientific method or the deep meaning of conservation of angular momentum. She was able to shut up an arrogant physicist who hadn't done his homework! Liz hadn't just memorized facts. She knew enough about the subject of energy that she could confidently present her case under duress when confronted by a supposed expert. Her performance is even more impressive when you recognize that solar power is only a tiny part of this course. She remembered the important numbers because she had found them fascinating and important. She hadn't just memorized them, but had thought about them and discussed them with her classmates. They had become part of her, a part she could bring out and use when she needed them, even a year later.

### **Physics for the future leader**

*PTffP* is not watered-down physics. It is advanced physics. It covers the most interesting and most important topics. Students recognize the value of what they are learning, and are naturally motivated to do well. In every chapter they find material they want to share with their friends, roommates, and parents. Rather than keep the students beneath the math glass ceiling, I take them way above it. "You don't have the time or the inclination to learn the math," I tell them. "So we'll skip over that part, and get to the important stuff right away." I then teach them things that ordinary physics students don't learn until *after* they earn their Ph.D.

The typical physics major, even the typical Ph.D., does *not* know the material in this book. He (and increasingly she) knows little to nothing about nukes, optics, fluids, batteries, lasers, IR and UV, x-rays and gamma rays, MRI, CAT, and PET scans. Ask a physics major how a nuclear bomb works and you'll hear what the student learned in high school. For that reason, at Berkeley we have now opened this course for physics majors to take. It is not baby physics. It is advanced physics.

I must confess that I made one major concession to my Berkeley students. They really do want to learn about relativity and cosmology, subjects superfluous for world leadership, but fascinating to thinking people. So I added two chapters at the end. They cover subjects that every educated person should know, but they won't help the President make key decisions.

The response to this new approach has been fantastic. Enrollment grew mostly by word-of-mouth from 34 students (Spring 2001) to over 500 (Fall 2006). The class now fills up the largest physics-ready lecture hall at Berkeley. Many of my students previously hated physics, and swore (after their high school class) never to take it again. But they are drawn, like moths to a flame, to a subject they find fascinating and important. My job is to make sure their craving is fulfilled, and that they won't be burned again. These students come to college to learn, and they are happiest when they sense their knowledge and abilities growing.

Students don't take the course because it is easy; it isn't. It covers an enormous amount of material. But every chapter is full of information that is evidently important. That's why students sign up. They don't want to be entertained. They want a good course, well taught, that fills them with important information and the ability to use it well. They are proud to take this course, but more importantly, they are very proud that they enjoy it.