So You Want to Become a Physicist?

You have come to the right place

I’ve often been asked the question: how do you become a physicist? Let me first say that physicists, from a fairly early age, are fascinated by the universe and its fantastic wonders. We want to be part of the romantic, exciting adventure to tease apart its mysteries and understand the nature of physical reality.

That’s the driving force behind our lives. We are more interested in black holes and the origin of the universe than with making tons of money and driving flashy cars. We also realize that physics forms the foundation for biology, chemistry, geology, etc. and the wealth of modern civilization. We realize that physicists pioneered the pivotal discoveries of the 20th century which revolutionized the world (e.g. the transistor, the laser, splitting the atom, TV and radio, MRI and PET scans, quantum theory and relativity, unraveling the DNA molecule was done by physicists.

But people often ask the question: do I have to be an Einstein to become a physicist? The answer is NO. Sure, physicists have to be proficient in mathematics, but the main thing is to have that curiosity and drive. One of the greatest physicists of all time, Michael Faraday, started out as a penniless, uneducated apprentice, but he was persistent and creative and then went on to revolutionize modern civilization with electric motors and dynamos. Much of the worlds gross domestic product depends on his work.

Einstein also said that behind every great theory there is a simple physical picture that even lay people can understand. In fact, he said, if a theory does not have a simple underlying picture, then the theory is probably worthless. The important thing is the physical picture; math is nothing but bookkeeping.

Steps to becoming a Physicist:

1) in high school, read popular books on physics and try to make contact with real physicists, if possible. (Role models are extremely important. If you cannot talk to a real physicist, read biographies of the giants of physics, to understand their motivation, their career path, the milestones in their career.) A role model can help you lay out a career path that is realistic and practical. The wheel has already been invented, so take advantage of a role model. Doing a science fair project is another way to plunge into the wonderful world of physics. Unfortunately, well-meaning teachers and counselors, not understanding physics, will probably give you a lot of useless advice, or may try to discourage you. Sometimes you have to ignore their advice.

Don't get discouraged about the math, because you will have to wait until you learn calculus to understand most physics. (After all, Newton invented calculus in order to solve a physics problem: the orbit of the moon and planets in the solar system.)

Get good grades in all subjects and good SAT scores (i.e. don't get too narrowly focused on physics) so you can be admitted to a top school, such as Harvard, Princeton, Stanford, MIT, Cal Tech. (Going to a top liberal arts college is sometimes an advantage over going to an engineering school, since it's easier to switch majors if you have a career change.)

2) next, study four years of college. Students usually have to declare their majors in their sophomore (2nd) year in college; physics majors should begin to think about doing (a) experimental physics or (b) theoretical physics and choosing a specific field.

The standard four year curriculum:

a) first year physics, including mechanics and electricity and magnetism (caution: many universities make this course unnecessarily difficult, to weed out weaker engineers and physicists, so don't be discouraged if you don't ace this course! Many future physicists do poorly in this first year course because it is made deliberately difficult.).

Also, take first (or second) year calculus.

b) second year physics – intermediate mechanics and EM theory.

Also, second year calculus, including differential equations and surface and volume integrals.

c) third year physics – a selection from: optics, thermodynamics, statistical mechanics, beginning atomic and nuclear theory

d) four year physics – elementary quantum mechanics

Within physics, there are many sub-disciplines you can choose from. For example, there is solid state, condensed matter, low temperature, and laser physics, which have immediate applications in electronics and optics. My own field embraces elementary particle physics as well as general relativity. Other branches include nuclear physics, astrophysics, geophysics, biophysics, etc.

Often you can apply for industrial jobs right after college. But for the higher paying jobs, it's good to get a higher degree.

3) so then there is graduate school. If your goal is to teach physics at the high school or junior college level, then obtaining a Masters degree usually involves two years of

advanced course work but no original research. There is a shortage of physics teachers at the junior college and high school level.

If you want to become a research physicist or professor, you must get a Ph.D., which usually involves 4 to 5 years (sometimes more), and involves publishing original research. (This is not as daunting as it may seem, since usually this means finding a thesis advisor, who will simply assign you a research problem or include you in their experimental work.) Funding a Ph.D. is also not as hard as it seems, since a professor will usually have a grant or funding from the department to support you at a rate of about $12,000 per year or more. Compared to English or history graduate students, physics graduate students have a very cushy life.

After a Ph.D: Three sources of jobs

a) government

b) industry

c) the university

Government work may involve setting standards at the National Institute for Standards and Technology (the old National Bureau of Standards), which is important for all physics research. Government jobs pay well, but you will never become wealthy being a government physicist. But government work may also involve working in the weapons industry, which I highly discourage. (Not only for ethical reasons, but because that area is being downsized rapidly.)

Industrial work has its ebbs and flows. But lasers and semi-conductor and computer research will be the engines of the 21st century, and there will be jobs in these fields. One rewarding feature of this work is the realization that you are building the scientific architecture that will enrich all our lives. There is no job security at this level, but the pay can be quite good (especially for those in management positions – it’s easier for a scientist to become a business manager than for a business major to learn science.) In fact, some of the wealthiest billionaires in the electronics industry and Silicon Valley came from physics/engineering backgrounds and then switched to management or set up their own corporation.

But I personally think a university position is the best, because then you can work on any problem you want. But jobs at the university are scarce; this may mean taking several two-year “post-doctorate” positions at various colleges before landing a teaching position as an assistant professor without tenure (tenure means you have a permanent position). Then you have 5-7 more years in which to establish a name for yourself as an assistant professor.

If you get tenure, then you have a permanent position and are promoted to associate professor and eventually full professor. The pay may average between $40,000 to $100,000, but there are also severe obstacles to this path.

In the 1960s, because of Sputnik, a tremendous number of university jobs opened up. The number of professors soared exponentially. But this could not last forever. By the mid 1970s, job expansion began inevitably to slow down, forcing many of my friends out of work. So the number of faculty positions leveled off in the 1980s.

Then, many people predicted that, with the retirement of the Sputnik-generation, new jobs at the universities would open up in the 90s. Exactly the opposite took place. First, Congress passed legislation against age-discrimination, so professors could stay on as long as they like. Many physicists in their seventies decided to stay on, making it difficult to find jobs for young people. Second, after the cancellation of the SSC and the end of the Cold War, universities and government began to slowly downsize the funding for physics. As a result, the average age of a physicist increases 8 months per year, meaning that there is very little new hiring.

As I said, physicists do not become scientists for the money, so I don't want to downplay the financial problems that you may face. In fact, many superstring theorists who could not get faculty jobs went to Wall Street (where they were incorrectly called "rocket scientists"). This may mean leaving the field. However, for the diehards who wish to do physics in spite of a bad job market, you may plan to have a "fall-back" job to pay the bills (e.g. programming) while you conduct research on your own time.

But this dismal situation cannot last. Within ten years, the Sputnik-generation will finally retire, hopefully opening up new jobs for young, talented physicists. The funding for physics may never rival that of the Cold War, but physics will remain an indispensable part of creating the wealth of the 21st century. There are not many of us (about 30,000 or so are members of the American Physical Society) but we form the vanguard of the future. It also helps to join the APS and receive Physics Today magazine, which has an excellent back page which lists the various job openings around the country.