Carleton College
Department of Physics & Astronomy

Guide to Graduate School Applications

From Past Seniors to You!

2007

This collection was assembled by the 06/07 Student Departmental Advisors, Melina Blees and John McDonough. It contains first- and second-hand advice from the internet, members of the classes of '04, '05, '06, and '07 who survived the applications process, and random other sources we would cite if we could remember them. Some of the material, such as the graduate school rankings, is under some sort of copyright, and therefore is not available in the online version. None of the content that follows is official endorsed by Carleton College or guaranteed to get you into graduate school, though we suspect it might help.

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Introduction

When we applied to college, we had a pretty good idea of what we were getting ourselves into. Our guidance counselors could look at our SAT scores and grades and tell us where to apply and what our chances might be; there were shelves full of books of advice. But when we started to think about grad school apps, we got scared. There were so many more factors that went into our chances, and a lot more things we had to think about when making our decisions. Advisors, specializations, funding.... We had to study for the GREs and wondered how much our scores would matter. Even with the support of our professors, the whole process was intimidating, nebulous, and expensive.

So after we all got done with it and started to get answers back and didn't *really* have to worry about our grades anymore, we sat down and put together this collection. It primarily contains advice relating to Ph.D. programs in theoretical or experimental physics, but much of it will also apply to programs in engineering, materials science, or related fields. It's an effort to pass on the advice of a few generations of seniors who have been through it all to those of you who are just getting started. This is just a starting point, but our hope is that when you start getting those happy emails back you'll take a moment to add your own advice to the pile. If you'd like a copy of your own, you can download this collection as a PDF from the department website.

Good luck, and keep your chin up, kids!

Melina Blees and John McDonough, SDAs 06/07

To Sophomores and Juniors

If you think you might want to go to grad school, you should start worrying about it during your sophomore year. You won't need to start the actual applications/GRE process until fall of your senior year, but there are a number of things you can do even before you declare that will significantly help your chances of being accepted to grad school.

1. **Apply to REUs.** These summer research programs are designed to give you a first look at real research, and they're a great way to figure out whether or not you actually want to go to graduate school. Although the programs tend to favor rising seniors, a number of rising juniors are accepted every year from Carleton. Applying sophomore year would not only give you the opportunity to have another research experience the next summer, but also provides pretty much the best summer job you can get. REUs are not only great experiences for you, but also *significantly* add to the strength of your graduate applications. In fact, REUs are so important to your competitiveness as an applicant that we suggest applying to somewhat obscure programs (in geographically undesirable places, for instance) as backups. Most programs provide housing and meals, plus a stipend in the $3000-$5000 range for about 10 weeks worth of work. There are REUs available for theoretical and experimental physics, electrical engineering, geophysics, and so on. If you have specific research interests you can note that on your application, but these programs can also be a great way to decide in what area of physics you might specialize at graduate school. Alternately, apply for summer research positions at Carleton. Professor Cindy Blaha is the contact person for REU applications.
2. **Start a special project.** Most graduate programs will expect you to have had some research experience, and work during the school year can be a big bonus. It can also help you to decide what you want to study in the long run, and develop a connection with a mentor who will help guide you through your Carleton career. Special projects can be taken for 2 or 3 pre-SCRNCed credits. Visit the Carleton Department of Physics and Astronomy's Faculty page to see what each professor is studying, and go speak to whomever's research interests you.
3. **Lab assist or tutor.** Teaching experience is looked upon favorably by admissions committees because you'll be expected to TA in grad school, and it can also be a good way to help you decide whether or not you want to consider a career as a professor. It can also be a lot of fun.
4. **Get involved!** If you have a (genuine) interest in department happenings and outreach, consider asking to join the Department Curricular Committee, apply to be a Student Departmental Advisor, or join the Prospective Student Liaisons. This sort of thing can give you an inside

look at department workings, which is helpful if you're considering a career in academia.

5. **Talk to Cindy.** Professor Blaha is the department's excellent career advisor, and is the person to go to if you have questions about REU apps, post-graduation plans, and so on.
6. **Learn about graduate school.** By all accounts, grad school is tough but rewarding. Read up on the process so you know what you're considering getting yourself into. Most people go straight for a Ph.D. in physics, without worrying about getting a masters along the way. We especially suggest *The Ph.D. Process: A Student's Guide to Graduate School in the Sciences* by Bloom, Karp, and Cohen (see additional resources) for what may be an especially brutal take on the trials of grad study. Carleton students have traditionally done very well at graduate school, though, so don't get too discouraged. Also consider discussing it with your research advisor(s), grad students at your REUs, or your favorite prof. The more you know about grad study, the better you can prepare yourself and choose a good program. You might also consider studying something that's not pure physics, such as materials science, electrical engineering, planetary science, biophysics....
7. **Think about taking time off.** Many Carleton students take a year or two off before they go to grad school, and admissions committees don't frown on this at all. Consider a one- or two-year national volunteer program, or join the workforce for a year. Don't go to graduate school directly if you're burned out. It's five to seven years more of school for a Ph.D., and there's no reason not to take a break. Some schools even say they prefer students with real-world experience, and some (but not all) graduate programs may let you defer for a year even after you've been accepted, especially if you'll spend the time with something like the Peace Corps or Teach For America.

Approximate Timeline
(adapted from *princetonreview.com*)

Sophomore year:

• Apply to REU programs (deadlines are in February/March). Consider beginning a research project at Carleton during the year.

Junior year:

Spring term:

• Start thinking about the GREs. Take a look at Carleton's copy of the ETS Physics GRE practice book, which you won't be able to find over the summer.

Summer:

• Hopefully you're doing research at Carleton or an REU. If you have research downtime, start studying for the physics GREs.

• Talk to the grad students in your lab about their experiences in graduate school.

• Summer is the best time to take the general GREs. You probably won't have to spend more than a week studying, but register as early as possible for the best choice of times.

• Start to make up a list of where you might want to apply.

Senior year:

Fall Term:

• Ask for recommendation letters. Even if you haven't finalized your list of schools yet, giving advance warning can be helpful to your writers.

• Register for the November physics GRE. When ETS sends you the paperwork, immediately register four schools where you want score reports sent.

• Study for the physics GREs as much as possible.

• Consider applying to fellowships; some have November deadlines, and you'll need rec letters for most.

• If possible, start your statement of purpose.

• If you have a chance, email a professor at each school whose research seems particularly appealing. Any contact is good, and if you live near the school you might be able to visit their lab over winter break if you've planned ahead.

• Finalize your list of schools, and give your recommenders the necessary forms and info. Request transcripts. Get GRE scores sent to all your schools.

Winter Break:

• Take the general GRE as soon as you get home if you haven't already; this is cutting the deadlines a bit close.

• Polish up your statement of purpose, and get some editors.

• Visit schools if you've made contact with friendly professors.

- Some deadlines will fall in mid-December, so get those applications finished!
- Make sure your recommendations went out. Try to finish up all your applications, even those due in January, while you're still on break. The earlier you get your applications in the better.

Winter Term:

- Fill out the FAFSA.
- Wait for those responses!
- Visit campuses.

Spring Term:

- Make your final decision by April 15th.

Where To Apply

When you decide to apply to graduate school, you'll need to narrow down your choices. How many schools you'll apply to is up to you, but most people suggest between six and nine. Applications cost $40 to $120, with most falling in the $60-$70 range.

Gauging where you fall in the competitiveness scale is tough for graduate apps. Talk to professors and advisors, and look at the admissions criteria of the programs you're interested in. Keep in mind that the "average" GRE scores listed by programs are inflated due to international student scores, and the admissions committees generally tend to forgive students from liberal arts schools for low scores. If you have a strong research background (one or more REUs and a special project) and strong grades you can aim for schools with fairly high average GRE scores. Look at where previous Carleton students have gone, and pick a few reach schools, a few good bets, and a few safety schools.

If you have a possible area of specialization, talk to professors in that subfield who can suggests especially strong programs. Some schools are great for plasma physics, for example, while weak in atomic physics. Hopefully by now you have some idea of what you want to study, but you'll at least have to decide whether you want to study astrophysics, experimental physics, or theoretical physics.

Organization has never been so important. Make a binder or a folder for each school, and write up a list of deadlines. Be careful - some schools have different deadlines for different parts of the application!

• Deciding where to apply can be very hard if you are not sure what you want to specialize in. Ideally, you would know what field you wanted to pursue and apply to the schools having the largest resources/faculty. Another consideration is breadth of research opportunities; for those who aren't sure what they'd like to do, larger schools tend to be better, offering a more diverse research landscape. I applied to six schools in all, and I think this is a good number to give enough variety but not bog you down in having to tailor applications to too many schools.
---Ted Holby '04, materials and science engineering, University of Wisconsin-Madison

• Apply to the best schools possible for what it is you want to do, even if it seems unlikely that you will get in. Also find a good school that you know you can get into for a backup. I did not choose the best schools to apply to, but instead chose what I thought were the best people to work for. You have no way of knowing whether that is a good choice or not, so go for the best department over what you think

is the best person.
----Mara Morgenstern '06, geophysics, University of Illinois - Urbana-Champaign

• I searched the internet for departments which had programs I was interested in and rated them on a scale of how interested I was in their research. Then I cross-checked that list with a similar list created by my girlfriend for her department. Then we decided which schools would both be happy at and that pretty much narrowed it down. I applied to six, which was way too few. I think we were really lucky getting in to the same school knowing how many people applied. Two-body problems are much harder to solve.
----Neal Meyer '06, experimental atomic, molecular, and optical physics, Penn State

• I applied to seven in total (six astro, one physics). That seemed just the right amount (I was accepted at three, so there were some choices). I wanted to live in the West, and thankfully many of the best astro grad schools were out here. I asked my profs, research advisors, and friends in grad school for suggestions, and also browsed heavily the websites of all the schools I was looking at.
---Kyle Willett '05, astrophysics, University of Colorado – Boulder

• I picked some schools because I thought they sounded prestigious, I picked others because I thought that they were in beautiful places. I also picked some schools because I had contacted them and I felt wanted. I applied to five schools, in a wide range of programs. It felt like the right amount. I could go PhD or Masters, ocean engineering, oceanography, or ocean physics, I could go with full funding, some funding, or no funding. Tropical, southern, northwest, and northeast. After visiting, it was an easy choice.
---Sam Kelly '05, physical oceanography, Oregon State

• Always apply to more than you think you should. It can only help. But that doesn't mean you should just apply to a mess of schools, find a bunch you're interested in. You can look at rankings information, but ultimately what's really helpful is asking faculty. They've all been grad students, and they know a lot. Especially if you're going to be continuing in their field. Look around online. Most departments have pretty good prospective grad student resources. You can look into specific projects and see what's really interesting to you. And don't apply to anywhere you wouldn't want to live for six years. Location is important.
----John McDonough '07, lab manager and research assistant, A&I Equipment

• I applied to eight schools. In retrospect, that was too many. Getting all of the applications filled out was pretty stressful, and I didn't have time to visit all of the schools I was accepted to. On the other hand, it's better to apply to too many and have lots of choices than apply to too few and not have many (or any!) choices. I decided where to apply by asking my research advisors to recommend some places. I visited some of them before I applied to get a feel for the departments and narrow the list a bit.
---*Sarah Vigeland '06, astrophysics and general relativity, MIT*

• Applications will take a lot longer than you expect. Limit yourself to nine at the *most*. I did eleven, but it took most of winter break and cost a *lot* of money. If you pick the right programs (a few reach schools, a few good bets, a few backups) you shouldn't have to do that. Of course, what constitutes a backup school may be really hard to judge, which is how I ended up with eleven... but don't do that.

Results-wise, it seemed like the competitiveness of admissions usually scaled closely with the school's ranking on the *US News* report, but I did get rejected from one of my backup schools. I think some places care more about things like GRE scores than others do, while some have a particular respect for the liberal arts background.
---*Melina Blees '07, experimental condensed matter, Cornell University*

• It's really important to not freak out about your subject GRE scores. As long as you've done a good job at everything else you'll probably be okay.
---*Kassie Wells '07, planetary science, Cornell University*

• I applied to eight schools, and that was a good number. Eight applications is pretty doable, but any more than that and I wouldn't have enough time to figure out what the schools had to offer. You want to send out a lot of applications because you will probably get a lot of rejections, so if you're pretty sure you want to go to grad school next year you'll want to blanket them.

I only applied to schools where I'd found two professors I wanted to work for whose research seemed interesting and had funding, and that weeded out a lot. I also made sure the departments were flexible. I want to do biophysics, but I made sure that if I decide to switch to nanotech it would be possible.

After I was accepted to schools, there were some that I didn't end up going to because I contacted the professors and they never got back to me, which I took as a bad sign.
---*Steve Meisburger '07, applied physics, Cornell University*

• Applying to grad school was a two-body problem. My wife, Megan (Economics '03), and I were both looking for grad schools. We did our

research individually and came up with lists of good programs. Then we compared our lists and looked for schools that overlapped or were in the same cities. I also talked to physics professors Bruce Thomas, Nelson Christensen, and others about the list of schools we had and solicited advice on schools to add. We settled on a list of eleven schools to apply to. I only got into four of them and we only got into two of them together. Fortunately, we both got into UW, which is a great school for both of us.
----*Clark Ritz '04, nanoscale physics, University of Wisconsin, Madison.*

• Location (as in a place I'd like to live) was the first thing I looked at, then I narrowed it down in terms of which schools I was interested in those given locations and then what those programs had to offer in terms of research. I applied to five schools, which was about right, but I kind of wish I had looked at a few more applied physics programs.
---*Ghidewon Arefe '03, nanoparticle science and mechanical engineering, University of Minnesota*

• I believe that your advisor is just as important as the school you attend. Your advisor will control your stress level, your productivity, and what you study. This person will introduce you into a research niche that will involve scientists at many different institutions. If your advisor has a good reputation, your education will be respected by people in your field. Your advisor's connections may also find you a job when you finish.
---*Sam Kelly '05, physical oceanography, Oregon State*

• I applied to seven schools and most of them were in the Midwest because I don't really want to leave, but I did apply to a few east coast schools because I wanted them to fly me out there for a visit. I pretty much chose the good schools around Wisconsin, Illinois, and Minnesota, and then the east coast schools I had a gut feeling about. I applied to physics and materials science programs, but at most schools if you want to apply to two programs you either have to send in two applications or they won't even let you, so at most places I applied to either one or the other. The non-physics programs are good, too, and they don't require the physics GRE.
----*Jon Emery '07, materials science, Northwestern*

• I applied to five schools, and I figured I'd apply to two that I could get into easily, two that were about right, and one reach school. I mostly looked at websites to decide.
----*Will Camisa '07, mechanical engineering, University of Minnesota*

• Schools in the UK are due early and they reply really late, so it takes some risk management to decide whether to accept schools here by

the deadline before the UK schools have gotten back to you. They don't automatically fund you, so you have to fill out a separate scholarship application, and those take a lot of time. They have a different way of approaching things; in theoretical physics, for example, there's a way to do an applied mathematics program for a whole year before you start your actual program.
---Hans Bantilan '07, numerical relativity, Princeton University

• I applied to eleven schools, but that was a bit much. Eight probably would have been good. I guess it's because there were a lot of reach schools that were either fairly hard to get into or had small programs, so it was sort of a risks/rewards thing. I'm going to study nuclear engineering, and if you're looking to do applied or engineering you may have to do a little more research to figure out what departments you actually have to apply to. Nuclear engineering ended up being a subset of the mechanical engineering department.
---Glen Perry '07, nuclear engineering, University of Texas at Austin

• A lot of times if you're in an interdisciplinary field, the department they stick it in can end up being pretty random. If you're doing biophysics, for example, it sometimes gets put in the medical school, at Cornell it's in engineering & applied science, and at Boulder it's just physics.
---Steve Meisburger '07, applied physics, Cornell University

• The school itself does not mean nearly as much as the group you end up working with. You'll be doing most of your grad school work with a single professor, so you really should not be looking at which school is good, but which groups you want to work with. To determine this, talk to anyone you can get in touch with (alums and faculty is a good place to start) to ask who is doing good work in the field you are interested in (if you don't know what you want to work on yet, then general school looking is what you're stuck with).
----Adam Libson '04, atomic optics, University of Texas – Austin

• I applied to twelve. It was enough.
---Hans Bantilan '07, numerical relativity, Princeton University

• I was already living in Minneapolis and my wife was a semester into a graduate program at the U. The U seemed to be a good fit for me and I didn't want to move away from her, so I only applied there. (My backup plan was to start a masters program in computer science which I had already been accepted for... long story.) I think that clearly most people should apply to more programs than this.
---Matthew Strait '03, neutrino physics, University of Minnesota

• I started with internet research starting from lists of top applied math schools, and narrowed to those with multiple people doing fluid dynamics. Also, correspondence with several graduate students I met at an REU in my intended field gave me valuable insight.
----*Ben Diehl '06, applied math, Columbia*

• I started by finding an REU program that I enjoyed. Once I knew a field I enjoyed and some people in the field who could write me recommendations, I went to the "faculty research" page at various universities to see what other folks were interested in. From there I contacted specific professors until I found someone I liked in a good department. Look for people doing interesting work in fields not directly connected to physics. There are plenty of interesting projects going on in other departments. I found that many schools were anxious to find physics students.
-----*Alex Petroff '06, chaotic systems in geophysics and climate change, MIT*

• I used the *US News* rankings and the book of graduate programs that the department owns to find programs that might be of interest. Then I used the internet to look at the specific research programs and professors. I applied to six schools total. If you're applying with a significant other and want to be together, start researching schools early, and apply to lots of school. I think I significantly underestimated the number of people who would be applying to the programs.
---*Neal Meyer '06, physics, Penn State*

Recommendation Letters

Most programs expect three to four letters of recommendation, with at least one being from a research advisor of some sort. Hopefully you've done REUs or summer research at Carleton, so that shouldn't be a problem. You'll also want at least one letter from a professor here, hopefully one who is very familiar with your academic history. Someone who you've had for multiple classes or your academic advisor can be good choices. Also consider asking professors from related departments if your interests span fields of study, such as CS, math, or biology.

The question of who you should ask from within a lab – a graduate student you worked closely with versus the PI, for example – often comes down to how much interaction you've had, but one possibility is asking for a joint letter on which the Impressive Person and the one who knows you well can collaborate.

Ask for rec letters politely (obviously) and early; then provide all the necessary information as soon as your finalize your list of schools. All forms should be to your recommenders as soon as possible, definitely before you leave for winter break. You'll want to include the Carleton Rec Letter Form (http://apps.carleton.edu/curricular/physics/for_students/references/), and this can be helpful for non-Carleton recommenders as well. Include a cover sheet listing the deadlines in order, and write the first deadline clearly on the outside of the packet. Fill out everything you can on each of the forms, leaving less work for your recommenders. Include stamped envelopes addressed to each program.

Some rec letters can now be submitted online, and this can save a lot of time and paperwork. You'll need to designate your recommenders on the application website, and the site will generate emails to your listed recommenders.

- Ask your comps advisor at Carleton, advisors from REUs or Carleton-based research, and any professor who knows you AND YOUR ABILITIES well (i.e., someone you've worked for as a tutor/grader, had several classes with, served with on a committee, etc). They need to be able to say something besides "this person got an A in my class".

---Kyle Willett '05, astrophysics, University of Colorado – Boulder

- Ask for recommendation letters early from the professors that know you best and, if possible, from a non-Carleton source like an REU advisor or someone you know from an industry internship. I've heard having outside references is important.

----Clark Ritz '04, nanoscale physics, University of Wisconsin, Madison.

• Ask profs who you've done research with; they'll have more to say than ones who have just had you in a class. It's also a good idea to ask profs with research interests that are similar to yours. The department webpage has guidelines for when/how to ask. Some profs want you to fill out forms to give them ideas of things to talk about.
---*Sarah Vigeland '06, astrophysics and general relativity, MIT*

• If you want more than the usual three people to write you letters, don't hesitate. It might be polite to call or email the graduate office to ask if you can send a fourth letter, but every school I applied to said yes, although some wanted the fourth sent to the department directly as a paper letter. Don't feel compelled to add an extra letter, but if you think it would really help your application it's worth the trouble.
---*Melina Blees '07, experimental condensed matter, Cornell University*

• Get someone that can write something about you in lab, so either someone who knows you here or at a summer research program. Someone who can vouch for not only your academic abilities but for your competence in a lab is extremely helpful.
---*Craig Hogle '07, atomic & molecular physics, University of Colorado at Boulder*

• I asked a bunch of physics professors if they felt comfortable writing a positive recommendation for me. I tried to ask way in advance, and gave each one of them an organized packet with my resume, grades, and even some notes about things I did in their classes.
---*Sam Kelly '05, physical oceanography, Oregon State*

• Ask people who have some sort of unique relationship with you that can say things more than just, 'so and so was a good student' etc. If you did an internship, definitely ask someone from it to give you a recommendation, because if you don't it may look like you had a bad experience.
----*Neal Meyer '06, experimental atomic, molecular, and optical physics, Penn State*

• A lot of the recommendation forms are online now. One of the first things you can do when you start an application is to fill out your recommenders. We only have eight or so faculty and they end up writing a lot of letters, especially the popular/ubiquitous faculty, so find out who's going to write your letters, do it early, do it before you leave for winter break. Give them a big stack of stuff. It helps if you print out information, both the cover letters and information about a particular lab if you've got one in mind. When you fill out the recommender form it'll automatically send them an email, and that's

good for two reasons: it alleviates your responsibility, and it acts as a reminder to your recommenders that they need to actually get that done on time. The forms will also let you know when the letters have been received, which is helpful at reducing your stress.
----John McDonough '07, lab manager and research assistant, A&I Equipment

• Make sure the professors have *agreed* to write your rec letters before you fill out the online rec forms, because otherwise they can get kind of grumpy.
---Kassie Wells '07, planetary science, Cornell University

• There's a check-box waiving your right to ever see the letters, and you'll want to check all of them. The schools and your writers both expect you to do that, and even if you don't you'll only get to look at the letters in the school's records after you attend - long after it's sent and done with.
---Melina Blees '07, experimental condensed matter, Cornell University

• Ask advisors, those how you've done research with, profs you think know you well enough to say all sorts of nice things. Give them as much time as possible. No one likes too tight a deadline, and its not good to annoy the person you're asking to sing your praises by not giving them time to fit it into their busy schedule. Some profs may not even write for you if you don't give them enough time.
---Ted Holby '04, materials and science engineering, University of Wisconsin-Madison

• Ask well before your applications are due (remember, professors are busy people). It's a good idea to provide them with a self-addressed envelope to make it easier. I had a letter from my advisor as well as one from a professor outside of the department with whom I had taken several courses.
---Ghidewon Arefe '03, nanoparticle science and mechanical engineering, University of Minnesota

• Get recommendation requests to professors as soon as possible, and if you had an internship, try to get a recommendation from them because it might look like you're hiding something if you don't.
---Neal Meyer '06, physics, Penn State

• Um... don't ask them the day before it's due.
---Matthew Strait '03, neutrino physics, University of Minnesota

The GREs

There are two GRE exams you will have to take if you're applying for graduate study in physics. Each test cost approximately $130, plus score reports. The general exam (usually just called "the GREs") is much like the SATs, and with minimal studying you will probably do very well. This exam, which covers math, reading, and writing skills, is computerized and can be taken at any time during the year as long as you sign up ahead of time. Testing centers exist around the country, including some in Edina and the Twin Cities.

The subject exam in physics, or physics GRE, is generally considered to be a rather brutal test. Forget you ever took the AP physics exams or the SAT II Physics. Carleton students tend to do worse on this test than they expect to, and extensive studying is advised. The test is 2 hours and 50 minutes long, 100 questions, and is a paper exam. It's given in May and early November, and Carleton does have a testing center (usually in the CMC). Register early to be sure you can take it on campus. If you take the subject test in early November, the scores will make it to your schools on time (assuming you pre-assigned them). Even if you think they won't be in by the deadline, the same is true for everyone else who took the test on that date (which is most people), and the schools know it. Furthermore, lots of schools receive your scores electronically, so they'll get them as soon as ETS actually scores your test (though this can take up to six weeks).

General advice for the subject test includes studying past exam question for a long time prior to the test, ideally beginning in the summer before you take the test. ETS used to print a book of four past exams, and this (now out of print) collection will be your only source for real example exams. This book costs about $400 online, but Carleton's physics department has a copy you should look over before leaving for the summer; in some cases (especially if you're at an REU), you may be able to get a copy from a university library. When you register for the subject exam, ETS will also send you a single and more up-to-date practice exam. There are a few other texts available, but they don't contain real test questions and are renowned for being really bad.

The General Exam:

• The best thing you can do for the general GRE is take a few practice exams. The questions aren't too difficult, but it is a challenge to answer them all in a short amount of time.
---Ghidewon Arefe '03, nanoparticle science and mechanical engineering, University of Minnesota

• Don't stress yourself out about the general GRE. Practice the math a little ahead of time just to warm up some of that high school math machinery. As long as you can read and write in English, you'll pass the verbal and writing sections.

---Sarah Vigeland '06, astrophysics and general relativity, MIT

• As far as the *general* GREs goes, try to take it during the summer or early fall term. Any time later and you're cutting it really close. Also, *study* for it... Carleton students tend to do well, but studying really can't hurt your score and it's an amazingly coachable test. I had the Kaplan book and it was immensely helpful. Also, In my experience, a lot of the people who work at ETS are stunningly incompetent. If you're having trouble with them for some reason, ask to speak to a manager (or two) until you find someone who actually knows what's going on.
---Melina Blees '07, experimental condensed matter, Cornell University

• Take the General GREs early. This summer even. Once fall term rolls around, you'll be busy. The Generals are not hard; don't stress about them. You'll do fine. But once you're done, STAY ON TOP OF YOUR SCORES. Don't let ETS screw you. Take advantage of every free score report you get. Make sure your scores get reported. If you're unsure, email the program.
----John McDonough '07, lab manager and research assistant, A&I Equipment

The Subject Exam:
• When you register, make some decisions about where you want to apply, because they give you four free score reports when you register and after that they're fifteen bucks a pop, plus a six dollar "service call fee" even though it's automated and you don't actually talk to anyone. They mail a score report form out to you when you register for the subject test, but it needs to be returned to them *more than a week before* you actually take the test. Knowing this can save you $60.
----John McDonough '07, lab manager and research assistant, A&I Equipment

• I took quantum from a more matrix-based approach, but almost all of the quantum on the GREs is from the wavefunction approach. I'd say it would be really intelligent to go back beforehand and get yourself acquainted with the formalisms of the PDEs wave approach. I probably could have answered more of the questions but I didn't know what they were asking because they weren't phrased in a way that was familiar. Although a few of the questions are in Dirac notation, but those are usually really simple as long as you understand the basics of the notation.
---Kassie Wells '07, planetary science, Cornell University

• I started studying from textbooks, over the summer, and figured I'd go back and skim through all my old textbooks. Don't do that, it doesn't work. The intro (113/115) and 228 books were really helpful, however; skimming through them and paying attention to equations in blue boxes can be really useful. Otherwise, I'd say do practice problems and go look up the things you don't remember.
--Melina Blees '07, experimental condensed matter, Cornell University

• You can sometimes find the tests online, even though they're not supposed to be there, if you look hard enough.
--Drew Brisbin '07, astrophysics, Cornell University

• Do all of the problems in those practice tests, because if nothing else, ETS loves to recycle questions, or give you the same question with one value changed. If you do all the questions there, odds are you'll end up with a question you've seen before. They also always love the question about Maxwell's equations and magnetic monopoles.
----John McDonough '07, lab manager and research assistant, A&I Equipment

• The other general strategy that I think worked pretty well was eliminating answer choices just based on the units, because a lot of times, you don't even really have to know how to do the question. You just have to know what units the answer would be in and then there will be only one or two answers with the right units. That said, the tests in the ETS book (the four old tests) are actually a lot easier than the real test, because a lot more of the old questions can be answered by dimensional analysis.
---Kassie Wells '07, planetary science, Cornell University

• If you had a textbook with you, you could solve these problems. You could do them easily if they were homework problems. It's very different from how we study for exams here or how we do all our homework. You could get ten or fifteen questions if they just gave you Purcell. Take a long period of time to look over your textbooks to remember those equations... flashcards are good.
---Ross Martin '07, atomic, molecular, and optical physics, Penn State

• There's something to be said for route memorization of equations... you get a hundred questions in just under three hours, so even if you really understand the Compton equation for wavelength expansion perfectly, you should have it there in your mind. You don't want to sit there and take five minutes to derive it.
--Drew Brisbin '07, astrophysics, Cornell University

• See if you can get the department to organize a timed, sit-down

practice exam. The modern test they send you in the mail can be a good one.
---Ross Martin '07, atomic, molecular, and optical physics, Penn State

• Practice the GRE in the CMC room where it will be in. Calms the nerves on the actual day.
---Hans Bantilan '07, numerical relativity, Princeton University

• The GRE sucks. Take it anyway. Study hard. Memorize those equations and practice cold recall (even though you'll forget them by third term). Finally, don't borrow a GRE practice book from Bill and then leave it out in the rain.
--Drew Brisbin '07, astrophysics, Cornell University

• If there's a dumb mistake you can make doing a problem, you can be sure that answer will be there. It'll be right next to the right answer.
----John McDonough '07, lab manager and research assistant, A&I Equipment

• There are a few practice GRE books that are put out by people that are not ETS, and they're awful. There's a big purple book ["The Best Test Prep for the GRE Physics" by REA, Joseph Molitoris], don't buy it. It was just a waste. We worked on the problems in there and couldn't get a single one.
----Jon Emery '07, materials science, Northwestern

• It's really helpful to go into the test knowing what kind of questions are your strength and focus on those. If you can pick out the types of questions that you know you have down cold and skip the ones you know you're not as strong on, that can really help your score. Also, basic special relativity and the Doppler shift equation are things that show up on *every* test.
---Kassie Wells '07, planetary science, Cornell University

• If you can get your act together to organize a weekly study session with your friends during fall term, do it. Despite your best intentions, you might find that's the only time you study for the GREs. It can be hard to prioritize it if you're working alone, and you have a hard term. It's gonna be a source of guilt for you all of fall term.
---Melina Blees '07, experimental condensed matter, Cornell University

• I've been told that GRE scores are used primarily for comparison of institutions that the admissions committee doesn't know a whole lot about, particularly the international institutions. So if you're from a place like Carleton and someone there knows about it, the GREs

might not be as big a deal. They really just want to know if you'll be well prepared, and studies have shown that the *only* thing the subject GRE predicts is how well you'll do in your first two years of classes.
---Kassie Wells '07, planetary science, Cornell University

• Your stupid score doesn't mean you're a bad physicist, and it says nothing about your research potential - which is what they care about.
----Ross Martin '07, atomic, molecular, and optical physics, Penn State

• I've heard first-hand from the directors of two different graduate programs that they expect liberal arts students to do poorly on the subject GREs. We haven't had as many specialized classes and tend to not be trained very well to do fast, multiple-choice tests. So they know we're not going to do as well as students from tech schools or big universities.
--Melina Blees '07, experimental condensed matter, Cornell University

• My advice is to do GRE practice tests until you get sick and then do some more. Go back and figure out all the ones you missed. Sorry. It's the only way.
----Clark Ritz '04, nanoscale physics, University of Wisconsin, Madison.

• I essentially did not study. It seemed to work out... I'd like to believe that good programs do not use your GRE score as a major deciding factor, but I really have no idea what they do with it. It's probably best not to stress too much about it.
---Matthew Strait '03, neutrino physics, University of Minnesota

• If you want to get into a program that fixates on test scores you should do well on the tests. I didn't take the physics GRE and I didn't study for the general GRE. That might have hurt one of my applications, but it may have helped me find an institution and advisor that were a better match for my personality.
---Sam Kelly '05, physical oceanography, Oregon State

• Especially for the physics subject tests, the more [studying] the better. I think many Carleton students don't put enough emphasis on this and resign themselves to a low score. Many schools that you might fit with perfectly research-wise may never even look at your application beyond this number. Go into the exam having at least taken two older exams under real testing conditions so that you know what you are up against.
---Ted Holby '04, materials and science engineering, University of Wisconsin-Madison

• Take the subject GRE now (your senior year), regardless of your immediate plans (you can take it again, but it's much more difficult if you've been out of school for a while, so I've heard). Study often, talk with other students taking it, and make sure you do old tests (preferably in a timed environment at least some of the time). Don't be nervous about aiming high, even with what you might consider mediocre scores - many people I know in grad school (professors and students) did not do spectacularly well on the physics GRE.
---Kyle Willett '05, astrophysics, University of Colorado – Boulder

• Practice tests. Practice tests. Eliminate answers before attempting to solve problems.
----Neal Meyer '06, experimental atomic, molecular, and optical physics, Penn State

• I would add that there's no such thing as doing *well* on the subject GREs, only doing well enough. The goal is to get into grad school, then throw it away and never look at it again.
--Steve Meisberger '07, applied physics, Cornell University

Fellowships and Funding

One bonus to going to grad school in the sciences is that you won't be accruing more debt. Most of the loans you may have now won't start to collect interest until after you're out of graduate school, and the program you attend should at least provide you with a tuition waiver and a stipend you can live on. Unless you're offered a fellowship as part of a recruiting move, you'll likely work as a TA for your first year or two and then move to a lab for a research assistantship. RA positions are often more difficult to get for theorists, but most schools will promise you continued funding of some kind.

Fellowships are large lump sums that you don't have to work for. You will be automatically eligible for a department fellowship at some schools when you apply, but there are often others (especially minority scholarships) that you'll have to apply for separately. In the fall of your senior year you can also apply to the National Science Foundation's ridiculously generous two-year fellowship, which is difficult to get but also very worth it. That will require some proactive efforts on your part, however, since it's due in mid-November.

Some schools have an earlier deadline for their fellowship applications than their program applications, so be sure to check!

- I didn't apply to any fellowships, but found that most science Ph.D. programs only accept students if they can fund them. Masters engineering programs don't always provide funding right off. Ask current students about how stable grad student funding is. Some students have to write grants to fund themselves.
---Sam Kelly '05, physical oceanography, Oregon State

- The available funding often changes by subsections. A lot of the theoretical stuff doesn't really have money for students, so they'll have to work as a TA for their entire career. They'll also be in a research group, but won't get any money for it.
----Ross Martin '07, atomic and molecular optics, Penn State

- A warning: many fellowships are geared towards fields with practical applications, which may hurt or help you depending on your interests.
---Sarah Vigeland '06, astrophysics and general relativity, MIT

- The more fellowship applications the better, if you have the time.
---Ted Holby '04, materials and science engineering, University of Wisconsin-Madison

- I suggest that you apply [to fellowships], especially things like the

NSF - if you get a good one, you can often write your own ticket as far as research advisors and areas of interest.
---Kyle Willett '05, astrophysics, University of Colorado – Boulder

• You're clearly not going to graduate school to make the big bucks, but it's also nice to be able to eat. Think seriously about the funding if there's a big discrepancy between your offers, look at the cost of housing in the areas, and consider calculating what the money will wash out to over five or six years; some offers may look great but end up summing to less in the long run.
---Melina Blees '07, experimental condensed matter, Cornell University

• You should apply for fellowships, and again in your first year of grad school if you don't get one this time around. I wish I had.
----Clark Ritz '04, nanoscale physics, University of Wisconsin, Madison.

• Figuring out who has funding is harder to work out - a lot of that is word-of-mouth. Those guidebooks do have some information about that, as well.
---Steve Meisburger '07, applied physics, Cornell University

• A lot of labs only have one graduate student, and that's usually a bad sign about how much funding the groups are getting. If they publish lots of papers and have lots of postdocs, that's a good sign that they have money, but the downside is they might not want to talk to you.
----Ross Martin '07, atomic and molecular optics, Penn State

• I found that the particularly well-endowed places like to tell you how much funding they get, so it might be a good way to think about it; if they tell you how much money they have then they probably have a lot, and if they don't mention it that can be a bad sign.
---Kassie Wells '07, planetary science, Cornell University

• I applied to two fellowships, each one from a specific school. I wasn't even aware of these fellowships until professors whom I wanted to work for mentioned them to me. Be sure to ask about fellowship opportunities, there is a lot of money hiding out there.
---Ghidewon Arefe '03, nanoparticle science and mechanical engineering, University of Minnesota

Contacting Potential Advisors

Many people suggest picking a professor whose work interests you at each of your schools, and contacting them well before your applications are due. This approach has multiple benefits: you'll begin to narrow down your interests, appear serious about the program, have someone to cite in your personal essay... and, if you make a good contact, maybe even have someone in a position of influence who will vouch for you.

A good phone call or introductory email expresses your interest in their research, includes a line or two about your background in the field (this is a great place to cite REU experience), and asks whether they plan to take on new graduate students in the next few years. Some professors will be frank about having no funding, some will never respond, and some will be friendly and enthusiastic. If they offer to speak to you by phone or invite you to visit their lab, take the opportunity. Graduate admissions, unlike undergrad, have a lot to do with who they want *that year.* Does someone with your interests need a grad student at the moment? It means grad school apps are a lot less predictable than undergrad apps, but it also means any contact you can make with professors will be valuable.

- If you go to Carleton, usually you're personable, and your communication skills are far better than other people's. Make the best of that opportunity! If you want to get in contact with a professor before you apply, *call them* and talk to them! Your verbal skills are far above that of most people, it's just how it is, so use everything to your advantage.
----Ross Martin '07, atomic and molecular optics, Penn State

- For each institution, contact a professor who's work interests you, early enough to get a response; having a person in mind while writing the personal statement makes the process more pleasant.
---Hans Bantilan '07, numerical relativity, Princeton University

- In my experience, some will be really friendly and some will blow you off with a "I put my efforts towards students who have already been accepted." Their reaction may actually end up telling you something helpful about their potential as an advisor. I contacted people and found it informative, but I think it helped me more than it helped my application.
---Melina Blees '07, experimental condensed matter, Cornell University

- I sent out emails to professors I thought were doing interesting things, or sometimes just to departments. Some professors wrote back, called me, or referred me to another professor. Others I never

heard from. Talk to professors before you apply, often times it is just a matter of funding. If they aren't looking for a graduate student you can save yourself some time.
---*Sam Kelly '05, physical oceanography, Oregon State*

• I tried contacting potential advisors, with mixed results (professors are busy). At my current school, professors went out of their way to contact me during the applications process, calling me at Carleton to discuss things with me personally, which I appreciated a lot (and contributed to my decision). Have some familiarity with profs' research and experience before contacting them, if you choose to do so - you want to be able to talk intelligently with them.
---*Kyle Willett '05, astrophysics, University of Colorado – Boulder*

• [Contacting professors] is probably THE biggest overlooked point by applicants. In particular, talking to professors about their research and ability to fund students can give you a good in.
---*Ted Holby '04, materials and science engineering, University of Wisconsin-Madison*

• I mentioned a couple of professors in my personal statement, and then I ended up contacting them as well. I found out later that they actually read my application and had recommended me for admission to the committee, which is kind of nice. I've heard a lot of strange things about admission to grad school, they have committees and a lot of it is professors saying that they want someone to work in their group and do x, and bid for people, so it's not always like undergrad where you get ranked. Little connections can help.
---*Steve Meisburger '07, applied physics, Cornell University*

• I did email individual professors at the schools I applied to and said, "Hi, I'm interested in your group. Are you planning to take on any new students in the next few years?" I also mentioned those people in my essays. I don't know if that helped me or hurt me... I think it helped, but I can't be sure.
----*Clark Ritz '04, nanoscale physics, University of Wisconsin, Madison.*

• Not all the professors you are going to talk to will have great people and verbal skills, so don't be totally awkward or weirded out if they're not personable. But make a mental check of that; do I want to spend the next six years working with someone has no social skills?
---*Kassie Wells '07, planetary science, Cornell University*

• I contacted professors ahead of time at all but one of my schools. It's a great idea. It will make your application stand out a bit, which is really important considering how many applicants they get every year.

Having a prof who is interested in working with you is a huge help.
---*Sarah Vigeland '06, astrophysics and general relativity, MIT*

• I contacted people at all the universities I applied to, and it definitely helped. Not only did they look for my file during applications, but they also provided a good place to start when going to visit.
----*Mara Morgenstern '06, geophysics, University of Illinois - Urbana-Champaign*

• I think [contacting potential advisors] helps in learning what the department is like, if they are generally good with answering questions, if they are helpful, who is taking grad students, etc. but I doubt it influences their decisions on whether or not they accept you.
----*Neal Meyer '06, experimental atomic, molecular, and optical physics, Penn State*

• I emailed a few professors. Most never responded, but one from UPenn did. She was very nice and pointed me at a few of her groups papers I could look into. I didn't get in, but I was waitlisted. Talking to her may have helped, but I can't be sure. If there's someone you're REALLY interested in working with, by all means get your name out there and try to get your foot in the door.
----*John McDonough '07, lab manager and research assistant, A&I Equipment*

• I e-mailed the professors I was referred to and asked them if they were looking for students. I then crafted my application to the school around that professor. Some background work on lab websites allowed me to find out what that professor was doing in particular, and then I talked about that in my statement of purpose. I also used my statement of purpose to describe how my background had prepared me for the work I wanted to do, and I tailored my statement to each individual professor.
----*Adam Libson '04, atomic optics, University of Texas – Austin*

• I came in and talked to a professor before I applied and it was very helpful. It gave me a much better idea of how the program worked than reading the official stuff.
---*Matthew Strait '03, neutrino physics, University of Minnesota*

The Personal Statement

By the end of fall term you'll be finished with the subject GREs, and you'll think the worst is over. It is, but writing the personal statement is often the second most stressful part of grad school apps. For college apps we were told to be exceptionally original, but it's hard to know what tone to strike for the graduate school personal statement. Get started early, and find a few really good critics to help you.

Two pages double-spaced is a good maximum length - much over that and you're risking being boring. Some schools will also provide specific length requirements.

The essay usually consists of a strong opening, a discussion of your research experience, your specific interests, and why you want to go to that school in particular. If you've made contact with a professor at the school, cite that and express your interest in their work. Also include any teaching experience or involvement in your department.

Finally, really investigate the programs you're considering. The more you know about what makes that program special the more you can tailor your essay, and they seem to really appreciate that. They want to know how well you'll fit in there and how good a grad student you'll be to them. If you can talk about their personalized graduate curriculum, research rotations program, or their new nanoscience institute, it'll show real interest and knowledge of their program. Personalizing each essay will take a long time (especially if you apply to lots of schools), but it'll be worth the work.

And the obvious: make sure you have the right school's name everywhere!

• Don't get too saccharine (the problem with mine), have lots of people vet it for you, and be honest about what interests you about physics and what *you* can bring to the school that accepts you.
---Kyle Willett '05, astrophysics, University of Colorado – Boulder

• We're Carleton students. I knew that there were a lot of liberal arts skills that I have that will make me unique and really important to a department, so I spent a lot of in my personal statement saying, "I've proven that I can do physics and that I can do research, but I also have these other qualities that I don't think a lot of your applicants might have, and here's how I will apply them to planetary science in your department. This is why you want *me* rather than someone else, because this is how I'm going to add to your program."
---Kassie Wells '07, planetary science, Cornell University

• Get many people to look over it. Give a balance of general statements and specific examples of what you've accomplished and

what you want to accomplish. Be unique, so that they remember your statement over the 500 others they read. Don't be afraid to talk yourself up. It's difficult, but you have to do it.
----Neal Meyer '06, experimental atomic, molecular, and optical physics, Penn State

• It helped me to think of it as a job application - what my background was, how I'd be a good TA/researcher, how I could help *them.* They don't really care about *why* you're motivated, they just want to know that you *are* motivated. My first version had a long story about how I got involved in physics, but I ended up cutting almost all of that in favor of saying, "Clearly I'm interested in this because I've done *x, y,* and *z* in terms of research and classes, and here's what I want to do with it in the future." Show that you're interested and excited, but that you really know what a career in science will entail. They want to know that you have direction and will stick with it when it gets tough. You don't want to be dry, obviously, but think of a personal yet professional way to explain your reasons for wanting to devote another six years to physics. Don't use the word "passion." Try really hard to avoid cliché of any kind. Sell yourself as a job applicant, more than by telling them how they can help you. Just saying, "I'd love to go to your graduate school to continue my dream" isn't necessarily what they want to hear.
---Melina Blees '07, experimental condensed matter, Cornell University

• The actual application process is grueling. You really should have other people help you with your personal statement. I didn't ask for comments on mine (I was too chicken), and I think that hurt me.
----Clark Ritz '04, nanoscale physics, University of Wisconsin, Madison.

• You don't want to be really redundant about information that's already in your application at other places, so if they have a separate place for really detailed information about the research that you've done, use that. You're only going to have maybe 500 words, and the whole point of the personal statement is to make sure that they remember you. If you're just putting in all the information into essay form that you've included elsewhere as a list, I don't think that's very helpful.

It's also a good idea to think about the atmosphere of the department you're applying to. Cornell, for instance, has a lot of liberal arts students, so in my application I played up my other interests and liberal-arts-style skills. But if I was applying to Caltech I don't think that would be a very helpful strategy, because I know that they don't really care about that, so I'd focus on other things that fit better with the atmosphere of that university. That's one way to tailor your applications to individual schools if you've done your research.

---Kassie Wells '07, planetary science, Cornell University

• Obviously, the technical aspects (grammar, spelling, etc.) are important. Be honest about your aspirations and explain what you hope to get out of the grad school experience. If you have an idea of the type of research you are interested in, mention that as well.
---Ghidewon Arefe '03, nanoparticle science and mechanical engineering, University of Minnesota

• Since I knew fairly little about the details of what I wanted to study, I spouted some boilerplate about wanting to study physics to understand the universe. If I had actually had the time/motivation/ability to figure out what the current big questions in neutrino physics were and what efforts were being made to answer them, it probably would have substantially strengthened my application to demonstrate this. However, given that I didn't, probably speaking in generalities was a better tactic than trying to BS based on Scientific American articles or whatnot.
---Matthew Strait '03, neutrino physics, University of Minnesota

• I started with an overview of research work and experience. Start with something solid, and then feel free to propose your own theories. Make sure that you start with really solid points about yourself. Then, if you have some revealing personal anecdotes, include that.
---Hans Bantilan '07, numerical relativity, Princeton University

• When submitting personal statements, read them through *very* carefully to make sure you don't still have the name of the last grad school you applied to hidden somewhere amongst your expertly cut-and-pasted masterpiece.
---Drew Brisbin '07, astrophysics, Cornell University

• The one thing you have to remember is what they're looking for in a graduate application. They're going to spend a ton of money on you for at least the first two years and they're not going to get a return for it, so what they want to make sure of is that by the time you're done with those two years you're going to be competent. So what you want to show on your application is that you're a safe investment for them to make and that you can do things well. I found it really helpful to think of it as selling myself as an investment to the university.
---Kassie Wells '07, planetary science, Cornell University

• The applications I put a lot of time into, I got in, and the ones I just sort of routinely filled out I didn't get in. At Princeton, for example, I emailed a professor and told him I was interested in numerical relativity, and he said they were hiring a new guy to start a numerical

relativity group at Princeton, so I wrote in my essay that I wanted to contribute to their new and growing numerical relativity group. That ended up being really effective.
---Hans Bantilan '07, numerical relativity, Princeton University

General Advice

• If you're applying to a lot of grad schools, it's a good idea to do your comps as early as possible. You'll start to visit schools at the end of winter term and the beginning of spring term, and if you do one of the later comps then you end up giving your talk at the end of winter term or the beginning of spring term, and it becomes more difficult to travel.
---Steve Meisburger '07, applied physics, Cornell University

• If you are waitlisted, do not be afraid to call and talk with department admissions. Had it not been for a call to the professor in charge of admissions, I may not have ended up in Madison.
---Ted Holby '04, materials and science engineering, University of Wisconsin-Madison

• Apply early. Don't be late. Don't be on time, either. Most deadlines are Jan. 15th but some are Dec. 15th, and some places will offer fellowship money to early acceptees. Also, put away some money if you're going to apply. Ask for help for Christmas. It costs a LOT of money to go through this application process.
----John McDonough '07, lab manager and research assistant, A&I Equipment

• It's a lot easier to decide a Ph.D. isn't for you after a few years and graduate with a master's than to finish a master's program and try to get into the Ph.D. program.
---Craig Hogle '07, atomic & molecular physics, University of Colorado – Boulder

• Don't feel pressured to enter grad school immediately out of undergrad. Most of the really good students I know here took a year or two off, usually doing useful things (lab work, travel, etc), and it has made them much better students. Consider deferring if you're unsure, or getting some physics-related experience before plunging back into classes. I know I've felt burned out at points, and could have benefited from a year off.
---Kyle Willett '05, astrophysics, University of Colorado – Boulder

• If you want to apply and then defer, don't tell them that initially. Get accepted, *then* tell them that. And make sure before you apply that they'll permit deferrals. They've secured a space for you, and they tend to find that a lot of the people that defer for a few years end up deciding that they don't want to go to graduate school after all. So it's more of a risky investment for the school, and even if they allow

deferrals it's better not to advertise that when you apply.
---Kassie Wells '07, planetary science, Cornell University

• If you want to take a year off, that's not at all unusual or looked down upon by admissions committees; if fact they often seem to prefer that, because the people who come back tend to be very dedicated and know *why* they want to do it, rather than just going because it's the next step. If you decide to wait before applying, though, try to take the GREs while you're still in school, and get your recommendation letters squared away.
---Melina Blees '07, experimental condensed matter, Cornell University

• If you are feeling a little burned out, don't worry, that's normal. Taking a year or two (or three?) off after Carleton is entirely healthy. Grad school can be an intense experience so make sure you start out with the same excitement and energy you had during new student week. Good luck!
---Ghidewon Arefe '03, nanoparticle science and mechanical engineering, University of Minnesota

• There are a ton of graduate programs that want physics majors. You'll learn new things very quickly in graduate school, so don't worry about going into something that you feel you know a lot about right now. Engineering, meteorology, oceanography, biophysics, and applied math are obvious possibilities, but depending on your non-physics classes there may be several other areas you can study. Many sciences depend on physics.
---Sam Kelly '05, physical oceanography, Oregon State

• Start looking at schools, coming up with your personal statement, talking to professors, asking for recommendations, studying for the GRE, and everything else, as soon as possible!
----Neal Meyer '06, experimental atomic, molecular, and optical physics, Penn State

• A word of caution: Do not make any agreements to work with somebody until you get to the department. I chose to come to UIUC because of the professor I was talking with. He seemed great, even in person, and asked me to come during the summer to jump-start research. I was excited. Of course, I did not do thorough research as to what it is I wanted to study in general, but thought that mineral physics would be a good area. I ended up hating my research as well as my advisor and got stuck in the middle of a departmental feud when I switched advisors to his enemy. Contact people you think you would like to work for to get a feel for what it is they do and what it would be like to do research with them. Do NOT make formal plans

to work with anybody until you get a chance to be in the department and get to know all your options. It's silly to narrow things down when you don't have to. Getting a jump-start on research is something you should do only if you are completely sure, and even then proceed with caution.
----Mara Morgenstern '06, University of Illinois - Urbana-Champaign

• Order transcripts early - it can't hurt, and hoping they get there on time isn't a stressor you'll need.
---Melina Blees '07, experimental condensed matter, Cornell University

• Do an REU and independent research. Independent research was one of the best experiences I had at Carleton (and it looks good on resumes).
-----Alex Petroff '06, chaotic systems in geophysics and climate change, MIT

• Getting into grad school is a lot of work. Worry about it and devote time to it. Sure you're already busy with comps, but forget that. Everyone passes comps. Not everyone gets into grad school. So if your aim is grad school, make it the priority.
---Drew Brisbin '07, astrophysics, Cornell University

• Be on top of things. Don't wait till the last minute. Don't be insecure. Talk to the faculty, they're a phenomenal resource. Lean on your friends; but be careful. Grad school is a touchy subject for a lot of people, and it can create a lot of stress since we tend to compete for a lot of the same spots. Be tactful, and keep in mind that not everyone gets in everywhere; as Carleton students, we're not used to being told "no," and its a competitive process. Be kind to your friends and support each other.
----John McDonough '07, lab manager and research assistant, A&I Equipment

• My recommendation is to start networking. The Carleton alums are very good for that, even parents who aren't in the same field. Talk to people you know who have parents in the field you're interested in, and get yourself out there. My way was mainly through an internship. By showing the school ahead of time what success I could have in the lab and research, they wanted to keep me working at their school. So get an internship, get your name out there, and start looking now!
----Rebecca Davis '06, quantum computing, George Washington University

• I guess the biggest piece of advice I would have is to talk to as many people as possible. Get advice from your current professors, people

you know who have gone through the process, etc... It *is* very stressful, but the more you talk to people, the more options you'll realize you have.
---Neal Meyer '06, physics, Penn State

- If you still want to go to grad school then read some of *Piled Higher and Deeper* at www.phdcomics.com. If you still want to go to grad school after that, then you might just be crazy enough to survive it. Best of luck!
----Clark Ritz '04, nanoscale physics, University of Wisconsin, Madison.

Visiting and Deciding

Most schools send out acceptances as they pick students, so the first emails you'll get will probably be acceptances and the rejections will come later (if they come at all). Offers should begin to arrive around March, and you'll need to decide for sure by April 15th, the universal agreed-upon deadline. Schools may offer to fly you out for a visit; if so, you should absolutely accept these offers, especially if they're someplace warm. In a lot of parts of the country, March is spring.

• When you're on the visit, talk to people! Ask questions! Be brave! They let you in, they're not going to toss you out because you ask to many questions on the tour.
----*Ross Martin '07, atomic and molecular optics, Penn State*

• Go expecting it to be an all-day thing. Be well rested. Most programs have a whirlwind of two or three straight days of breakfast at 8am and evening events, and you really want to make the most of it.
---*Craig Hogle '07, atomic & molecular physics, University of Colorado at Boulder*

• Don't get discouraged if you get turned down. You are not a failure. Most people who will respond to this questionnaire will tell you how great it is to be accepted, and how much fun it is to visit, and how exciting it is to make your choice. But the truth of the matter is, you will not get in everywhere you apply. And that's not a bad thing; it's a fact of life. The admissions process is subjective. There will be a lot of applicants. You will be turned down. But don't let it get to you, and don't let it consume you. I learned that the hard way.
----*John McDonough '07, lab manager and research assistant, A&I Equipment*

• Listen to your gut about where to apply and where to accept. You'll know which places feel like a good fit and which ones don't.
---*Sarah Vigeland '06, astrophysics and general relativity, MIT*

• If you're seriously considering a school, take the time to talk about housing with current grad students when you visit. At some schools everyone lives in the school-sponsored housing their first year, and you probably wouldn't want to be left out, but at other schools it's not your best option. Your visit may be your only chance to get that information. Also, some schools will put you on a housing waitlist before you've even accepted, so it's worth asking if that's possible.
----*Melina Blees '07, experimental condensed matter, Cornell University*

• PAY ATTENTION TO CURRENT GRAD STUDENTS!! When you visit schools

make *sure* you talk to the grad students. If the department is hiding them from you, it usually means they are unhappy in the department. If they complain they hate their lives, listen to *why*. I got fair warning from the grad students of my former advisor and didn't listen. I thought it would be different with me. It was not. But also know that being a grad student automatically means lots of work and lots of complaining, so be able to filter advice.
----Mara Morgenstern '06, geophysics, University of Illinois - Urbana-Champaign

• Visit as many places as you can even if you don't think originally that you're interested in a given school, because you might be totally surprised. Plus, I thought it was really fun to meet the other incoming grad students in my field because a lot them I met at all of the places I went to, and some of the professors were telling stories about they met colleagues they work with at grad school visits, so it's a good way to get to know people who are going to be working on the same things as you are.
---Kassie Wells '07, planetary science, Cornell University

• Talk to current graduate students. They, more than anything else, will give you an idea of the department. Ask them if they're happy. You can just straight-up ask if they're happy, ask what they don't like, and most of them will be very honest with you, especially the students you just meet and haven't been set up with by the department. The disgruntled people will tell you at least as much about a department as the happy ones. If you have time, get a sense of the environment of the school and the housing situation, what quals are like (some places pass everyone, some fail out half of their 2nd-year grad students), whether the atmosphere is competitive or collaborative, and whether there's funding. A campus visit will give you a strong sense of atmosphere, which you may love or hate; I would say *never* go anywhere you haven't visited.
---Melina Blees '07, experimental condensed matter, Cornell University

• I visited my top choices and made sure to seek out professors who had interesting research projects. Even if you aren't invited to an official recruiting weekend, make sure to check out the department's website, and if possible, make a trip out there on your own if it's one of your top choices.
---Ghidewon Arefe '03, nanoparticle science and mechanical engineering, University of Minnesota

• In addition to paying attention to all the things they say, also pay attention to the things they *don't* say. These visits are very well-run and well-scheduled, and someone has thought a lot about the things that they want to focus on and the things they want to sort of push under the rug. So those are the things that you should make a mental note about: "They didn't mention this, so I should remember to ask a grad student about it."
---Kassie Wells '07, planetary science, Cornell University

• Applications are expensive, but if you get in, it's kind of a payback. They

treat you well.
---Steve Meisburger '07, applied physics, Cornell University

• I visited the schools where I'd been accepted (on their dime) and decided where I wanted to be. When you're deciding where to go, I'd recommend making sure to take some time to talk to each professor you're thinking of working with, to see if they're a person you can spend six years working with. Also be sure to talk to the grad students. They'll likely tell you what it's really like working there, the professor's management style, the degree of bureaucracy at the school, the financial support provided (RA/TA), the ease of living on such a salary and other such things. Ask tough questions, since you will be there for a while, and try to see if you would get along with the professor and the other grad students in the group.
----Adam Libson '04, atomic optics, University of Texas – Austin

Further Resources

http://pages.physics.cornell.edu/~larrimore/gradschool.html

http://www.dartmouth.edu/~physics/academics/beyond.ug.degree.html

http://www.csus.edu/indiv/t/tumminia/Grad.htm

The Ph.D. Process: A Student's Guide to Graduate School in the Sciences by Dale F. Bloom, Jonathan D. Karp, and Nicholas Cohen. Oxford University Press, 1998. ISBN: 0195119002.

GRE: Practicing to Take the Physics Test by the Educational Testing Service (ETS). Educational Testing Service, 1997. ISBN: 0886851971 (although other editions occasionally surface).

Kaplan GRE Exam 2006, Premier Program (Book & CD-Rom) by Kaplan Publishing, 2005. ISBN: 0743265440.

Peterson's Game Plan for Getting into Graduate School by Marion Castellucci. Peterson's, 2000. ISBN: 0768903912.

A Ph.D. Is Not Enough: A Guide to Survival in Science by Peter J. Feibelman. Perseus Books Group, 1994. ISBN: 0201626632.

- Read the websites of the programs you're interested in detail; many have links to student's individual pages, which are also great for seeing what life as a grad student permits you.
---Kyle Willett '05, astrophysics, University of Colorado - Boulder

- Any of the professors is a good resource; after all, they've all been through the grad school application process!
---Sarah Vigeland '06, astrophysics and general relativity, MIT

- Gradschoolshopper.com is a great resource. It's all the content of the Big $70 Book-O-Graduate Programs, only free and searchable!
---Melina Blees '07, experimental condensed matter, Cornell University

- I did a lot of websurfing to find some cool non-tradition physics programs. Google schools, peoples names, and science topics.
---Sam Kelly '05, physical oceanography, Oregon State

- Utilize the GRE practice books we have. They give you a lot of good practice questions. Other than that I tend not to trust a lot of the

material out there because you never know who has what agenda when they're creating all of it.
----John McDonough '07, lab manager and research assistant, A&I Equipment

- www.insertphysicsdepartmentwebsitehere.edu. The departmental websites of most schools have a lot of information regarding the program, the professors, the campus, etc. [Neal also offered to give advice to individual Carleton students: nem150@psu.edu].
----Neal Meyer '06, experimental atomic, molecular, and optical physics, Penn State

Final Thoughts

The application process is a pain, and it's often terrifying. The wait can be very long. It's tough to judge your own competitiveness, and you may start to second-guess just about everything. One nice thing to discover, however, is that Carleton's physics program is well respected and widely-known within the physics community, and a strong record here will serve you well in the long run. We're the top liberal arts producer of Physics Ph.D.s in the country, and the alumni tend to be extremely friendly and more than happy to help you out; so if you're considering a school or just have general questions, don't hesitate to contact one or more of the students who came before you.

The resources for grad school apps aren't as easy to find as they were for college applications, but they do exist. Your winter break will be full of personal statement drafts and time spent in the line at the post office, but keep in mind that in the end you'll be getting paid to go to school instead of accruing the unimaginable debt of med school or non-science graduate school. Think about that a lot when you're writing checks to your reach schools.

You'll survive.

Melina Blees and John McDonough, SDAs 06/07

Physics (Ph.D.)

Ranked in 2006*

Rank/School		Average assessment score (5.0 = highest)
1.	Massachusetts Institute of Technology	5.0
	Stanford University (CA)	5.0
3.	California Institute of Technology	4.9
4.	Harvard University (MA)	4.8
	Princeton University (NJ)	4.8
	University of California-Berkeley	4.8
7.	Cornell University (NY)	4.7
8.	University of Chicago	4.6
	University of Illinois-Urbana-Champaign	4.6
10.	University of California-Santa Barbara	4.4
11.	Columbia University (NY)	4.3
	University of Texas-Austin	4.3
13.	University of Michigan-Ann Arbor	4.2
	Yale University (CT)	4.2
15.	University of Maryland-College Park	4.1
16.	University of California-Los Angeles	4.0
	University of California-San Diego	4.0
	University of Colorado-Boulder	4.0
	University of Pennsylvania	4.0
	University of Washington	4.0
	University of Wisconsin-Madison	4.0
22.	Johns Hopkins University (MD)	3.8
	SUNY-Stony Brook	3.8
24.	Ohio State University	3.7
	Pennsylvania State University-University Park	3.7
	Rutgers State University-New Brunswick (NJ)	3.7
27.	Rice University (TX)	3.6
	University of Minnesota-Twin Cities	3.6
29.	Brown University (RI)	3.5

	Carnegie Mellon University (PA)	3.5
	Duke University (NC)	3.5
	Michigan State University	3.5
	Northwestern University (IL)	3.5
	University of California-Irvine	3.5
35.	Boston University	3.4
	Georgia Institute of Technology	3.4
	Indiana University-Bloomington	3.4
	New York University	3.4
	Purdue University-West Lafayette (IN)	3.4
	University of Arizona	3.4
	University of California-Davis	3.4
	University of Florida	3.4
	University of Rochester (NY)	3.4
	University of Virginia	3.4
45.	Florida State University	3.3
	University of California-Santa Cruz	3.3
	University of North Carolina-Chapel Hill	3.3
	Washington University in St. Louis	3.3
49.	Texas A&M University-College Station	3.2
50.	Case Western Reserve University (OH)	3.1
	CUNY Graduate School and University Center	3.1
	University of Notre Dame (IN)	3.1
	University of Pittsburgh	3.1
	University of Southern California	3.1
55.	Arizona State University	3.0
	Dartmouth College (NH)	3.0
	Iowa State University	3.0
	North Carolina State University	3.0
	Rensselaer Polytechnic Institute (NY)	3.0
	University of Massachusetts-Amherst	3.0
	University of Oregon	3.0
62.	Brandeis University (MA)	2.9
	College of William and Mary (VA)	2.9
	University of Illinois-Chicago	2.9
	University of Iowa	2.9
	Vanderbilt University (TN)	2.9
61.	Rockefeller University (NY)**	2.9
67.	Northeastern University (MA)	2.8
	Syracuse University (NY)	2.8
	University of California-Riverside	2.8
	University of New Mexico	2.8
	University of Tennessee-Knoxville	2.8
	University of Utah	2.8
	Virginia Tech	2.8
74.	Boston College	2.7
	Emory University (GA)	2.7
	Louisiana State University-Baton Rouge	2.7
	Tufts University (MA)	2.7
	University of Connecticut	2.7
	University of Delaware	2.7
	University of Georgia	2.7
81.	Colorado State University	2.6
	University of Hawaii-Manoa	2.6

	University of Kansas	2.6
	University of Nebraska-Lincoln	2.6
85.	Colorado School of Mines	2.5
	Kansas State University	2.5
	Ohio University	2.5
	Oregon State University	2.5
	University at Buffalo-SUNY	2.5
	University of Houston	2.5
	University of Missouri-Columbia	2.5
	University of Oklahoma	2.5
	University of South Carolina	2.5
	Washington State University	2.5

*This ranking was computed in January of the year cited, based on data from a survey sent out in the fall of the previous year.
**The school was mistakenly left out of the 2006 survey because of an error in interpreting data from the National Science Foundation's WebCASPAR database. Data and rankings from the 2002 survey appear.

Physics Specialties: Atomic/Molecular/Optical

Ranked in 2006*

1. University of Colorado-Boulder
2. Massachusetts Institute of Technology
3. Harvard University (MA)
4. Stanford University (CA)
5. California Institute of Technology
   University of Michigan-Ann Arbor
7. University of California-Berkeley
8. University of Arizona
9. Rice University (TX)
10. University of Maryland-College Park
    University of Rochester (NY)
    University of Texas-Austin
13. University of Washington
14. Kansas State University
    Princeton University (NJ)
16. University of Virginia
    Yale University (CT)

*This ranking was computed in January of the year cited, based on data from a survey sent out in the fall of the previous year.

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Address | City

State | Zip | Email

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Physics Specialties: Condensed Matter

Ranked in 2006*

1. University of Illinois–Urbana-Champaign
2. Cornell University (NY)
3. Harvard University (MA)
4. Massachusetts Institute of Technology
5. Stanford University (CA)
6. University of California–Santa Barbara
7. University of California–Berkeley
8. Princeton University (NJ)
9. University of Chicago
10. California Institute of Technology
11. University of California–San Diego
12. Pennsylvania State University–University Park
    University of Maryland–College Park
    Yale University (CT)
15. Columbia University (NY)
16. University of Pennsylvania
17. Ohio State University
18. University of Minnesota–Twin Cities
19. University of Michigan–Ann Arbor
    University of Texas–Austin
21. Rutgers State University–New Brunswick (NJ)

*This ranking was computed in January of the year cited, based on data from a survey sent out in the fall of the previous year.

Physics Specialties: Cosmology/Relativity/Gravity

Ranked in 2006*

1. California Institute of Technology
2. University of Chicago
3. Princeton University (NJ)
4. Massachusetts Institute of Technology
5. Harvard University (MA)
6. University of California-Berkeley
7. Stanford University (CA)
8. University of California-Santa Barbara
9. Pennsylvania State University-University Park
10. University of Texas-Austin
11. Cornell University (NY)
12. Ohio State University
    University of California-Davis
    University of California-Santa Cruz
    University of Maryland-College Park

*This ranking was computed in January of the year cited, based on data from a survey sent out in the fall of the previous year.

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Physics Specialties: Elementary Particles/Fields/String Theory

Ranked in 2006*

1. Princeton University (NJ)
2. California Institute of Technology
   Stanford University (CA)
4. Harvard University (MA)
5. Massachusetts Institute of Technology
6. University of California-Berkeley
7. University of Chicago
8. University of California-Santa Barbara
9. Cornell University (NY)
10. University of Michigan-Ann Arbor
11. Columbia University (NY)
12. University of Wisconsin-Madison
13. Rutgers State University-New Brunswick (NJ)
14. University of Illinois-Urbana-Champaign
15. SUNY-Stony Brook
    University of Texas-Austin
17. University of Washington

*This ranking was computed in January of the year cited, based on data from a survey sent out in the fall of the previous year.

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Address | City

State | Zip | Email

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Physics Specialties: Nuclear

Ranked in 2006*

1. Massachusetts Institute of Technology
2. Michigan State University
   University of Washington
4. SUNY–Stony Brook
5. California Institute of Technology
   Yale University (CT)
7. Indiana University–Bloomington
8. Columbia University (NY)
9. University of California–Berkeley
10. University of Illinois–Urbana-Champaign
11. Duke University (NC)
12. University of Maryland–College Park
13. Florida State University
    Ohio State University
    University of Notre Dame (IN)
16. Texas A&M University–College Station
17. College of William and Mary (VA)

*This ranking was computed in January of the year cited, based on data from a survey sent out in the fall of the previous year.

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First Name | Last Name

Address | City

State | Zip | Email

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Physics Specialties: Plasma

Ranked in 2006*

1. Massachusetts Institute of Technology
   Princeton University (NJ)
3. University of California–Los Angeles
4. University of Wisconsin–Madison
5. University of Maryland–College Park
6. University of California–San Diego
7. University of Texas–Austin
8. Columbia University (NY)
   University of Iowa
10. University of Colorado–Boulder
    University of Michigan–Ann Arbor

*This ranking was computed in January of the year cited, based on data from a survey sent out in the fall of the previous year.

Physics Specialties: Quantum

Ranked in 2006*

1. Massachusetts Institute of Technology
2. Harvard University (MA)
3. California Institute of Technology
4. Stanford University (CA)
5. University of California-Berkeley
6. University of California-Santa Barbara
   University of Michigan-Ann Arbor
8. Princeton University (NJ)
9. Yale University (CT)
10. Cornell University (NY)
    University of Colorado-Boulder
    University of Illinois-Urbana-Champaign
    University of Maryland-College Park

*This ranking was computed in January of the year cited, based on data from a survey sent out in the fall of the previous year.

Sample Personal Statements

The following examples have been generously donated by past seniors. They will hopefully give you an idea of the kind of essays that have been successful in the past, but of course each essay should be very tailored to the particular program to which you're applying. These statements have been made (moderately) anonymous by the substitution of NAME and SCHOOL, respectively, and are of course still the intellectual property of their respective authors. The statements are available in the Olin binder, but will not be included in the online edition of the handbook.

Sample Personal Statement #1

NAME **Astronomy**

"Data! Data! Data! I can't make bricks without clay." These are the words of Sir Arthur Conan Doyle's famous fictional detective, Sherlock Holmes. This particular quote has always held special appeal for me, because it alludes to Holmes's belief that the complex world we inhabit is not irrational. Rather, it is a conglomeration of observables that the well-trained mind is capable of organizing into a logical pattern. The solution is out there, Holmes assures us, we need only be dedicated and observant enough to allow the facts to reveal themselves.

Reminiscent of Sherlock Holmes and his detective work, astronomy relies not on controlled experiments where variables can be manipulated and removed, but rather on the close scrutiny of the variables with which nature chooses to present us. Like the famous detective who can deduce the personality and station of a suspect by the mark of his boot, the astronomer determines the composition of a galaxy or the topography of a distant planet wielding nothing more than the information contained in a few electromagnetic waves. This super-sleuth facet has made the work I have undertaken to this point in astronomy very satisfying, so much so that I have decided to pursue graduate study in the field.

My primary research interest as a graduate student would be the field of planetary science, where I could apply my physics background to the study of geophysics and planetary surfaces and interiors. As a graduate student at SCHOOL, I hope to unravel obscured planetary histories by applying my ability to recognize patterns and observe fine details in a way that would make even the detached Holmes proud. For instance, my training as an artist has taught me how to scrutinize the light brush strokes and glimmers of cool under-paintings that peek through the final layers of the vibrant oil creations of the masters. By utilizing these stray clues, an observant student can reconstruct the process by which these works were created and produce copies which retain the depth and complexity of the originals. This ability could be easily extended to the analysis not of paintings but of planetary surfaces, whose sculptural qualities and sprawling vistas provide as bold a narrative of their formation as could be provided by a stray marking on the surface of a canvas.

Thus, I can picture myself studying any one of a variety of topics ranging from planetary volcanism, impact histories, and magnetospheres to weathering of Martian terrains. In particular, however, I am drawn to Donald Campbell's work in radar remote sensing, Marina Romanova's investigation of the influence of magnetic fields on the formation of gas giants, and James Bell's research with the PANCAM instruments on the Mars rovers Spirit and Opportunity. Eventually, I plan to utilize the skills I would develop at SCHOOL

to become a professor of physics and astronomy at a small liberal-arts school like the one I have attended as an undergraduate. As a professor, I would endeavor to balance exceptional teaching with state-of-the-art, pertinent research, as my professors at Carleton have done.

Because of my early interest in the field of astronomy, I was invited as a college freshman to join Carleton College Professor Joel Weisberg in his research at Arecibo Observatory. At Arecibo, we collected spectral data of small scale OH clouds using pulsars as background sources. I also worked with Dr. Weisberg at Parkes Observatory to observe spectral absorption and emission in OH clouds on the lines of sight of several pulsars visible from the Southern Hemisphere. On both of these trips I had the opportunity to operate the telescopes on my own, an exciting but immense responsibility.

Another valuable skill I have developed in my research experiences is the ability to work independently. My undergraduate institution, Carleton College, emphasizes collaboration between scientists and requires extensive group projects, so the self-directed nature of this research has provided a balance to my class work. In particular, when I was an REU student for the National Radio Astronomy Observatory in Socorro, New Mexico, I was responsible for learning several reduction software packages while my advisor, Dr. Steven Myers, was away for three weeks at conferences. Despite his absence, I learned to reduce the data and we were able to use red-shifts and analysis of the Sunyeav-Zeldovich intensity decrement from our radio and other published x-ray data to determine a preliminary value for the Hubble Constant. Most importantly, perhaps, the time I spent at the NRAO gave me the confidence necessary to admit when I was confused; I quickly learned how to ask concise questions that cut to the essence of what I needed to know to continue with my work.

In addition to responsibility and independence, good research requires creativity. My best test of this skill has been the work I undertook as an REU student in the SCHOOL University Astronomy Department this past summer. During this project, I studied the size-frequency distribution (SFD) of two groups of secondary impact craters possibly formed by the young lunar crater Tycho. After examining the literature to see how others had tackled the problem of secondary crater counting, I devised my own methods for counting and classifying primary and secondary craters from polarization ratio maps of 13-cm Arecibo radar data near the lunar South Pole. I also created Mathematica code to organize and analyze the SFD's and presented our findings in a poster at the American Astronomical Society's Division of Planetary Science Fall 2006 Conference. This work was particularly rewarding because it required me to take what others had done and determine how a similar system could be manipulated to fit the parameters of the particular problem at hand—an opportunity that I would love to replicate throughout graduate school.

Above and beyond the intriguing work I had the pleasure of conducting at SCHOOL, I was also very enthusiastic about the atmosphere of the department. Graduate students with whom I interacted seemed to hail from a

variety of different backgrounds and boast diverse approaches to learning. As a physics student who doesn't necessarily solve problems best with the conventional, number crunching approach, but rather employs contextual clues and examines the relationship between part and whole to derive meaning, I found this environment stimulating. I am excited about the niche I would be likely to find at such an institution, where my particular talents would complement and enhance those of my professors and peers, as theirs would mine.

On the whole, my experiences in astronomy as an undergraduate have taught me many things about the universe we inhabit, as well as valuable lessons concerning what it takes to be a quality researcher. What I have found is that good research—like the successful pairing of Holmes's exacting analysis and the adept storytelling of his assistant, Dr. Watson—requires the ability not only to find and assess facts but also to communicate them eloquently to others. I feel that one of my greatest strengths as a researcher will be my communication skills, which I have polished through a variety of lengthy research papers, scientific talks, and poster sessions both at Carleton and during my summer research. I have developed confidence and fluidity in my public speaking by lecturing for introductory German classes at Carleton College. These twice weekly, hour long lectures are presented entirely in German and have taught me how to deliver clear, audience-appropriate academic presentations.

I have done my best to hone these communication and research skills as an undergraduate, and I believe I have made great strides. However, I look to my time at SCHOOL to truly cultivate in me the technical skills necessary to explore the boundaries of our understanding and the expertise and confidence to share that knowledge with students and the public—an experience that would give me great pleasure.

Sample Personal Statement #2

Statement of Purpose **NAME - Physics**

Pondering how we each specialize within physics, I've realized that it often comes down to a simple question: which subfields have we studied in enough depth to come across the major questions left unanswered? Which pending problems really *bother* us? I knew for a long time that I would be an experimentalist, but my induction into the broad and lively world of condensed matter was by chance.

I applied to the University of Minnesota's REU program my sophomore year and was placed in Professor C.C. Huang's lab, where I worked with visiting professor Mick Veum to measure tension in liquid crystal films. From soldering wires and programming in *LabVIEW* to spreading films and collecting data, the table-top-scale setup gave me a chance to have a hand in every part of the experiment. Our work was later published in *Physical Review E*, which allowed me to have an inside look at the process of writing in academia. That summer was my introduction to the rare thrill of holding unexpected data in my hands and struggling with my advisor to make sense of it in a larger context.

To foster a growing interest in condensed matter physics, I signed on to help Carleton professor Melissa Eblen-Zayas set up her new lab. This ongoing project has included diverse duties, from reconfiguring an evaporation system to running samples of europium oxides on a SQUID at the University of Minnesota. It has offered both an enjoyable chance to work hands-on in the grimy and duct-taped world of a truly new lab, and an introduction to the world of magnetic materials. This work provided me with excellent background for my summer at UC Davis's REU program, where – after alarmingly brief training – I was given full run of the magnetron sputtering system and vibrating sample magnetometer. I worked in Associate Professor Kai Liu's lab to fabricate submicroscopic cobalt/copper wires with the goal of eventually observing current-induced switching. Along with the experience of working on my own project for the first time, that summer gave me the chance to discuss graduate life and postdoctoral plans with current graduate students in an effort to plot my own lifelong career in academia.

Although I am excited to begin a more long-term research project, I realize that graduate school is not an end in itself. Working as a tutor and lab assistant for physics classes has shown me firsthand what I'd often been told: that we understand an idea best when we teach it. I know TA duties are often considered a burden, but I've discovered unexpected joy in teaching. Some of my favorite victories have come from finding a better way of explaining a difficult concept to students, and as a bonus, my own understanding has

invariably been deepened along with theirs. I plan to eventually become a professor at a university or small college, where I'll be able to offer students of my own some of the potentially life-changing laboratory experiences that I've had.

Of the many excellent research opportunities SCHOOL offers, I find the Ralph group especially compelling; they are currently performing work on spin transfer that draws on many of the most intriguing topics I studied at UC Davis. In the process of surveying the relevant literature that summer I read a number of papers by this group and its close collaborators, and I hope to join them in continuing the fascinating inquiries made possible by modern nanofabrication techniques. I'm drawn to SCHOOL's tradition of excellence in research which I know will offer the kind of rigorous and stimulating atmosphere I'm searching for, and I'm enthusiastic about the obvious care taken to provide each graduate student with advising and a customized curriculum through the Special Committee program. Coming from a small school that provides a great deal of personalized advice and mentorship, and having become very involved in the department's curricular planning efforts, I know how much this sort of support can help to shape one's academic career.

Although my research interests could easily have developed in some other direction, I've discovered that experimental condensed matter suits my skills and interests especially well. I believe that my research background, in addition to the communication and critical thinking skills emphasized at a liberal arts school, have provided me with the knowledge and drive necessary to excel as a graduate student in your program. I hope that I will have the opportunity to learn from and contribute to SCHOOL.

Sample Personal Statement #3

NAME Physics Department

I am NAME, a senior at Carleton College completing a double major in physics and mathematics, and I am keenly interested in pursuing graduate studies in the field of general relativity. I currently hold membership with the LIGO scientific collaboration, the Phi Beta Kappa Honor Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics.

For the past four years, I have been active in gravitational-wave physics through the LIGO collaboration, working with N. Christensen at Carleton College in analyzing interferometer data from the S3, S4, and S5 science runs. Most of my early work involved looking at signals from environmental monitors in order to identify sources of noise in the detector, published under Class. Quantum Grav. 23 S29-S39. My later efforts were bipartite. One of my projects culminated in the development of a graph-theoretic glitch-finding algorithm, dubbed graphMon, which we immediately implemented on science run data. The other project involved code for a grid-enabled script that generates veto statistics, aimed at facilitating the veto studies that the Carleton College relativity group conducted following the S4 run. In addition to my continuing efforts in the field of gravitational physics, my early experience in other fields of research includes work with A. Pattanayak of Carleton College in connection with studies on quantum decoherence. Through this early work, I gained proficiency in several programming languages including C and Matlab, as well as experience in running jobs on computing clusters and supercomputers.

More recently, my work has led me to consider the problem of parametric instabilities in the LIGO interferometers. This work with W. Kells at the California Institute of Technology has resulted in the first numerical simulation code that calculates parametric gain values for all possible destabilizing test-mass acoustic modes. I am currently in the middle of mathematics research on the Pfaffian transformation with E. Egge of Carleton College, and am in the process implementing a grid-enabled script, written by N. Fotopoulos at the Massachusetts Institute of Technology, which calculates the pair-wise coherence between S5 data channels as a means of noise identification. In terms of immediate tasks, I am also preparing a publication on my work with graphMon.

As may be gleaned from this listing, I consider physics and mathematics as inseparable disciplines, and as a result, the way I do my physics and the way I do my mathematics often intertwine in interesting ways. Though all my research reflects this to a certain degree, I'd like to focus on my work with graphMon, as I think it is singularly illustrative. This project was initiated by a general need to identify excess-power glitches in the LIGO data channels due to seismic disturbances, which are now known to have caused several spurious

gravitational wave detections. Initially, the work was done by eye using Fourier analysis; indeed, looking back at my first term of research during my freshman year, I could have aptly called myself "undergradMon" without straining the analogy. It soon became clear, however, that I could easily abstract away the fundamentals of what I was doing: I quickly realized that these excess-power glitches were characterized by their contiguity in time-frequency space. At the time, I had just completed a course on differential geometry and had gone through *Gravitation* by Misner, Thorne, and Wheeler, so naturally the first thought that came to mind was that I needed a new metric for this space. I had also been introduced to graph theory. As I tossed and turned in the middle of a particularly humid summer night, the thought occurred to me: after Fourier transforming the data into time-frequency space, why not perform an additional transformation into the space defined by a graph? I jumped out of bed, ignored a terrified roommate, flung myself to my Linux machine, and started coding. By morning, the end-product was the first version of graphMon, an automated graph-theoretic glitch-finder. Since that time, my interest in manifolds and in the metrics defined on these manifolds has only exponentiated. This, and many other factors, has led to a deep-seated fascination with the field of general relativity.

My current interests in general relativity gravitate around finding connections between differential geometry and graph theory. As a physically intuitive example, consider the Laplace operator ∇^2 on a closed manifold M. The Laplace operator is one of the basic differential operators in mathematical physics; by discretizing the Laplace equation, one gets the Laplacian matrix $L(G)$ of the discretized space represented by a graph G. In fact, this process is conceptually the same as approximating the continuous manifold M by a discrete net of vertices and edges given by the graph G. In my studies, I have noticed quite a few useful corollaries of this fact. For example, consider a statement of the matrix tree theorem given by $L(G)=MM^T$, where M is the incidence matrix of G. The incidence matrix M can then be seen to correspond to the gradient operator ∇, and thus has clear physical interpretation.

I am greatly interested in how a merging of differential geometry and graph theory can be used in numerical studies of general relativity. My short-term career objective consists of contributing towards our understanding of gravitational waves, by pursuing this perceived connection in the context of gravitational physics, and by further developing my existing graph-theoretic data analysis techniques. To this end, and for my future aspirations of research and teaching at a university or at an international collaboration, I eagerly look forward to pursuing graduate studies at SCHOOL.

In particular, I've been informed by Dr. David Spergel that the SCHOOL physics department has recently hired Dr. Frans Pretorius, who works on numerical relativity. In numerical relativity, I see fruitful grounds for pursuing my interest in a graph-theoretic approximation of spacetime; discretizing a continuous manifold into a mesh is a well-known approach to the problem, after all. However, this is still something that I've yet to explore thoroughly; I

still feel the need for a firm grounding in the classical theories such as general relativity, for example. As such, I would greatly appreciate an opportunity to collaborate with your growing numerical relativity group while further developing my knowledge base through graduate studies in physics, expanding on previous work as well as exploring new possibilities.

Here is a copy of the letter I sent in the fall. Now as spring term approaches, many of you are dealing more directly with those life after Carleton issues, so I thought this might be useful. Even if you already have a real job lined up, there are many useful links talking about networking, mentoring and preparing for careers in the sciences. Happy web surfing…

Hi folks,

Hope your new term is going well for you. As you begin your senior year I know many of you are thinking "Hmmmm…what am I going to do with my life?" Some are planning on finding a job in the real world, others aiming for grad school and many still not sure of plans after graduation. It all seems a bit overwhelming to keep all of your coursework going AND deal with these career issues. But relax – it'll all work out. We in the department are all available to talk with you about plans for your "Carleton afterlife". As career coordinator I'm eager to help, so please feel free to stop by and we can talk about plans for the road beyond Carleton.

We have our annual meeting to discuss comps and careers today. If you'd like to get your career thoughts cooking before then, you might want to check out a few of these resources on the web. We'll talk about them in our meeting and I thought you might like a "clickable" document for easy access.

Career Center

First of all, if you haven't visited the Career Center, give it a try. There are a huge number of resources available to you. And, while you will always have access to the Career Center as a Carleton alum, it's much easier to check it out now rather than later. Here's their link in case you want a virtual view of the electronic resources they have available: http://webapps.acs.carleton.edu/campus/career/

Physics Resources

Another good site for physics-types is Gradschoolshopper. This is the creation of the American Institute of Physics (AIP) and it is a good site for physics career info as well as science and math related careers in general. Don't let the name fool you – it has more than just grad school info. There are lots of job-hunting tips and links as well. Its URL is: http://www.gradschoolshopper.com/resources.jsp#studjobs

There are links there to specific career pages for the different physics societies but here they are if you would like to go directly to visit these sites.

The Physics Today Career Network: http://www.physicstoday.org/jobs/
The American Physical Society Career site: http://www.aps.org/jobs/
The American Astronomical Society Career pages: http://www.aas.org/career/articles.php

The Society of Physics Students also has a useful physics career page (Careers Using Physics – CUP): http://www.spsnational.org/cup/index.html
and an interesting series of essays on advice for physics majors:
http://www.spsnational.org/cup/advice.html

On to the Real World? Perhaps Expanding Your Horizons Outside Physics?

If you plan on heading directly out into the real world, chances are you'd probably like to find a job. The previous links discuss many possible choices, strategies and techniques forCheck out the resources for job-hunting at the Career Center:

http://apps.carleton.edu/campus/career/jobs/

Grad School Now or Ever?

If you find yourself asking – "Do I want to go to grad school – now or ever?" check this one out: http://www.phd-survey.org/advice/advice.htm

Or to find out more about the job market post-PhD: http://www.phds.org/

Yes to Grad School ?...Things to Think About...Questions to Ask

A number of you have told me of grad school visit plans and wonder what types of questions you should be asking during your visits. There has been a great deal of discussion about that lately. Here are two general grad student info links with questions and more:
http://www.astro.umd.edu/%7Ekartik/questions.html
http://www-personal.umich.edu/%7Edanhorn/graduate.html

Here are a few links which are aimed for astronomers, and in particular women in astronomy. But the suggestions are useful for anyone considering graduate work in science or math.
http://spider.ipac.caltech.edu/staff/rebull/goodquestions.html
http://www.ociw.edu/~jrigby/gschool/index.html

The following is a link to the Committee on the Status of Women in Astronomy's January 2005 STATUS newsletter. Fran Begnal's article for prospective grad students has many good suggestions: http://www.aas.org/cswa/STATUS.html

And finally, here's a link for advice about succeeding in grad school once you make the plunge: http://www.cs.indiana.edu/HTMLit/how.2b/how.2b.html

If there's anything I can do to help you with your plans for the future, please let me know. Stop by – I'd be happy to talk with you about your "Carleton afterlife"

Cindy

REFERENCE FRAME

LOW PAY AND LONG HOURS

Leon M. Lederman

Last summer I gave a lecture entitled "Low Pay and Long Hours" to an audience of aspiring college students. My sermon had to do with the joys of the life of science. About a week later, a thoughtful letter arrived from a young undergraduate who had attended the lecture. His remarks carried the following thrust:

Dear Dr. Lederman:

I have worked hard and performed reasonably well in my academic studies, but I have yet to show real promise in any area, and despite all my efforts, I seem to be stuck in the crowd of average students. I ask myself why should I bother to work hard in graduate school and then in an academic or a governmental research career, only to discover at best one or two things that anyone else who went through the same motions might discover? Instead, with only a bachelor's degree, I can get a high-paying job with 9-to-5 hours as an actuary.

I have to admit that the possibility of becoming an actuary seems somewhat dissatisfying, because I want to pursue a career that actively promotes the welfare of humanity, and I believe that for me, science will provide the best way to accomplish this goal. However, I am very discouraged by the fact that my best only seems equal to what is average, and at times I really wonder why I should bother to pursue a career in science. In your talk, you suggested that the rewards for participating in science are those moments when you make a discovery and realize that you know something that no one else knows. Yet if my past is any indication of the future, I can expect such moments in my career to occur infrequently. Indeed, it seems to me that only the people who have done well and won awards in the past succeed and win awards in the future.

(Incidentally, it seems to me that the only people who say one should not care about winning awards are those who either know they will win awards or know they do not have a chance to win awards. It is people like me—who know what greatness is and can just taste it, but cannot seem to achieve it—who care about awards. Also, when our society gives awards, it seems to focus on actual accomplishments rather than on the hard work that led to those accomplishments. It is the general lack of appreciation for people who work hard but do not succeed that tends to discourage me.)

I would like to conclude by asking you two sets of questions. My first set of questions concerns you: What motivated you to pursue a career in science? When did you recognize that you were talented in science and that you excelled in relation to your classmates or colleagues? Also, did you know that you were "Nobel Prize stuff" when you did your research 40 years ago that earned you the 1988 Nobel Prize in Physics? Perhaps most important, what has kept you motivated throughout your long and productive career?

My second set of questions concerns the "rest of us"—those aspiring young students who, despite their efforts, have yet to distinguish themselves from the crowd of other average students: Why should we bother to pursue careers in science? What are our prospects for success, both in terms of making great scientific discoveries and in terms of pulling ourselves above the crowd? Is hard work an adequate substitute for natural talent, or must one work hard *and* possess natural brilliance to succeed? Finally, how can we keep ourselves motivated throughout our careers, especially during the long pauses between our successes?

Sincerely,
A Young Undergrad

Dear Young Undergrad,

I'm not sure I can offer clarifying guidance on so complex and subtle a series of issues. But I can tell you my own experience. In high school I was a B-to-B + student. I graduated from City College, a tough (free) college in New York, *cum laude*—that is, with a B + average. I had a passion for science, but I knew that I was far below the class leaders in both high school and college. But they were my best friends and the ones I enjoyed being with over all others. Three years in the US Army during World War II gave me time to think, and so I started graduate school in physics with this idea: If I can do well enough to associate, inconspicuously, with my genius friends, that will result in a good enough life. My Depression-years upbringing also fashioned a fatalistic attitude toward money. In City College we used to say: "I'm going to be unemployed in chemistry. What are you planning to be unemployed in?"

Today any trained scientist or engineer who is average (B) is assured employment at reasonable wages. But what I think you must know is yourself: What do you want out of life? If you can imagine waking up in the morning and not being able to wait to get to work; if staying up for 30 hours is for you a sign of passion and not of desire for overtime pay; if you seek real joy in the workplace, whether you're there 40 or 70 hours a week (it will still be a major occupier of your time)—if all of these are true of you, then you still have to ask: Are these "joys" worth the extra $20 000 a year you'll give up when you give up actuary work? What will the better-paying job do for your life?

Leon Lederman is director emeritus of Fermilab, in Batavia, Illinois, and a professor of physics at the University of Chicago. He is an experimentalist in elementary particles.

I don't think you *need* the great rewards of the superscientist. Teamwork is more often than not essential. Much of the pleasure of science is a kind of voyeurism; you have to learn to take joy in other's achievements. If you struggle hard through the drudgery of the academic process and win through, then you are a scientist! Instantly, you are part of an awesome set of traditions and masters: Newton, Faraday, Einstein, Fermi.... Think of how you will describe your daily work to your children when you come home at night.

To summarize:

▷ Being average *now* isn't decisive. Find out about yourself. Do you dream? Do you ever have ideas, even wrong ones? Do you enjoy the scientific process, even as an observer?

▷ Aiming higher than you believe plausible *is* worthwhile. You can retreat later. As far as I know, we are only given one shot at the whole living process.

▷ Ask yourself lots of hard questions. Try to be as hard-nosed and skeptical of your own motivations as you can. What really gives you pleasure? What is really worthwhile on this planet? Why did you decide to do such and such last week? What has driven you in the past? And so on.

To answer your specific questions: It was probably five years after my PhD when I began to realize that I was fairly competent. By year 10, I realized to my surprise that I was as productive as those best friends who brought me into physics, even though they understood much more than I did.

A good experiment like our neutrino research led to the pleasure of giving talks but much more obsessively it led to the next experiment.

The continuing drive? The science itself! The extra added ego boost of success. At low points (many!) it was a job, but there were my associates, students, teachers, pals worldwide, who gave me support.

I've already more or less addressed the second set of questions. Hard work—yes, it really accounts for a lot of the success. Most scientists aren't brilliant. Some are even very slow. Being solid is important—that means really knowing what you have to know even if it takes a long time. Many "brilliant" guys are superficial. Determination, doggedness and hard work are the characteristics that are highly valued in a group. Imagination puts the icing on the cake.

I hope some of this is useful. Good luck!

Sincerely,
Leon M. Lederman ■

Choosing the Best Graduate Program For You

I. PICKING AN ADVISOR

An integral factor in your graduate education, possibly even more important than where you go to school, is your PhD advisor. At best, he/she will be your mentor and your connected to the outside world of physics and guide you towards a successful research career. At worst, this person will be breathing down your neck constantly and may have ideas about your research direction and future that aren't what you had in mind. Thus, you should be *really* careful in choosing your advisor because a good relationship will make graduate school immensely more enjoyable and productive and a bad match could make your experience painful.

When you compile a list of prospective schools, take the time to go through their websites and make a list of the professors whose work interests you. Try to pick people on the younger side, not only because you don't want them to retirehalf way through your education, but also because they will generally be more "in touch" with new trends in research. Additionally, these advisors may be the ones who will be more comfortable with female students. Ironically, this fact could even be true for the female professors!

As part of your investigations, track the careers of former students. Has this advisor been successful at getting these people good postdoctoral positions? What ratio has stayed in the field or gone on to promising careers in industry? How many current and former students have won prestigious fellowships or prizes?

Try to visit as many of your prospective schools as possible and set up meetings with the professors on your list. This battle plan is good for several reasons: first, you get a chance to see what he/she is like in person. If he/she is too busy to see you, a female student from a prestigious university, it is a bad sign because you are exactly the kind of student they should be recruiting! When you talk to them, ask them what kinds of projects they have students working on. Before you visit, be sure to do background reading on their research. This strategy never fails to impress. It is a *really* good sign when they have done some background research on *you*.

Finally, meet with their graduate students alone and ask them what it is like to work with this advisor. If they are unhappy, however, they probably will not say it outright as it may get back to the advisor. So, it is your job to read between the lines. Pay close attention to indirect wording and "hidden" comments. These responses tend to fall along the lines of:

- "He/she is nice, but sometimes can be a bit weird..."
- "He/she is okay most of the time, but be prepared to work independently since he/she is not always around or is too busy to answer e-mails..."
- "He/she can be a bit difficult to deal with at times..."
- "He/she loses interest if you are not doing exactly what his/her research direction is..."

To sum it up, if the graduate students don't say "this person is really great, and I am really happy here", they probably are not!

II. CONSIDERING THE SCHOOL ITSELF

Visiting your top choices is a must, if you can manage it. If you are being heavily recruited, schools will often fly you out to see the place, so definitely take advantage of this opportunity. While there, pay attention to the community among students. It makes your graduate experience better if the students have a good interaction between each other. Look into the offered classes, and sit in on some lectures if you can.

Unfortunately, several of the better schools treat their graduate students as slave laborers in terms of teaching loads, especially since they know their reputations are so good that this fact may not deter everyone. We recommend accepting an offer of admission which includes a research assistantship or fellowship position instead of teaching for at least the first year, if not more. It will make a huge difference in terms of your stress level. Your first couple years will be taken up by classes and preparing for the PhD qualifying exams, so you want to be able to dedicate your time and energy to those. Even if it is a better school, you may be miserable if you do not have time for research for the first two or three years. The best situation is when you can do mostly research from the beginning and teach when you would like.

As a side note, even if you have fellowships for your entire graduate student career,try to teach at least one class. It will give you preparation for a faculty position later in your career.

Lastly, look at some statistics. Similar to tracking students of prospective advisors, try to get a feel for how many students in the program go on to bigger and better things.

Questions to Ask While Visiting & Considering a Graduate Program

QUESTIONS TO ASK THE DEPARTMENT

- What are the academic requirements to graduate?
- What percentage of students pass qualifying exams the first time?
- How many chances are there to

QUESTIONS TO ASK CURRENT GRAD STUDENTS

- Do different research groups interact? Is there collaboration with the department or across departments?
- What is the *actual* time commitment for a TA/RA?

pass qualifying exams?

- What is the average time to obtain a PhD?
- When and how do you choose your advisor?
- Who selects the dissertation committee?
- Is financial support offered through a teaching or a research assistantship?How much is the stipend?
- How many hours per week is expected for a TA or RA?
- Is funding guaranteed?
- Is there a teaching requirement? How are teaching assignments made (lottery or choice)?
- What sort of computing facilities are available?
- What are the provisions for housing, day care, health insurance, etc.?
- Is the TA/RA stipend enough to live on in the area?
- What is the social atmosphere like?
- Do graduate students have access to university facilities?
- Is there a graduate student organization?
- Are the provisions for housing, health insurance, etc. adequate?
- Ask female students: do you feel this program/department is supportive toward women?
- What are their likes/dislikes of the department?

I graduated from Swarthmore College in 2002. In the spring of my senior year, I organized a Graduate School Information Session so that graduating seniors could tell other students about their experiences applying to physics graduate school. I gave this handout to students at that meeting. Some of the information is specific to Swarthmore, and some is already outdated, but I think students applying to physics graduate school might still find this useful.

In my third year of grad school, I am still very happy with my decision to attend Cornell. Also, after getting an "honorable mention" for the NSF Fellowship for two years in a row, I finally won last year -- so be persistent!

Applying to Physics Graduate School

Lisa Larrimore

April 26, 2002

When I was applying to college, I was surrounded by counselors, teachers, and adults who had been through the process and could tell me exactly what to do. Last summer, I realized that there was no one to do that for me during the graduate school application process. Sure, our professors are helpful, but they have not been to grad school in a while and they are not going to make sure you are doing all the things you need to do. I had to figure many things out on my own, and now I know a bunch of things that I wish I knew a year ago. This handout is my attempt to put some of those things on paper. Note that this is just one person's opinion, not an authoritative guide, so please talk to other people and investigate things on your own.

I ended up applying to Cornell, MIT, Stanford, Illinois at Urbana-Champaign, Berkeley, and Harvard. Of the schools I was accepted to, I visited Cornell, MIT, and Stanford, and I have decided to attend Cornell in the fall. I spent a lot of time at MIT talking to one of the faculty members on the admissions committee about what they look for in an application, so I will include his comments as I proceed.

This is arranged somewhat in the order I did things, which is probably similar to the order you should worry about them.

The General GRE Test

All the graduate schools I applied to (as well as fellowships) required the General GRE. It is a computerized test, so you just go to www.gre.org, find the testing center nearest you (the closest one to here is in the basement of the Curtis Center in Philly), and schedule an appointment to go in and take the test. It will cost you $100.

The General GRE currently consists of three sections: Verbal (like the SAT verbal section, but harder), Quantitative (like the SAT math section, but easier), and Analytical (logic puzzles). As of October 1, 2002, the multiple-choice Analytical section will be replaced with a Writing section, for which you have to write two essays. Unless you find logic puzzles really difficult (you can try practice problems by downloading the POWERPREP software from www.gre.org), you might want to take the test before October 1. You will probably want to spend some time reviewing vocabulary and the types

of questions they ask, so taking the GRE over the summer (when you don't have classes to worry about) might be a good idea. I am leaving my Princeton Review book, which has a nice list, in the physics lounge; please don't take it for long, in case someone else wants to use it.

The MIT faculty member I talked to said that the first thing they do is throw out applications with really low GRE scores. They expect all their students to do very well on the Analytical section, and fairly well on the Verbal, since they want students who can think and communicate. He said the Math section was probably the least important.

The Physics GRE Subject Test

The Physics GRE is a written test offered on specific dates (see www.gre.org); I took it here at Swarthmore in November. It costs $130. The physics department organizes a lunchtime review session in the fall, which is very helpful.

The Physics GRE does not test your ability to think, to solve physics problems, or to be a good physics graduate student. It tests whether you have memorized formulas and can recall them quickly. The thing I did to prepare that was most helpful for me was to skim through the Physics 3/4 textbook (the clinic copy is in the student lounge, but should not be removed).

The MIT professor I talked to said that they recognize that students from liberal arts schools do not do as well on the Physics GRE as students from universities (just like all American students do much worse than the more specialized international students), and that this does not mean that liberal arts students will not be successful as graduate students. MIT rarely accepts students who got below the 50th percentile. Do not expect to do as well on the Physics GRE as on the General GRE.

Letters of Recommendation

You will need three or four letters of recommendation for the graduate schools and fellowship programs you apply to. So start thinking about faculty you can ask, and try to give them notice well in advance. If you are not sure whether asking a particular person is a good idea, it is perfectly ok to ask if they would feel comfortable writing a letter for you. You do not have to limit yourself to Swarthmore physics faculty, either; you can ask people at other places where you have done research, or professors in related departments, like math.

Your letters of recommendation are very important, and you want to ask people who can say something special about you. If one of your seminar professors is writing for you, feel free to remind him/her about aspects of seminar you really enjoyed, things you did presentations about, etc.

Transcripts

Transcripts from the Swarthmore registrar cost $3 each for the first 10 you request at once, and the rest are free. You'll probably need more than 10 transcripts. While I was around over winter break this year, I requested more copies of transcripts with my fall semester grades on them, and I sent one of these to each of the schools and fellowships I applied for. I included a cover letter explaining the "IP" grade for my thesis and elaborating about the things I did in each of those classes; I have attached this letter at the end of this handout.

Fellowships

The NSF offers three-year graduate research fellowships that give you much more flexibility in choosing a graduate school and in doing what you want there. Talk to faculty members here about whether you should apply, and start your application in advance -- it requires four time-consuming essays, and the application is usually due around the same time as the Physics GRE. The good news is, this application requires a lot more work than actual grad school applications, so you.ll be prepared. You don't hear back until April, so be patient. And if you don't get one the first time around, you can apply again as a graduate student. This year, Mike Seifert (Swarthmore physics major who graduated last year) was one of the winners.

Here are some links providing information about the NSF and other graduate fellowships:

- NSF: http://www.orau.org/nsf/nsffel.htm
- Department of Defense: http://www.asee.org/ndseg/html/preface.htm
- Hertz Foundation: http://www.hertzfndn.org/
- More links: http://www.gradschool.cornell.edu/grad/fellowships/fellowships.html

Graduate School Applications

Most physics grad school applications are due in the beginning of January. Harvard's was due December 15. Most applications are online, and you can find them by going to the school's homepage and looking around.

Deciding where to apply is probably the most difficult step of this process, and the one I can offer the least advice about. Here are a few things you might think about:

- Do you know what subfield of physics you want to study? If so, talk to professors about what schools are good in that area. If not, apply to schools that are good at a lot of things.
- Do you definitely want to go to grad school next year? If so, apply to enough schools to give you a decent number to choose from (professors have a pretty good sense of what places you might get accepted, but it's still a crap shoot). If you have your heart set on a particular school but don't need to go there immediately, you can apply again next year if you don't get in the first time.
- Is there a particular region of the country or setting (city/suburban/rural) you want to be in? Remember, you are going to live in this place for the next 5-7 years.

You should also remember that your decision is not final. If you go to a school for a year and decide you do not like it, you can always transfer somewhere else -- it's a lot easier than transferring between colleges.

You might also consider looking at departments other than physics. At Stanford, the Applied Physics students have access to the same experimental physics professors as the Physics students, but they have fewer requirements, qualifying exams, etc. Or you may find that geophysics or earth and planetary sciences are interesting fields and be able to apply in them.

To find more information about specific schools, you can visit their websites, look up unbiased information in 2002 Graduate Programs in Physics, Astronomy, and Related Fields (Cornell REF

QC29.G76X 2002, or www.GradSchoolShopper.com), or check out the links at: http://www.phds.org/index.php?section=7

You have to decide which schools you are applying to in enough time to give your recommenders advance notice, but the only time-consuming parts of the applications are writing your personal statement and contacting individual professors. Both of these involve deciding what field you are going to apply in; all schools will ask to have some sense of your interests, though this is rarely a binding decision. I decided to apply in Condensed Matter Experiment.

The Personal Statement

All applications require a personal statement, or "Statement of Purpose," somewhere in the 500-1000 word range.

The MIT professor I talked to said that statement of purpose was rarely the deciding factor in an application, and that it was more often used to keep someone out than to get someone in. They want to see that you can write well, so ask a friend or a Writing Associate to look it over. Demonstrate that you know what research is (by writing about previous research experiences and possible plans for the future) and that you have been involved in your school (as a clinician, sysadmin, Writing Associate, tutor, etc.). If you know exactly what you want to do, this is your chance to talk about it. If there is something that makes you unique, write about that -- the MIT guy said that one student was finishing a M.A. in music from the New England Conservatory, and that he was admitted because he would add something different to the grad student community.

Even if you do not know exactly what you want to do, you should sound like you have some direction. Which brings up the question of applying as an experimentalist or as a theoretician ...

Experiment vs. Theory

From everything I've been told, it is easier to get accepted to grad school in experiment than in theory. I talked for a while with Bob Laughlin, the Nobel-prize winning condensed matter theorist at Stanford, about the difference between theory and experiment. He said that at any grad school, there is much less funding for theory, and there are fewer job opportunities afterwards. "The days of being paid to think about physics are going away." He said that a lot of people think the future of physics is biophysics, but that there is really not much physics there, and that he thinks the future of physics is in making things, in nanoscience. He suggested thinking about what you want to do after you graduate. "I decided that I wanted to discover something really new. And I did. If your goal is to discover something, maybe the risks of theory are worth it. But if you just want to be a solid member of the academy with a good position, experiment is a much easier way to that." Just because he won a Nobel prize does not mean he is always right, but there is some truth to what he said.

So there are two questions to consider: What do you actually want to do in graduate school, and what do you want to say that you want to do on your application? The MIT professor I talked to, who was a condensed matter experimentalist, said, "This is one of the easiest areas to get accepted to, so if you knew how to play the game, you would apply to this area and then transfer out later." Whatever you decide to apply in, make sure it reflects your record. If you have spent the past three summers working with theorists and advanced laboratory was your worst class at Swarthmore, graduate schools are not going to believe that you are really passionate about physics experiment. They want students who

have experience in experimental labs.

I worked for two summers with Amy Bug doing computational physics and one summer in an experimental optics lab at NIST. I talked about the latter in my personal statement to show my interest in experiments, and I talked about the former to show my interest in condensed matter physics.

Contacting Individual Professors

If there are specific professors you want to work with, you should definitely email them before you apply and let them know you are interested and ask about their research. Many of the grad school applications have a place for you to write the names of any professors you have contacted.

I did not know exactly what I wanted to do, and I could not think of anything intelligent to write to any professors before applying, so I didn't. In my personal statement, as you can see, I mentioned the names of individual professors whose research sounded interesting. This worked out ok for me, since I was accepted to all but one of the schools I applied to, but I probably would have contacted more professors if I had had the time.

Hearing Back from Grad Schools

You will start getting letters in March and April. Schools do not send out all their acceptances and rejections at once; they send out acceptances as soon as they have decided on a particular student, so the first letters you receive will likely contain good news and fellowship offers. Once a school decides to accept you, they will probably have professors and students call or email you to tell you about what a wonderful program it is. Besides being flattering, these are great chances to ask questions you have about the schools (see below).

Once you are accepted, you will want to know how much money the school is offering you. Some schools will support you through part time TAs (teaching assistantships) or RAs (research assistantships). Others may offer you fellowships, which are usually larger amounts of money that you do not have to work for. My offers ranged from $20,000 to $30,000 per year, and I think that is pretty standard.

Visiting Graduate Schools

Once you are accepted, graduate schools will pay you to fly out and visit them. If you have been accepted to a lot of schools, you will have to narrow down your list, since it is hard to get away from Swarthmore for more than about three trips. Most schools have an organized open house, and if the open houses fit into your schedule, I heartily recommend them. They require much less work from you, since otherwise you will have to schedule all your own meetings with professors or tours of labs, they involve more yummy free food, and they give you the opportunity to meet your future classmates. I've included below some of the questions that I found it helpful to ask while visiting.

Questions to Ask Current Grad Students

- General: Do you like it here? Why did you decide to come here? What surprised you most about being here? What do you like least? What are my responsibilities as a first year?

- Academics: How many courses are required? How many do students usually take? What are the classes like? Do the faculty seem interested in their classes? What's the average class size? Do students work in groups and learn from one another?
- Requirements: What are the requirements for graduating? What kind of qualifying exams are there? How many chances do you have to take them?
- Research: When and how do you choose your advisor? How difficult is it to switch advisors? Do students have trouble working with a research group they want to? What is the average time to obtain a Ph.D.?
- Money: Is the stipend enough to live on? Is housing expensive? What kind of housing can most students afford? Is the health care provided by the university adequate? Do students ever have trouble finding financial support during their time here? How much time do you spend working as a TA?
- Social life: What do you do when you.re not doing physics? Do you have time to do the things you want? Do you like it here? Do you have time to take breaks and eat lunch? Does everybody work every weekend? How are the restaurants? Can I pursue (insert hobbies here)? What about campus safety? What's the weather like?
- For women: Is there a women's support group? Have you ever felt uncomfortable as a woman in this department? What's the male/female ratio among graduate students? Among faculty members? Are the women friends with each other?

Questions to Ask Faculty/Prospective Advisors

(It is generally a bad idea to go to graduate school because you want to work with one particular person, especially if he/she is a new faculty member who does not yet have tenure. Make sure there are a variety of professors whose work interests you.)

- I have read some general information about your work, but I was wondering if you could tell me more about it. (People love to talk about what they do.)
- Where do you see your research heading in the next five years?
- How many students do you currently supervise?
- Do you plan to accept new students next year?
- Do you anticipate taking a sabbatical or retiring or moving in the next five years?
- How long do your students usually take to complete their Ph.D.s?

Advice and Tips: Writing Your Personal Statement for Graduate School

Problem Statement: Browse the Web and find advice and tips about writing personal statements. Form your own opinions on what is important to include/omit from your personal statement.

Assumptions: Information available on the Web about writing personal statements is generally written by people who know what they are talking about.

My Solution:

I can conclude with a high probability that it is important to check and recheck your personal statement for errors. Some of the most common errors in personal statements are grammar, spelling (do not rely solely on spell check), exceeding the maximum word count specified, and sending the wrong personal statement to a school (i.e. putting the Harvard personal statement in the Yale envelope). It is good to have multiple people review your personal statement.

It is generally recommended that you tailor your personal statement to each individual school you are applying to. This doesn't necessarily mean generating a completely unique masterpiece for each school you are applying to, but it certainly does mean addressing the question or topic a school requests.

Think about your audience. What type of students do your readers want in their next incoming class of graduate students? What traits would their "ideal" student possess? Which of these desirable attributes do you possess which are not evident in your other application materials? Also, be careful not offend your reader by lecturing them or bringing up controversial subjects. Adding some humor can be a nice touch but be sure not to come across like a clown. Be professional.

Your personal statement is an OPPORTUNITY to discuss things that are not evident in your other application materials. Some people mention that you can utilize a small portion of your personal statement to explain problems or inconsistencies in your record. However, this could highlight the negative and may prove to be counter productive. I would not make excuses or try and justify poor performance. If you discuss hardships or challenges then be sure to show how these adversities have enabled you to grow into an even more promising candidate. Focus on the positive.

Your personal statement is not a biography, resume, or research paper. I tend to think of a personal statement as something like a non-fiction short story with the applicant being the main character. Ideally the reader should find it effortless to logically arrive at the conclusion that the main character would make an excellent addition to their incoming graduate class. It would be great if

the personal statement is memorable and enjoyable to read.

Try to captivate the reader's attention right from the start and make them want to read more. Some people recommend you try and "hook" the reader with something like a question, anecdote, quote, engaging description of a scene, life-changing experience, etc.

You should show the reader what you want to convey though writing about your experiences and what they mean to you. Stating that you found something stimulating or challenging means nothing compared to showing it though actual experiences and sharing how those experiences affected you.

Avoid cliches and platitudes. They bore the reader and may make you sound naive. Although it is admirable to want to do something like revolutionize a particular field of physics or win a Nobel Prize, stating things of this nature is probably not going to convince the admissions committee that you are a promising candidate with originality and character.

Don't try to impress your reader with big vocabulary words or long, complicated sentences. Write clearly and concisely. Avoid unnecessary words that do not support the theme of your personal statement.

There were a number of other general writing techniques that were frequently discussed. Brainstorm before you write. Have a friend interview you. Write an outline. Write a rough draft. Write in the active voice and not the passive voice. Vary your sentence structure. Use a thesaurus. Don't be afraid to use the delete key. Use transitions between paragraphs. Avoid qualifiers. Don't use contractions or slang.

As always, please share you comments in the Graduate School Forum.

More Graduate School Guides

- Researching Graduate Physics Programs
- Financial Aid and Student Loans

Graduate School Personal Statement Secrets

Information provided by Petersons.com

by Geoffrey Cook, Founder EssayEdge.com

The best way to approach your personal statement for graduate school is to imagine that you have five minutes with someone from the admissions committee. How would you go about making the best case for yourself while holding the listener's interest? What would you include and omit in your story? Figuring out the answer to these questions is critical to successfully preparing an effective statement.

To arrive at these answers, you should begin by asking yourself two specific questions:

- Why have I chosen to attend graduate school this specific field, and why did I choose to apply to this particular school's program?
- What are my qualifications for admission?

The answers will not necessarily come easily to you, but this exercise will have great practical benefit in readying you to write an outstanding personal statement. By answering each question thoroughly, you will have given much thought to yourself, your experiences, and your goals, thereby laying the groundwork for formulating an interesting and persuasive presentation of your own personal story.

As the founder of EssayEdge.com, the Net's largest admissions essay prep company, I have seen firsthand the difference a well-written application essay can make. Through its free online admissions essay help course and 300 Harvard-educated editors, EssayEdge.com helps tens of thousands of student each year improve their essays and gain admission to graduate schools ranging from Harvard to State U.

Having personally edited over 2,000 admissions essays myself for EssayEdge.com, I have written this article to help you avoid the most common essay flaws. If you remember nothing else about this article, remember this: Be Interesting. Be Concise.

Why Graduate School?

Graduate school is a serious commitment, and it may have been your goal for a long time. Describing your early exposure to a field can offer effective insight into your core objectives. Watch out, however, that you do not your point in such a cliched, prepackaged way as to make your reader cringe. For example, you should not start your essay, "I have always wanted to" or "I have always known that _____ was my calling." Instead, you should discuss specific events that led to your interest in the field.

Graduate school is, of course, a means to an end, and admissions committees prefer students who know where they're going and to what use they'll put their education (though the occasional soul-searcher, who may exhibit exceptional raw