# The Unofficial Guide to Life as a Physics Major: How to Survive and Thrive at TCNJ

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Preface:

The purpose of this guide is to provide all incoming and current physics majors with the "things I wish someone had told me earlier". It is a culmination of advice from upper level majors and consultation with department faculty. The content here is geared toward those considering graduate school as this intimidating but rather straightforward process is not well documented for the uninitiated. Nonetheless, those considering a job after obtaining an undergraduate degree in physics will also find much of the content useful. This is by no means a complete guide to the major, and I alone am by no means qualified to write it all, but it should provide a solid foundation to help carry you through your four years here. It is my hope that this truly informal and unofficial guide will save you much frustration and many "if I had only known earlier" moments. **I urge all incoming majors to read this in its entirety to save much headache and frustration.** Good Luck!

- Mitchell Revalski

Class of 2014

**Table of Contents:**

**The Freshman Year:**

**So you have made the plunge and decided to come to TCNJ as a physics major, now what?** Freshman year is a great time to start making connections. Get to know your fellow majors, this is very important! Find other freshman who you study well with, as a good study group can help carry you through all four years. The key is to use each other's help appropriately, and not for copying. Despite how it may feel, freshman classes are generally not that taxing, and give you time to get involved with other activities as well!

**Get to know the upperclassmen**, we have had plenty of dealings with class selection, PAWS, administration, and so forth. A great time to do this is during the Physics and Astronomy Club meetings which normally meet on Wednesday afternoons. This is a great place to be social with the other majors as well as have some fun with various activities. Don't use studying as an excuse to not come, since if you are truly diligent enough to actually be studying during this time, you will have already made other time!

**Come to know the professors.** None of them bite, and they are all very friendly. The full time faculty will be a huge part of your learning experience over your four years, and the vast majority will go out on a limb to help you learn and understand if you are working hard. As discussed later, getting involved in a professor's research is a great way to learn and eventually have a place to turn to for strong recommendation letters. In particular, you are assigned an adviser who will help you plan out your academics. Most are very helpful. Be sure to tell your adviser of your interests and what you are hoping to accomplish with your education whether that be graduate school, a job, or a teaching position.

**Use office hours!** Each professor has their own set of office hours, usually twice per week, when they are literally sitting in their chairs waiting for your questions! By working on assignments ahead of time you can always get extra help on tough problems, and usually end up learning more than you originally needed when you walked in!

**Come to department events!** Whether it is the annual end of year dinner or picnic, physics club, or astronomy club star parties, these events are always a great time. It is a chance to see other majors and faculty in rare form, out of the classroom and having lots of fun!

**Attend department colloquia!** Each semester the department invites speakers to discuss their research with us. These presentations are almost always interesting and you will have the opportunity to talk with the speakers about their work and institutions.

**Physics and Astronomy Clubs** are normally held on Wednesdays from 12:30-1:30 in the physics computer lab. We engage in all sorts of fun games and activities as well as intramural sports such as volleyball and soccer.

**An important note on textbooks**; as a general rule do not buy your books from the school bookstore. You can usually get them in excellent condition from Amazon or Half Off for a fraction of the price. The exceptions are freshman classes which often require online access codes. Also, if you intend to continue with physics in grad school, **save your text books** particularly general physics, math physics, along with classical mechanics and electromagnetic theory, trust us.

**As a last note, get involved with something you enjoy!** As time goes on many of us find a need for activities and clubs which provide a much needed stress release. Whether it is a physically demanding sport club or just something which takes your mind off things in a productive way, get involved, and try new things. Find clubs and organizations that interest you by attending the activities fair each semester.

**This may all seem overwhelming, but it need not be.** Getting to know the department should be an enjoyable and fun progression. The best way to do so is talk, talk to everyone! Being involved with the department and not a silent body in the back of the class will not only help you later, but make your time at TCNJ much more enjoyable!

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**Choosing Physics and Math Classes:**

Choosing classes is simplified by talking to upperclassmen majors and using the online schedule for when classes are offered. Core classes are offered every year, though not every semester. Upper level option classes are offered on a rarer basis, usually every other year, making it possible to loosely plan out all four years. Put it on paper, and be sure you meet all your major and liberal learning requirements. This is where your adviser and other fellow majors come in handy. In addition, for those planning on graduate school, take MORE than the basic requirements. Specifically, take as many upper level physics classes as you can handle in addition to math classes. In particular, in terms of non-physics classes we recommend differential equations and statistics along with computer science 215. Learn as many computer languages as possible.

Other advice when thinking about classes is to have the big picture in mind. That is, think about how you will fit in independent research with a professor. Don't wait until your last year to think about this! Also, when it comes to planning, think about study abroad. TCNJ offers many outstanding study abroad opportunities, and these need to be carefully planned in advance so that you continue your progress towards your physics degree. These will be discussed more later.

Always talk to the other majors and professors before deciding on your classes; never take one word as definitive, as a general rule. A list of class offerings along with a sample four year schedule is available on the department website:

The Department Website: http://physics.pages.tcnj.edu/

Sample Four Year Schedule: http://physics.pages.tcnj.edu/academics/programs/

Upper Level Class Offering Schedule: http://physics.pages.tcnj.edu/resources/

**Liberal Learning**

As an additional note on liberal learning classes, try to take ones which double and triple count toward the various requirements. This may mean putting them off till you are an upperclassman and can more easily get into classes which fill up quickly. A chart which shows what each class counts towards can be found on the college's liberal learning website. In this way you can find classes which count for two or even three requirements thus greatly reducing how many classes you have to take! This leaves room for more physics, math, and even just interesting classes you enjoy!

Liberal Learning: http://liberallearning.pages.tcnj.edu/courses-information/approved-courses/

**Language Requirement**

In addition, the physics major (for some strange reason) currently has the standard three-semester language requirement. If you know another language fluently, excellent! Even if it is not offered at TCNJ there are ways of taking placement exams so you can completely fulfill this requirement without taking any classes. If not, it is recommended you take the placement test for whatever language you took in high school and you can often place out of one or two semesters, freeing up slots for other classes. If you have no idea what language to take, but think you may want to study physics abroad for a semester, consider taking German. The TCNJ physics department offers study abroad semesters in Germany, and although the classes are taught in English, it helps to know a bit of German, check on the status of this program before committing.

**Specializations**

What is the deal with the "specializations"? You can think of a specialization as a concentration within physics. Having a specializations means that you will take five to seven option classes which fit the specialization and you should decide upon these early if possible. The current department constructed specializations are Astrophysics, Computational, Biomedical, Condensed Matter, Pre-Grad, and Geophysics. Together with your advisor, you may create a brand new specialization that best captures your interests. All "pre-packaged" specialization courses count toward your major requirements, so you won't be taking extra courses if you declare a specialization. The specialization may be declared at any time, even after many classes have been taken toward it, by filling out a select portion on the standard "Change of Major Form" (Don't worry, this won't change your major! Have it looked over before submitting). More information on the major and a detailed description is available on the physics department website bulletin:

Bulletin with Major Info: http://www.tcnj.edu/~bulletin/current/Physics.pdf

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**The Physics Teaching Track**

Physics teachers in New Jersey are in high demand so if you plan to go into teaching this is the program for you. The physics teacher track is classified as a Dual Major, similar to a double major, but slightly different, since the secondary ed. program can't be taken as a stand-alone program. The program can be completed in 4 years, leading to a New Jersey grade 6-12 physics teaching certification AND a full physics Bachelor of Science degree with the same basic requirements as the non-teaching track.

TCNJ has a long history and tradition of training great teachers, and our department has trained nearly 1/3 of new physics-certified graduates in New Jersey over the past several decades. In recent years, retirements of New Jersey physics-certified high school teachers has far outpaced new certifications, averaging about 40 retirements and 15 new certifications. Because of this, newly certified physics teachers in New Jersey are in greater demand than any other certification and typically receive multiple competitive job offers following successful completion of the program.

Future physics teachers still CAN, and are encouraged, to do research with a faculty member or pursue an additional minor or concentration. Since a large fraction of the required education courses cross-count in liberal learning or in the physics major, the program can be completed in no more total courses than required of most physics majors. Lastly, it is possible to switch into or out of this program until the spring of sophomore year without jeopardizing a 4-year graduation. You can still switch into physics teaching in your junior year, but you are likely to need an extra semester to do this, so you may be better off finishing your regular degree, and then pursuing an "alternate-route" certification or 1-year master's in teaching program.

Dr. Nathan Magee is currently the lead professor involved with the secondary ed. program so further questions may be directed to him.

In addition, here are a few pieces of advice from some majors in the teaching track. Everyone should note this track may require an additional physical science certification for middle school teaching. Also, keep in mind that Physics teaching track requires students to complete a junior field experience (JFE) and student teaching. Since both of these requirements take place during junior and senior year it may be difficult to take the upper level physics courses that interest you most. JFE is generally taken in the fall semester and consists of three courses and a field placement so only one additional course can be taken during this time. Student teaching generally takes place during the fall or spring semester of a student's senior year and it is strongly recommended that no additional courses be taken concurrently with student teaching. So it is a good idea to look at the upper level course offering schedule and plan out which courses you would like to take and when since not every course is offered every semester. The sooner you can do this the better!

None of these things is meant to sound negative; you will still take all the same core and many of the upper level classes typical majors do, leaving you well qualified to teach!

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**Life as a Sophomore and Upperclassman:**

So, you have survived the first year and taken the previous advice to get involved with the department and meet fellow majors and professors (**HINT**)… now what? The remaining three years provide a number of challenges which need not be too stressful if understood.

**Research:**

Get involved in research! Typically freshmen are not allowed to take credit for research, as administration wishes you to get acclimated to college life. While this is true, if you find a professor whose work interests you, most will be open to letting you "sit in" freshmen year and learn what you can. This puts you in an excellent position to pick up research sophomore or junior year and hit the ground running. Speak with the professors you are interested in working with and see what can be done.

The demands of each research project will vary, however typical majors will take research on top of their normal four class course load and only claim a half credit of research so as not to overload. This normally involves working six or so hours per week as opposed to roughly twelve for a full credit. A full credit of research can also be done, either as a fourth class or by overloading for a semester with five classes. The exception is for senior level research which is typically the capstone required for graduation, and is taken as a full credit due to the time demands needed to produce a quality result.

It might be helpful to mention that any research is better than no research. So even if you aren't sure what you want to do and don't know what really interests you yet don't use this as an excuse not to do research. It's better to get involved in some projects to gain valuable research skills and so you have experience to put on your REU apps, etc. Even if you find out you don't like it, you will still learn something and can move on to trying different areas.

In general, doing some kind of research with a professor is an outstanding way to build a network that will help immensely in your post-TCNJ life.

**Who's Doing What?**

The best way to see what each professor is doing is to talk to them and/or ask for a quick tour of their lab when they are available. But as a general guide, the full time faculty members (who will forgive me if I'm simplifying their work!) work in the following areas listed alphabetically,

Dr. Margaret Benoit – Geophysics and Geology
Dr. Danielle Dalafave – Computational Biophysics
Dr. Ronald Gleeson – Particle Physics
Dr. Nathan Magee – Atmospheric Physics
Dr. David McGee – Photonics and Materials Science
Dr. Tuan Nguyen – Experimental Biophysics
Dr. Romulo Ochoa – Optics and Photonics
Dr. Raymond Pfeiffer – Astrophysics
Dr. Thulsi Wickramasinghe – Cosmology & Astrophysics
Dr. Paul Wiita – Astrophysics & Fluids Dynamics

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**What About the Summer?**

Okay so now you've gotten a crash course in what to do for your first few years, what about the summer? For those not looking to go to graduate school a job is often always desired, but for those looking to go on to graduate studies, what should you do?

**MUSE:**

MUSE is an acronym for TCNJ's Mentored Undergraduate Summer Experience. This is essentially a paid two month research experience. Many professors are open to MUSE opportunities, but talk with them early to be sure. Applications are generally due during the first weeks of the spring semester. Discuss this with your professors in the previous fall semester. Professors form their summer research plans early, and the sooner you show an interest in a professor's work, the better.

This is an excellent chance to immerse yourself in research. Since it is full time without other classes taking up your time, a student or a group of students can often complete the equivalent of several semesters work if things are managed properly. This is an excellent opportunity to work with a professor and fellow majors, and is also a lot of fun!

The beauty of this program is it is open to all levels, including freshmen. This provides an excellent platform to start or continue research, and eventually obtain REU's.

Also keep in mind that some TCNJ professors have government funding for summer research that may be separate from MUSE funding. Be sure to ask, as this presents yet another opportunity for summer research.

**REU's:**

REU is an acronym for Research Experience for Undergraduates. The purpose of these programs held at universities around the country is to give undergraduates, particularly juniors interested in going to graduate school, a chance to see what graduate research could be like. Typically these programs highly favor juniors during their summer before the senior year. However, some programs do accept sophomores and the experience gained in the application process is exceedingly valuable for improving your application the second time around. Conveniently, all typically funded REU's may be found through the National Science Foundation (NSF) website.

NSF Website: http://www.nsf.gov/

NSF REU Section: http://www.nsf.gov/crssprgm/reu/reu_search.cfm

REU's are highly competitive but also desired for entrance to graduate school. Grad schools like to see that you have field research experience, and someone (your REU director) who can vouch for your skills other than those at your university. This is also your chance to branch out and try intensive research in an area of your choice. Most students apply to many REUs to better their chances, ranging from 10 to 30 different programs in general. If you never obtain an REU, do not fret, many students still get into excellent graduate programs.

This is where your cultivated relationships with professors pay off, as you usually need two letters of recommendation for REUs, and eventually for graduate school. If you have not been involved and present in your classes, department events, and research, it is hard for professors to write a strong letter. Help them help you, be involved! Additional information on REU's, research, jobs, and advice from other majors, etc. can all be found on Dr. Ochoa's excellently maintained blog:

Dr. Ochoa's Physics Blog: http://tcnjphysics.wordpress.com/

**International Study:**

Physics is an international enterprise, and it is almost certain that in your career in physics, engineering, or science in general you will be working with people from another continent. Getting international experience as an undergraduate is valuable as you apply for graduate schools and/or jobs; particularly since so few US students pursue this option. Hint: the people hiring you or deciding on your grad school acceptance will likely have international experience. So, the TCNJ physics department has study abroad opportunities in New Zealand at LaTrobe University (confirm

the details of this program before committing) and a new opportunity to spend a semester studying physics in English at Beuth University of Applied Sciences in Berlin, Germany. Feel free to contact Dr. David McGee for more information about these programs. But remember, do this planning early in your time at TCNJ.

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**Preparing for Graduate School:**

Q. With what undergraduate major can you attend graduate school for FREE and get PAID?
A. PHYSICS!

Yes, this is the world's best kept secret about physics (and other science degrees). If you get in to grad school, your PhD is (almost always) free and you receive a monthly stipend that is enough to live on.

Going to graduate school (this coming from those much wiser and older than myself) can be a mentally trying but also very rewarding experience. It requires jumping through a few standard hoops which need not be hard if adequate preparation time is allowed. Graduate schools will generally weigh, with different importance depending on the school, the following areas:

**Undergraduate GPA:**

Your overall and in-major GPA will generally be looked at. It is important to learn and do well in your physics classes and show them you did so. Graduate classes will only be harder, in general.

**Research Experience:**

Your research experience will come in handy. Graduate schools want to see your potential in terms of what you can do for them! The ability to be creative and problem solve can be demonstrated here and is important to a strong application. Also, this gives you the chance to explore what you are truly interested and help steer your graduate work. Presentations at conferences and any publications are a great bonus.

**Letters of Recommendation:**

Graduate schools want to hear from experienced professors how you stack up and what you have to offer in terms of knowledge and character. This is why research and involvement is so important. You alone are responsible for giving professors the ammunition they need to show schools you have the perseverance and talent to perform at a higher level.

**The General GRE:**

You took the SAT's to get to college; well the Graduate Record Exam (GRE) is the equivalent of the SAT for graduate school. It tests general math and literacy skills. These tests are offered on a regular basis in computer format, and there are plenty of books for preparing for this basic skills exam. This is generally taken at the beginning of the senior year but may be taken earlier as well, including over the summer (hint, so you don't have to study on top of a semester course load!). Be sure to take this early as some applications deadlines can be as early as December.

The General GRE Website: http://www.ets.org/gre/

**The Physics GRE:**

As you may have taken SAT subject tests for college, there is, of course, the Physics GRE for graduate school. This 100 multiple choice written exam is your chance to demonstrate to graduate schools that you really learned what your grades reflect, or that you have since improved your knowledge and your grades are not all that make you up. American students are generally expected to do worse than international students who may take a year or more to study solely for this exam. Cramming in a few weeks is typical for this exam, but three or so months should be considered a practical minimum to refresh and improve on all your undergraduate coursework. Again, practice exams are available, as well as official lists of tested subjects and areas within those subjects to help prepare effectively. This is generally taken during the fall of the senior year when all the necessary core classes have been completed. It is offered in written format twice in the fall and once in the spring; sign up well ahead of time. One should use caution if taking this exam close to midterms or finals.

The Physics GRE Website: http://www.ets.org/gre/subject/about/content/physics

Link to Practice Tests (Scroll Down): http://www.physics.ohio-state.edu/undergrad/ugs_gre.php

Solutions to the Practice Exams: http://grephysics.net/ans/all-solutions_list.php
(USE WISELY. YOU HAVE BEEN WARNED.)

Additional excellent advice offered from upper level majors,

For the general GRE, examine how the test questions are structured. In particular, for the quantitative part take note of comparative questions and questions with multiple answers which aren't necessarily hard but can be tricky. Also, if you aren't familiar with the test format you may lose valuable time trying to understand what the questions are asking. Try doing at least one (several would be ideal) practice writing exercises. It might also be helpful to practice the writing portion on a computer without using spell check to simulate real test taking conditions.

For the physics GRE it's worth mentioning the following, when studying and going through the publicly available tests taking each one as if it was a normal test. First start out without studying anything just to see how much (or how little) you know. Next, go through each solution one by one and for each question if you got the answer right, move on. If you got the answer wrong but more or less had the right idea about going through the problem, make sure you understand what you did wrong and ensure you don't make those mistakes next time. If finally, you had no idea how to begin the problem or didn't know the answer at all (mainly conceptual questions), this is when you go back to a textbook from one of your previous classes or look the explanations of the topics online. Reading a textbook for hours a day won't help you much on the exam as the questions are specifically written in a standardized test style manner

Finally, there is no reason why an American student can't get a really great score so don't let anyone discourage you by saying that international students usually perform better. You will have learned almost every topic on the exam (there's usually 1 or 2 questions on fluid dynamics and acoustics that you may or may not have learned). The only limiting factor on the test is the time constraint. You have to answer 100 physics questions (mostly involving calculations or derivations with NO calculator) in 170 minutes. If you can churn through those practice tests and really be able to solve these questions quickly and efficiently (and most of all correctly), you can definitely get a great score that would get you into a top 20 graduate program (assuming a very good GPA and significant research experience).

These things, together with your oh so important letters of recommendation, a personal statement, and possible work experience, are the main things graduate schools will weigh in their decision to admit you. While there is great hype about the competitiveness of graduate school, lacking in one area or not having the most stellar GPA is not a death sentence, and graduate programs can be found for the majority of hard working students (Pretend I didn't tell you that though, and work your tail off while stressing a little less). Do not rest too easily if you are an achiever; top programs are just as competitive as people make them out to be, if not more so.

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**Applying to Graduate School:**

If you have made it this far, applying to graduate school is the last major step. It involves getting letters of recommendation, finding programs which interest you, and even deciding if graduate school is for you! For this I defer to the advice of professors and other majors more familiar with the process.

Making an effort to contact the people you are interested in working with can be a good idea. Ultimately, you are probably only going to be working very closely with one or two faculty members so if you already know the field you want to work in don't hesitate to reach out and ask questions.

Generally, professors seem happy to answer questions and like to hear from students who are interested in their work. On the other hand, it isn't uncommon to be unsure of what you would like to research in grad school. If that's the case you will want to find a department that has faculty members who do research in a variety of areas so that you have some options to work with.

A power point with things to think about before applying to grad school and what it could be like is available on Dr. Nathan Magee's website (lower right corner) here: http://www.tcnj.edu/~magee/

While there are scarce resources to guide you (see recommendations below), I hope this will help all incoming majors orient themselves. I would **strongly** recommend the following resources which will help students decide if graduate school is right for them, where and how to apply, as well as many more details on the topics covered here. Again, professors who have all gone through this process can comment more!

**Highly Recommended Readings:**

"Getting In to Grad School for Physics", Vincent Klug, 2011
(See additional recommendations on the last page of this book)

"Getting What You Came For: The Smart Student's Guide to Earning a Masters or Ph.D.", Robert Peters, 1997

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**Going Through Graduate School**

While not the purpose of this guide, the following general pieces of advice are common for those who do decide to go to grad school.

- Take time to decide if grad school is really for you; don't just go because you don't know what else to do.
- If you do go to grad school, keep your mind open about what you would like to do following it as there are no set paths!
- Apply to many schools, depending on the applicants for that year you can often be declined offers from places which you may be well qualified for.
- Don't set your mind on one school or one particular region. There are excellent grad programs in physics and related fields all around the country.

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**Debunking Physics Myths:**

*I am going to work much harder than other majors and not have a social life!*

False! It is true, you may put in more time or effort than some other majors, but you get out what you put in and hard work yields great opportunities. Most upperclassmen are involved in many clubs or have hobbies and play sports, see significant others (on a regular basis!), etc. It is possible to do well and learn as well as have fun if one stays organized and balances time well.

*If I don't go to graduate school I won't be able to get a job!*

False! Many undergraduates find jobs in industry, teaching, etc. Dr. Ochoa maintains a physics blog detailing the many companies and fields majors have gone to work for with only an undergraduate degree. In addition, undergraduates have been accepted to non-physics graduate programs such as engineering, medical school, and law school. The physics department office has a record of where graduates have gone over many years.

Industries, high schools, and government labs love physics majors at all levels, including the bachelor level. But, you won't find these jobs in the Sunday NY Times classified under the letter "P". You have to dig and you need to network. In general, if you want to go into industry with your BS degree, take as many applied/lab/computer classes as you can while at TCNJ and be sure to get a research experience with a professor. Classes in electrical engineering are also particularly useful. Dr. David McGee has worked in industry and can tell you more. If you are interested in high school teaching, Dr. Nate Magee directs the secondary education program for physics majors, and can tell you more about these outstanding opportunities.

*If I can't get into a math or physics class I need, there is nothing I can do!*

False! With the exception of general physics, there is rarely a problem getting into an upper level physics class. While often there is a problem getting into correlate math classes, a simple trip to the math office will usually result in you being enrolled in if you ask politely and show it is the only class you do not have a conflict with, etc. In addition, if you are missing a pre or co-requisite talk to your adviser or the department chair and see what can be done. As a general rule of thumb you'll want to put off (some of) your liberal learning till you've completed many of your major courses so as an upper classmen you will be able to register early and get the (double or triple counting!) liberal learning classes you need/want.

*I can just substitute Calculus C and Linear Algebra for Math Physics.*

While this is *technically* true for those with schedule conflicts, I urge all those thinking about it NOT to. This is recommended only for double Math/Physics majors and requires permission from the

department chair. Mathematical physics covers a LOT of needed material, geared toward physics with less of the unneeded technical bits (e.g. abstract proofs) of a standard math class. In addition, it's only one class instead of two, and taken with a physics faculty member!

*If I want to one day be a university professor, I should be in the Physics Teaching Track.*

False! Almost all faculty positions require a masters or Ph.D. and the teaching track is specifically for "secondary education", meaning high school. Secondary ed. physics teachers are in high demand so this route is often an excellent idea, but if you desire to go to graduate school, the teaching track is most likely not for you.

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**Closing Remarks:**

I would like to again thank all the physics majors and faculty who read this production and made excellent suggestions. In many cases their suggestions have been dropped in nearly word for word in the appropriate sections. Without their notes, this guide would not be nearly as complete as it is. If there is anything you feel is incomplete or misleading, or you have additional material you would like to see added, do not hesitate to contact me!

If there is **one** message to take out of this entire writing, it is, GET INVOLVED! Good Luck!

Mitchell Revalski
Class of 2014