LEAPING INTO THE

PHYSICAL SCIENCES

YOUR GUIDE TO FRESHMAN COURSE SELECTION

Many people experience a whirlwind of emotions as they enter college. You may be excited to move out and begin a life on your own, as well as meet new people and try new activities. However, it is perfectly natural to be a bit nervous, too, as college is a completely new experience and you may feel pressure to choose a course of study. Towards an Inclusive Community of Undergraduate Physicists (TiCuP) and Princeton Society of Physics Students (PSPS) have come together to demystify course selection and the physics and astrophysics majors. Drawing on the wisdom and experience of past, current, and prospective majors, we are here to help you overcome any confusion or academic unsureness and guide you through your first years at Princeton.

After working hard in high school, it may seem like the only viable path to a challenging major such as physics or astrophysics is to take the hardest, most advanced courses as early as possible. The goal of this guide is to convince you that this is not the case. Just as there are a plethora of research fields within physics and astrophysics (atomic physics, cosmology, biophysics, nanotechnology, etc.), there are a plethora of ways to pursue the physics and astrophysics majors. While your junior and senior years give you the opportunity to explore your research interests, your first year allows you to choose your fundamental physics base. The important thing to take away is this:

> It is more important to get a solid understanding of physics than to push oneself to take a course that is too advanced.

We all come from different schools, states, and countries, and therefore we approach our studies with different backgrounds and perspectives. With this in mind, it doesn't make sense to compare yourself to your peers; rather, it is more important to ensure that you build the unique foundation that you need to be successful.

To figure out which courses you want to take, think about which subjects most interest you. If you are reading this guide, then your interests probably involve some combination of physics, astrophysics, and math, although they may also involve chemistry, biology, poetry, music, or any number of other things. When looking through courses, don't worry about making the "right" choice. Invest some time in thinking about your courses, but remember that your first year is not going to make or break your Princeton career; there are plenty of students that begin in one field, and, after their first year, decide to move somewhere else. The liberal arts system ensures that your first two years are open to explore your academic interests, so don't restrict yourself.

Once you have some courses in mind, look at course reviews. At the end of each term, students are asked to review the courses they took. You can find these reviews either on the Registrar's page or through a variety of student-built course selection websites (one favorite being Princeton Courses). It is also very important to think about scheduling. The easy part of this is to ensure that none of the courses you want to take, including elective classes, overlap (a good resource for mapping out your schedule is Recal). You should also put some thought into the kind of life you want to have at Princeton. Are you an athlete? Which clubs or activities do you want to try? Do you need downtime to relax, or do you thrive off intense academic work? A course not only involves going to class, but also doing the homework and studying for exams. Keep in mind what is important to you and choose a level of academic engagement that fits how you want to structure your time.

If you are debating between two classes, remember that Princeton has a two week "shopping" period. This period is designed for you to sample the classes you are deciding between. With the exception of a few courses, it is much easier to switch to the "easier" course than the "harder" course. While shopping classes, pay particular attention to (for example) how accessible the professor seems to be, and how the pacing of the class feels to you; any issues that you have with these things in the first two weeks will likely persist. The most essential part of shopping, however, is to take both courses seriously while you are trying them so that you can get an accurate gauge of which is a better fit for you.

Finally, once you are in a class, take advantage of opportunities and resources. If you are struggling in a class, seek out the help that you need. Don't automatically assume that your struggles are a weakness or sign that you are not fit for the class. Talk to your professor, your peers, your advisers, a mentor, upperclassmen, and/or your dean - take advantage of your resources to help determine if a course is the right one for you. In this guide, you can find a "Campus Resources" section at the end, which can be a starting point for what is available. Don't be afraid to ask questions, whether it be during lecture, in precept, office hours, or at a problem session. It can often feel as though silence is a sign that everyone understands the concepts, but the reality is at least one other person probably has the same question as you. Speak up if there is something you don't understand; it will not only benefit you, but most likely your classmates as well.

Good luck, and we look forward to meeting you!

Sincerely,
Towards an Inclusive Community of Undergraduate Physicists (TiCuP)
Princeton Society of Physics Students (PSPS)

To the GREAT Class of 2026:

WELCOME TO PRINCETON!

CONTENTS

A MESSAGE FROM THE DEPARTMENTS OF

PHYSICS & ASTROPHYSICAL SCIENCES

Welcome to the Princeton Department of Physics! We on the faculty are eager to meet you and to discuss physics together. If you are interested in majoring in physics, then there are a variety of course options for the fall semester:

- PHY 103: This introductory mechanics course is a great place to start if you have not previously taken a college-level physics course with calculus. In the spring term, this course may be followed by either PHY 104, or the PHY 109/110 sequence, which emphasizes physics concepts, methodologies, and problem solving techniques.
- PHY 105: If you have a 5 on both the Physics C Mechanics and Physics C Electricity and Magnetism exams, and have taken a calculus based, college level physics course, then PHY 105 may be the better fit for you. It presents a more advanced treatment of mechanics and includes an introduction to Lagrangians.
- ISC 231/232: The Integrated Science Course is a double-credit course that provides an integrated introduction to physics, chemistry, molecular biology, and computer science.
- PHY 207: If you have already covered the material in PHY 105, then you may request to take PHY 207, the sophomore-level mechanics course. Placement into PHY 207 is by examination only; note that you must sign up for PHY 105 in the initial course registration process.

In deciding which course is the best fit for you, keep in mind that the most important thing is to build a strong foundation in the core concepts as opposed to over-stretching towards the most advanced option. Feel free to sit in on the first week of a class, study its syllabus, flip through the required textbook in the library, and/or try your hand at the first problem set. This will give you a feel for what any given course will be like, and will help you decide if it is a good fit. And of course, never hesitate to reach out to a faculty member for advice!

Looking forward to meeting you,

PROFESSOR WILLIAM JONES
PROFESSOR MARIANGELA LISANTI
ON BEHALF OF
PHYSICS UNDERGRADUATE PROGRAM COMMITTEE

For students interested in Majoring in Astrophysics — the study and exploration of our Universe — the important courses to take are the following:

- PHY 103 or 105 (Fall) and 104 or 106 (Spring) of Freshman year. The PHY105, 106 sequence is a more advanced level (for those who have 5 on AP Physics C).
- PHY 207 will be taken Fall of sophomore year.
- AST 204, "Topics in Modern Astronomy", is a prerequisite for all students interested in an Astro Major. It is offered every Spring, and can be taken the Spring of Freshman year if you have Calculus and AP Physics; otherwise take it the Spring of Sophomore year.
- MATH 103-104 (Calculus) and 201-202 (or 203-204) are prerequisites for becoming an Astro Major and should be taken during Freshman and Sophomore year. (AP Calculus is used to determine your MATH placement).

Students are welcome to consult with the Astro Director of Undergraduate Studies, Professor Neta Bahcall (neta@astro.princeton.edu) if you have any questions.

PROFESSOR NETA BAHCALL
ASTROPHYSICS DIRECTOR OF UNDERGRADUATE STUDIES

WHAT ARE THE DIFFERENT CLASSES?

WHERE DO I FIT IN?

As you can see, there are more options for introductory physics than just one honors physics sequence, and all of these options are viable. You can be a successful astro/physicist no matter which course you take. The message we hope you take away is that there are many definitions of what it means to be a Princeton astro/physics major. It is much better to choose a class where you can stay on top of the material than one where the material is out of reach and difficult to absorb. We hope that our breakdown of course difficulty gives you a better sense of where you fit, taking into account your high school preparation.

"While I certainly could have taken PHY 105, I chose to take PHY 103 because I wanted a smoother transition to Princeton. I was pretty convinced that my high school physics courses were not as difficult as those at Princeton, so I wanted to make sure that I felt comfortable my first semester. I think it was a great way to start my physics career at Princeton! During the first lecture, the professor told everyone "Hard work will be rewarded". I think that this statement was 100 percent true. As long as I studied rigorously for the quizzes/tests, I was confident that I would do well (and not to sound arrogant, but I did)."

— Anonymous (PHY, Class of 2022)

ASTRO/PHYSICS

"If you're on the fence, I encourage you to both be willing to challenge yourself and respectful of your needs as a new college student. If taking 105 is going to make your fall term a nightmare, then it's really not worth it. I know a lot of successful physics majors who took 103, and we need to debunk this myth that there is a "one track path" to becoming a physics major at Princeton. On the flip side of that, I want to remind first year students that you're capable of so much more than you think. A lot of us here suffer from impostor syndrome, and that can hold us back from pushing outside of our comfort zones. But we learn the most when we let go of that fear and embrace the challenge; so push yourself, but also be kind to yourself."

— Tori Edington
(PHY, Class of 2022)

CHOOSING THE RIGHT PHYSICS COURSES

PHY 103/104 VS PHY 105/106

The quick answer is: if you didn't learn physics in high school or your physics classes weren't calculus-based, then PHY 103/104 are probably the better classes for you. If you have a very strong physics background from high school, then PHY 105/106 or ISC (or a combination of the two) might be better for you. This answer, however, is limited, as it does not reflect some of the experiences of students who have passed through these classes.

The biggest misconception students have when choosing between 103/104 and 105/106 is that "true" astro/physics majors take 105/106, and an astro/physics major is not realizable if you take 103/104. Your choice of first-year physics courses is not a reflection of your ability to do physics; rather, it is a consequence of your high school physics preparation. Just because you have a different level of preparation does not mean you can't study physics or astrophysics.

The official recommendation says that you should take PHY 105/106 if you received a 5 on both parts of the AP Physics C exam. However, you should not be discouraged to try PHY 105/106 if that doesn't apply to you. When speaking with the department and other students, keep in mind that their recommendations are exactly that — recommendations. Their statements should not be interpreted as restrictions or pressures to take these courses. There are students who have very little physics background who jump into PHY 105 and love it, and there are students who have taken AP Physics and AP Calculus classes in high school and feel much more comfortable starting in PHY 103 to cement their understanding of the material. PHY 103 is structured to introduce students to calculus-based physics, whereas PHY 105 assumes a base level of experience with calculus-based physics.

If you are unsure which class to take, many students strike a balance by starting in PHY 105 and then switching to 103 if they feel out of their depth. The choice is very different from person to person.

Taking PHY 105 does not lock you into taking PHY 106, nor PHY 103 to PHY 104. The first semester (PHY 103/105) is mechanics, and many people have a stronger background in mechanics than electricity and magnetism. Thus, when it comes to electricity and magnetism second semester (PHY 104/106), many students feel less prepared and decide to take PHY 104. You also have the option to take the PHY 109/110 Spring/Summer sequence to replace PHY 104 if you feel you need the extra math and physics boost to tackle E&M.

"I knew I wanted to major in physics, however I was initially hesitant to take 105 since I had taken AP Physics 1&2 rather than AP Physics C in high school. During registration, I talked with Professor Lisanti and she assured me that I would be fine in 105. I definitely feel like it was a good fit for me. I found the course to be challenging, but not unmanageable, and the pace kept me engaged and excited about physics."

— Tori Edington (PHY, Class of 2022)

"I did not have a particularly strong background in mathematics or physics. I should have probably technically have taken PHY103, but chose PHY105 out of interest. I am incredibly glad that I did -- Professor Lisanti is a fantastic lecturer, and the course's emphasis is on teaching problem-solving techniques and introducing students to the more theoretical/abstract content that is typically taught at university. As such, I felt that I learned far more from taking and being challenged by PHY105 than I would have if I'd stayed within my comfort zone and taken PHY103."

— Anonymous (PHY, Class of 2023)

"PHY 103 was a good fit for me since I took AP Physics B [an algebra-based physics class equivalent to taking AP Physics 1 and 2] in high school. With my preparation, the class was somewhat easy. But I doubt I would have been prepared for PHY 105. There's plenty of time to take rigorous courses in the future, but during the first semester, it's nice to be in a manageable course."

— Bhaskar Roberts (ELE, Class of 2019)

SKIPPING AHEAD & ALTERNATIVES

SKIPPING TO PHY 207 (FROM CLASSICAL TO QUANTUM MECHANICS)

If you have an exceptionally strong physics background and think that you are ready to jump past the general introductory sequence, you can consider going straight to sophomore-level physics courses, starting with PHY 207 (From Classical to Quantum Mechanics). In order to do this, you must take a placement exam. For some students this is the perfect place to start, but for others, they decide to take 105/106 even though they have a strong physics background. Please note that this is the first year this course has been offered, as it is replacing PHY 205 (Classical Mechanics).

> "I was certain that I wanted to be a physicist and thought I was ready and willing to jump into 205. I ended up loving it — totally worth the hard first semester."
>
> — Jonah Herzog-Arbeitman (PHY, Class of 2019)

> "I took PHY 205 in freshman fall (skipping PHY 103/105) because I had taken a college-level Lagrangian+Hamiltonian mechanics class as a high schooler. I feel like it was a good fit—although I had seen Lagrangians and Hamiltonians before, much of the material was still new to me."
>
> — Jupiter Ding (AST, Class of 2024)

PHY COURSES VS. ISC 231/232

Choosing between one of the general physics tracks or the Integrated Science track is a bit more difficult. The Integrated Science Curriculum (ISC) is geared towards students with strong STEM backgrounds who are interested in research in biology-related interdisciplinary fields (biophysics, computational biology, biochemistry, etc.). It gives students a combination of intense theoretical lectures, delving into physics and math relevant to biological systems, and unparalleled lab experiences. Keep in mind that ISC is double course, which, at the end of both semesters, gives you equivalent credit for PHY 103/104, MOL 214, COS 126, and CHM 201/202.

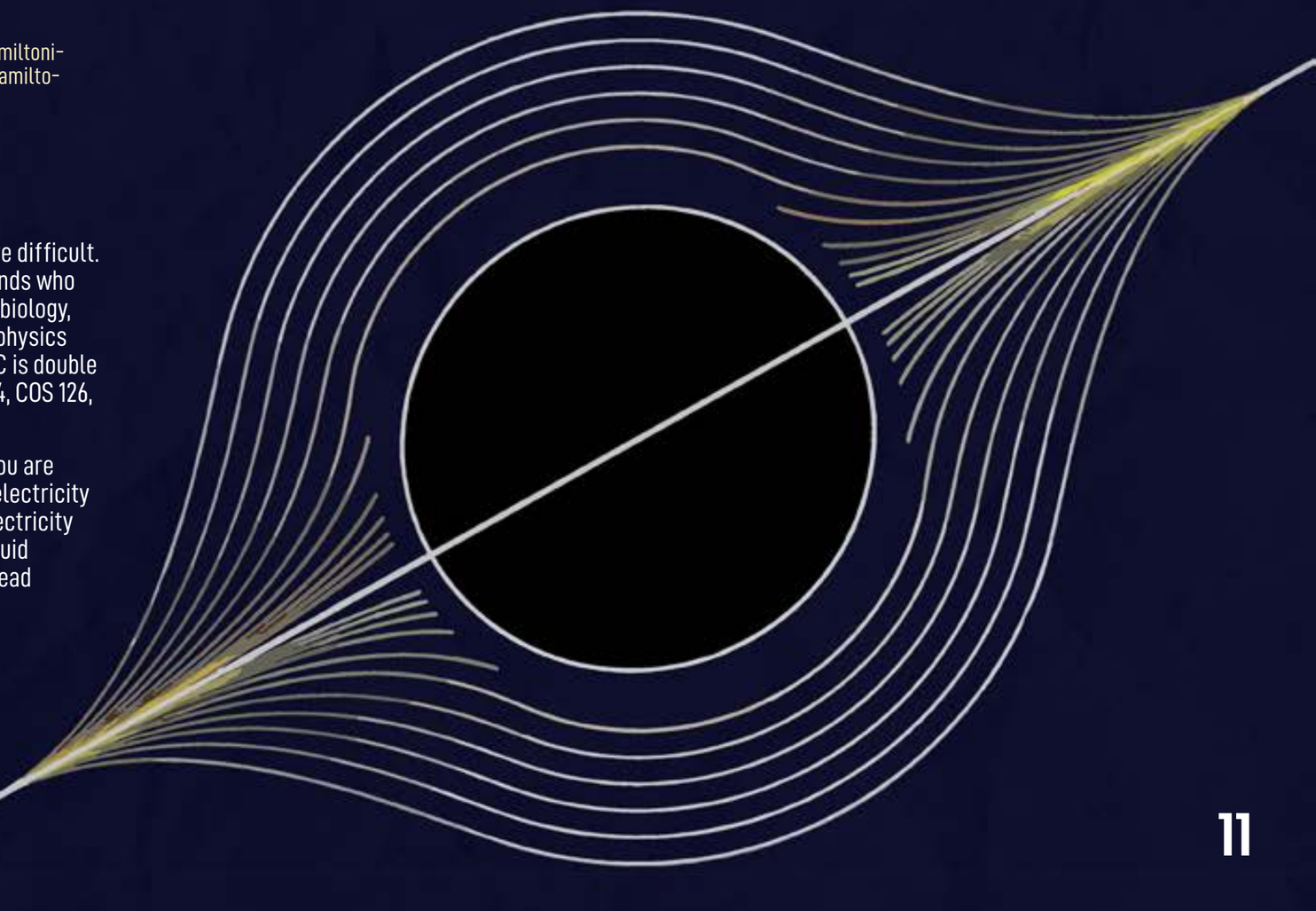
When trying to decide between general physics and ISC, it is useful to think about what topics you are more interested in. PHY 103/104 and 105/106 will give a deeper understanding of mechanics and electricity and magnetism, while ISC will give a broad interdisciplinary understanding of mechanics and electricity and magnetism, in addition to an introduction into quantum mechanics, statistical mechanics/fluid dynamics, and computer science. For more detailed information on the content covered in ISC, read the Integrated Science Curriculum section later on in this guide.

> "I was unsure about what area of science I liked the most and I also wanted to have a good foundation on all of them to support a carrier as a researcher. I think [ISC] was a good fit for me because the course was challenging but also manageable given the preparation I had. The lab part of the course was also really exciting and exactly what I was looking for as an introduction to scientific writing, reasoning, and data analysis."
>
> — Gabriel Toneatti Vercelli (PHY, Class of 2020)

> "If you are unsure which course is best for you, take 105. You can always switch to 103 later. I chose 105 and stuck with it. Don't be surprised if you find it very difficult. It's a tough course but it's a very good way to gauge how physics classes are taught at Princeton, and it helps get you more comfortable with material that you may not understand right away."
>
> — Michelle Baird (PHY, Class of 2020)

> "ISC is time-consuming (no one in my year managed ISC alongside MAT 203), but for me it was totally worth it (in fact, I partly regret not staying on second semester). The labs are unlike most other first-year labs that students can get, you get a great first look at thermodynamics and statistical mechanics. I would say that the physics majors complained about there being "too much" bio (the labs felt very bio-heavy) while the MOL majors complained about there being "too much" physics (the lectures are very physics-heavy, as is the homework), and first semester didn't have too much chemistry at all, but this is an excellent course for anyone with interdisciplinary and applied interests in the natural sciences."
>
> — Sara Anjum (PHY, Class of 2019)

> "ISC is best for those interested in interdisciplinary work or undecided about major; I did not feel left behind relative to those in 105/6 when I got to sophomore year."
>
> — Christopher Russo (PHY, Class of 2020)



YOUR CHOICE OF INTRODUCTORY MATH

Choosing a math course can often be harder than choosing a physics course because there is a broader spectrum of options. Most students leaning towards physics take MAT 201 or MAT 203 (multivariable calculus) their first semester, as the material covered in these classes is the best preparation for PHY 104/106 in the spring. Students leaning towards math take MAT 215 or MAT 216 (honors analysis: the official first steps in the introductory math sequence). The overlap between the two majors in the first year is large, even though the recommended classes may be different. You can be a physics major if you take 215 or 216, and you can be a math major if you take 201 or 203. Furthermore, you can also be a physics major starting in MAT 103 or MAT 104 (Calculus I and II).

If you are unsure which class is best, spend some time looking at the syllabi for the different classes and maybe even take the calculus placement exam. By reading the syllabus for a class, you can learn which topics are covered and identify interesting or repetitive parts of the material. It is important to keep in mind that college math courses are not all the same and the depth that you covered a topic in high school (or even at a local college) may not be sufficient to skip over the class at Princeton. To better gauge this, the Math Department has provided practice problems for each of the classes. These questions can give you a sense of whether the style and difficulty of problems is right for you.

The most important thing is that you find a class that fits and that you communicate any concerns with the department in order to ease your worries and find the best path for you. [1]

[1]The director of undergraduate studies for physics:
Prof. William Jones (wcjones@princeton.edu)

And for astrophysics:
Prof. Neta Bachall (neta@astro.princeton.edu)

With all that said, the next few pages include a summary of the four main options. For more detailed info and FAQs curated by the Math Department, follow the links.

"Find a branch of math you like and take a lot of it, there will always be unexpected uses."

— Jonah Herzog-Arbeitman
(PHY, Class of 2019)

"Expect the physics and math courses at Princeton to be very different than anything you took in high school. If you struggle in the first semester of Princeton math and physics don't necessarily take it as a sign that you won't be a good physics major. It probably just means you need to rethink how you go about doing the homework and studying for the exams."

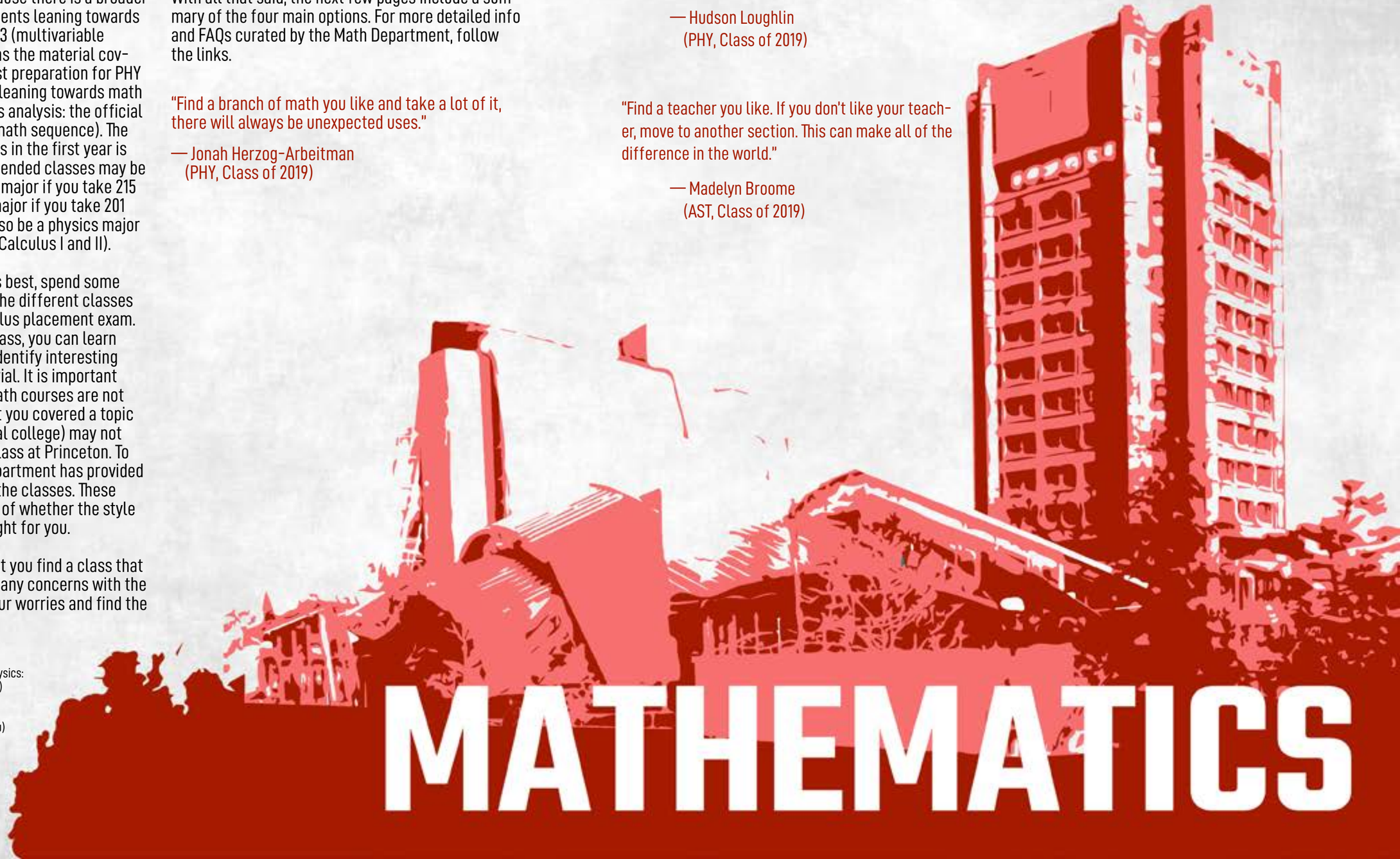
— Hudson Loughlin
(PHY, Class of 2019)

"Find a teacher you like. If you don't like your teacher, move to another section. This can make all of the difference in the world."

— Madelyn Broome
(AST, Class of 2019)

"Don't be afraid to ask for help! The best way to make the most out of classes is working with other people and talking to professors for help."

— Sam Cohen
(PHY, Class of 2021)



MATHEMATICS

PROOF VS. APPLICATION

"APPLICATION-BASED" CLASSES: MAT 201/MAT 202 OR MAT 203/MAT 204

MAT 201/202 are the standard multivariable calculus (201) and linear algebra (202) courses that physics majors take. MAT 203/204 extends past the material covered in MAT 201/202, venturing into slightly more abstract territory. Whereas 201 tends to stick to calculus of 3 dimensions, 203 generalizes concepts to n-dimensions. Similarly, 202 focuses on linear algebra computations confined to matrices, while 204 extends the same principles to more abstract object types such as functions. 204 also places a stronger emphasis on how the material covered in lecture can be applied to other fields (computer science, physics, etc.).

The 203/204 sequence is generally recommended for physics majors, but 201/202 will definitely suffice, especially if you are not interested in in-depth theory. Most of the core physics classes use 201-level multivariable calculus and 202-level linear algebra (the linear algebra used in physics classes is fairly basic matrix multiplication and eigenvalues/eigenvectors), so don't hesitate to take 201/202 if your background and/or interests make those classes a better fit.

"Even though I took multivariable in high school, I thought I would get more out of MAT 201 than MAT203. I'm more of an application kind of person. I don't really like proofs and things along the lines of proofs, so I was happy enough with taking MAT 201. It was the same material as high school, but I felt like I learned more about why something was done vs just how to do something. It wasn't the most challenging class I took, but I was very happy that I took it and got a lot out of it."

— Anonymous (AST, Class of 2023)

"My high school [did] not offer any math courses past AP Calculus AB (MAT 103 equivalent) so I chose to take MAT 104. It was a great fit for me--I found that it challenged me enough without being overly stressful. As long as I prepared for exams/quizzes and stayed up-to-date on the homework, I was confident that I would be successful in the course."

— Anonymous (PHY, Class of 2022)

"I'm glad I took MAT 203...This class might seem like a stiff challenge, but the people at problem sessions are amazing and will make the learning process a hundred times easier!"

— Andrew Ji (Undecided, Class of 2025)

"The most important result of the first semester is that you come out of it confident. Nobody cares what you took, and taking a harder class does not put you ahead in a long-lasting way. But if you're confident, you will work harder and take more risks. I felt burnt out after MAT 203 and started avoiding math. I've since ventured back and done well in math courses, but MAT 203 set me back. If you're interested in MAT 203, I recommend enrolling in it (it's really interesting), but don't hesitate to drop."

— Bhaskar Roberts (ELE, Class of 2019)

"PROOF-BASED" CLASSES: MAT 215/MAT 217 OR MAT 216/MAT 218

MAT 215/217 is the standard first year curriculum for incoming math majors, providing an introduction to real analysis (MAT 215) and linear algebra (MAT 217). MAT 216/218 goes faster than 215/217 and covers more (and slightly different) ground: introduction to real analysis, linear algebra, and then a little bit of differential geometry. Neither sequence is perfectly geared towards aspiring physics majors (students in 215/217 will never learn any multivariable calculus, for example), but most students who opt for this route end up learning what they need to from their physics classes and are perfectly fine. MAT 216 assumes prior experience with proofs, whereas MAT 215 tries to ease students into this new way of approaching math — although the pace is anything but slow. It is especially worth considering one of these options if you are interested in theoretical physics. A lot of higher-level classes that are important to theory (Algebra and Differential Geometry in particular) list 215/217 or 216/218 as prerequisites.

"I wanted to do theoretical physics, so I think a rigorous proof-based math course would be useful. The difference between 216/215 is that 216 covers a broad range of topics, whereas 215 mostly only covers analysis (the baby Rudin textbook). I've learned some analysis in high school, so I [decided] 216 would be a better option for me. That being said, the course itself doesn't require any background in proof-based math nor analysis. It is very self-contained and provides a perfect introduction to mathematics that touches a little bit of everything. I absolutely loved the material. It is definitely a good course for people who are interested in rigorous proof-based math. And if you don't know whether you like proofs or not, shop the class and find out!"

— Anonymous (PHY, Class of 2022)

"I chose [MAT 215] because I wanted to take math beyond the standard multi/linear sequence. I feel like I wasn't very well prepared for it because I didn't know how to write proofs and had to spend a lot of time figuring that out. But I am still glad I took it because it was necessary for the courses I took afterwards."

— Loki Lin (PHY, Class of 2022)

"I want to do theoretical physics, and I wish I'd had the confidence to try out MAT 215. I took MAT 201 and MAT 204 during my first year, and I've found that those have been sufficient for math courses I've taken so far (though I'm trying harder math courses in the next year!)"

— Hanako Helton (PHY, Class of 2024)

A MESSAGE FROM THE HEAD PROFESSOR OF THE

INTEGRATED SCIENCE CURRICULUM

Welcome to Princeton!

I wanted to let you know about an exciting educational initiative at Princeton, the Integrated Science Curriculum (ISC).

A little about the program:

- The ISC curriculum is founded on the expectation that much of the most important science of the future, though based on the classical disciplines, will lie in areas that span two or more of them. As such, we see a need to educate students with a unified view of the scientific endeavor who seek out, rather than shy away from, cross-disciplinary topics of research.

- Integrated Science is an interdisciplinary curriculum for students excited about learning science. It presents a mathematically-sophisticated, integrated view of the sciences that will allow you to tackle the problems of the future.

- Integrated science is challenging and time consuming. Ours is a double-course that will account for roughly half of your workload for the whole first year. It might just be the hardest academic experience you've ever had. However, if you stick with it, you will gain proficiency in introductory Chemistry, Computer Science, Molecular Biology, and Physics, allowing you to major in any science or engineering discipline.

I encourage you to learn more about the program by going to the ISC page of the Academic Expo website and http://lsi.princeton.edu/integratedscience. I have recorded a brief video introduction to the course which you can watch here: https://youtu.be/ZF63CRaEPCU

We all hope to see you in the fall.

Best wishes,

JOSHUA W. SHAEVITZ
PROFESSOR OF PHYSICS AND THE LEWIS-SIGLER INSTITUTE FOR INTEGRATIVE GENOMICS
DIRECTOR, INTEGRATED SCIENCES CURRICULUM

AN ISC

GENERAL OVERVIEW

COURSE GOALS[1]

ISC motivates students to approach science with a research mindset: problems and topics tend to be open-ended and exploratory rather than procedural, collaboration and seeking help is encouraged, and concepts are combined in creative ways. The course is not organized into biology, physics, and chemistry sections, but rather by mathematical concept. In each unit, new math concepts are introduced then put into the context of various problems in the sciences. Lectures introduce a concept and then precept will typically look at a harder application of this problem. The course begins with basic, single-order differential equations, followed by second-order differential equations and oscillators (damped and harmonic) and then statistical mechanics. The time commitment is challenging and peer collaboration is crucial; the course isn't designed to be completed alone, and one gains a lot from collaborative discussions.

"One important thing about ISC is that it is possible to complete all of the assignments and "finish" the course without really understanding how everything works and just scraping by. If you're already putting in the time and commitment to the course, take full advantage of all of the resources available: from the professors, textbook, and your peers. Make sure that you really understand what's going on every week and can work through the P-Sets/additional textbook problems more or less by yourself because the level of proficiency that you will need for the midterm and final is not something you can just cram before the exam. I know you'll hear about how hard ISC is and have a ton of other time commitments once you're in the course, but if you truly want to take ISC, know what you want to get out of the course and be ready to work for it."
— Anonymous

[1]This overview is edited from a Principedia article authored by Milena Chakraverti-Wuerthwein (PHY, Class of 2020) and Shiye Su (PHY, Class of 2020). It covers the first semester of ISC and is based on how the course was taught during fall 2016. The curriculum changed slightly in fall 2017 to include more chemistry (removing some statistical mechanics), but the general course structure remained the same.

A CONTINUED OVERVIEW OF THE INTEGRATED SCIENCE CURRICULUM

LEARNING FROM INSTRUCTION

The first half of the semester (until fall break) follows the COS126 curriculum as well as the PHY/CHM/MOL lectures. The COS126 lectures are on Tuesdays and Thursdays. Monday, Wednesday, and Friday lectures are PHY/CHM/MOL and are taught by one professor most of the time, but sometimes other professors will come to expose you to their research or problems/topics related to what they research. Precepts are half COS and half PHY/CHM/MOL. After fall break, you will switch to entirely PHY/CHM/MOL lectures and precepts.

During the PHY/CHM/MOL lectures, it is most important to have a conceptual understanding of the larger picture rather than necessarily following all the details of the derivation. Do not get discouraged if you are lost in a derivation, just try and take a step back to see the larger concepts, because you can get the finer points from the lecture notes. Often, reading over the lecture notes will clarify or reinforce understanding significantly.

PHY/CHM/MOL precepts are unusual in that new content is introduced. Precepts take lecture concepts to a new level with more complex problems. Try to get a sense of how to approach problems and appreciate connections between the ideas presented, because, likewise, it is not necessary to follow every line. A good way to stay engaged is by asking questions. When faced with a silent room, it is easy to assume that everyone else understands and therefore feel as though your questions are somehow naive, but, in reality, your question is probably something that your peers are confused about as well. Once you shift into exclusively ISC precepts (not COS), there will be breaks halfway through precept. These breaks are a great time to talk to the preceptors one-on-one about the larger concepts or specific steps in the derivations that you didn't understand. The preceptors also hold office hours.

The ISC labs are really fantastic, well designed and fun. In-lab, the instructors (Jenn Gadd and Quan Wang) as well as the grad student TAs are super nice and helpful if you have any questions. They are especially happy to talk to you if you are curious about how a specific task works, or why you are doing something. Take advantage of being able to talk to them about the science behind the labs, because it can be really interesting and sometimes can help with lab write-ups. Don't underestimate the time required to write the lab report, especially the MATLAB script. It is important to be meticulous with figures and their captioning, which in terms of grading, is more important than the text.

"[ISC is] often a miserable amount of work but in higher-level classes that'll probably be the norm so it'll prepare you better for the grind. The labs also forced me (a noob) to quickly learn scientific writing skills and MATLAB, which I've found very useful post-ISC."

— Anonymous (NEU, Class of 2020)

LEARNING FOR /FROM ASSIGNMENT & ASSESSMENTS

For the problem sets, collaboration is important. Get started early, as they are time consuming and you learn a lot more with time to think over the questions, than you do with a solution hastily explained in an hour of desperation. There are problem set sessions, which are held on Wednesday evenings with a grad student TA who is also your grader for that week. If you are uncertain about what a question is asking, by all means ask them! They are there to help you. It is helpful if you have at least looked through the problems, and possibly started them, so that you have some concrete questions to ask during the session. The TAs are also typically very open to meeting with you one-on-one and going over specific problems or questions if you are still confused on Thursday before the problem set is due on Friday.

Lab reports are typically MATLAB heavy, but don't forget that neither MATLAB nor programming experience is a prerequisite. Many tips, techniques, and built-in functions for extremely specific objectives exist online; both the documentation and informal platforms like MATLAB Central are great. Using LaTeX is very common with lab reports, but this is not a requirement. There is no grading advantage to LaTeXing your lab reports; the content is far more important, so stick to whatever word processor you are most comfortable with. Lab office hours can be great opportunities to ask questions about lab report guidelines or data analysis, but are also a really good way to force yourself to start working on the lab report and prevent procrastination. Lab reports take A LOT of time. Do not procrastinate on them — start early.

In preparation for exams, it's more important to have an understanding and intuition of the concepts than knowing formulae and minutiae. Do the problems in the notes, including reviewing those from problem sets, as there may be some explicitly on the test, and otherwise will help you get mindset of hard problem solving. It can be helpful to work through problems with someone and be exposed to different ways of solving and combining ideas. Cheat sheets are allowed for the exams. Different people emphasize different things, but it can be helpful to include important formulae and also example problems.

EXTRA INFO & FREQUENTLY ASKED QUESTIONS

WHAT STUDENTS SHOULD KNOW

ISC is indeed challenging and a substantial time commitment, but don't be put off by its reputation. If you have a true interest in biology-related interdisciplinary science and are willing to invest the effort, you can succeed in the course while maintaining balance. The class is immersive and there's much to be gained from the social experience. Furthermore, remember that Princeton has a 2 week "shopping period." Plenty of people start out in the class before deciding it's just not for them and then take other classes. If you decide to shop ISC, make sure you are treating the course as if you were actually taking it. Putting in half the effort because you are unsure will only set you up to drop it later. Enjoy, because some beautiful ideas are presented.

FAQS

Q: What math background do I need for ISC?
A: Successful completion of AP BC Calculus or equivalent is highly recommended for the class. It can be helpful to take multivariable calculus (MAT 201 or 203) and linear algebra (MAT 202, 204, 217, or 218) concurrently.

Q: Do I need to take AP Bio/Chem/Physics (or equivalent) for ISC?
A: While more advanced coursework in the natural sciences (especially physics) will help, AP science courses are not necessary for success in ISC. The course does assumes some basic knowledge in all 3 areas, but not at the AP level.

Q: Will I be behind when rejoining the main physics major path?
A: Many ISC students will continue on to become astro/physics majors. Most of these students do not feel disadvantaged within the major, but the way that the two paths are structured, gives each different advantages. ISC covers a broader spectrum of topics, so you will have exposure to quantum mechanics and statistical mechanics/fluid dynamics, which the general physics track does not give you until sophomore year or later. PHY 105/106, however provides a stronger preparation for advanced mechanics / E&M classes because they have a stronger, narrower focus on those topics than ISC. In the grand scheme of things both classes prepare you to be a physics major, but in different ways (and with different strengths). You have to choose based on [1] whether you want a solid pure physics foundation in mechanics/E&M (PHY 103/104 or 105/106) or a broader biology-geared interdisciplinary foundation (ISC) and [2] what kind of work environment you want and how you want to balance that with extracurriculars.

Q: I've taken AP Bio/Chem/Physics (or other advanced courses). Will I get anything out of ISC?
A: In most cases, high school courses are not as challenging as ISC. Many people enter having taken any combination of such classes and still exit feeling as if they were exposed to a lot of new content from a new perspective. ISC synthesizes the disparate course content in a unique way, introduces students to potentially more advanced - or at least different - biology than was covered in the high school / AP curriculum, and introduces students to thermodynamics from a statistical mechanics perspective, which is not something that is on the standard AP curriculum. The labs are also, very likely, not ones a person would have done in high school (e.g. one lab involved determining Boltzmann's constant by observing and recording the motion of microscopic beads in a fluid.), and they involve heavy lab report-writing as well as extensive data analysis via MATLAB.

Q: What kind of student is ISC meant for?
A: While ISC is largely geared towards students in the natural sciences, students pursue a wide variety of majors. Many become physics and computer science majors, while others use ISC to fulfill BSE requirements. Some students do end up pursuing majors in the social sciences or humanities after ISC; though this is atypical, it is not not impossible.

Q: What if I'm still not sure if I want to take ISC?
A: If you want more in-depth answers or have questions that were not answered in the FAQ, ISC alums are more than willing to answer your questions. Feel free to contact us at uwip@princeton.edu, and we can put you in contact with an ISC alum! In all likelihood, there is someone who was in a similar situation to you that could answer your question.

"If you want to [take ISC and didn't have the opportunity to take calculus or calculus-based physics], get on edX and do those Calc BC and physics C courses. Physics might be more of a hindrance than math, depending on how challenging you find it. I also want to say, the reason I'm so optimistic about ISC being possible for basically anyone is because my high school was the most underfunded place ever, and I'm self taught in so much, and even I made it and even liked it. So yes there are lots of people going in who went to fancy prep schools and have already taken college courses and whatnot, but ISC is really one of those things where determination and self discipline and sometimes coffee intake is slightly more important than preparation. " — Anonymous (COS, Class of 2020)

EXTERNAL RESOURCES

This class has an amazing support network, both due to the small class size and to the many enthusiastic alumni. It is easy to develop close relationships with instructors and upperclass mentors. Check out when group tutoring is scheduled (several days of the week); these are led by past students who can not only provide academic help (MATLAB/LaTeX tricks, problem-solving approaches, etc.) but also general advice on the course and Princeton. Make friends with the tutors and TAs! Lab office hours are great for image/data analysis and other problems. If you are struggling a lot with lab, reach out to Jenn Gadd (jgadd@princeton.edu). She has in the past worked one-on-one to go through lab reports (ideas, writing, figures, etc.) or to give more support and instruction with lab techniques (pipetting, plating cell cultures, using a microscope, etc.)

One thing that students in general do not take advantage of in this class is the amazing faculty. ISC is lucky to have multiple professors on staff, in addition to the 4 TAs (2 lab, 2 problem set) and 2 preceptors, every one of whom is doing interesting research. All of these people are more than willing to set up one-on-one meetings with you if you need help with material, or just want to learn about what they do. Professors are very helpful after lecture, or if you make appointments with them to talk through the material. This is especially true for the professors who may only teach one week of lectures and then have a few problems specific to their field of research on the problem set for that week. The problem set graders may not be acquainted with this specific field, so it can be useful to go to that professor and ask about topics covered in lecture or about the problems in particular. Most of all, take advantage of the amazing opportunity that ISC gives you to interact with an extremely wide spectrum of brilliant researchers.

It's also important to know how to seek out resources independently on the Internet, especially for MATLAB and LaTeX tricks. If something interests you, read up on it!

ACADEMIC HELP

For many people the academic shock is huge and it takes a semester (or more) to adjust study habits to match the Princeton academic pace. This is very strong in STEM classes because most students have not had assignments that are as involved as Princeton problem sets. Nevertheless, there are a lot of different ways that people adjust within this environment.

PROBLEM SET SESSIONS & STUDY GROUPS

Collaboration on problem sets and assignments, when allowed, is key. Physics and math professors typically encourage students to collaborate on assignments because it builds camaraderie and enhances students' learning. There are three main methods through which students collaborate: course-organized problem set sessions, self-organized study groups, and the McGraw Study Hall (details later).

Course-organized problem set sessions provide a time and space wherein students can drop in to collaborate on problem sets and ask questions supervised by an undergrad or graduate student course assistant, so they are helpful / in touch with course expectations. If your course organizes a regular problem set session, it will often be a few days before the assignment deadline, so they go a long way to helping you finish a problem set, but may not be ideal for learning entirely new concepts.

While problem set sessions are great, don't underestimate the power of forming your own informal study group. Working with others in the course provides a peer group that you can compare answers and solving methods with. Such life-saving attachments, when mutual and constructive, go a long way to better understand the material and different ways to approach problems. Before seeking help of any form, be sure to have made a solid attempt!

"Going to the problem sessions and making friends to work with was invaluable." — Anonymous (PHY, Class of 2018)

"Office hours and UCA[Undergraduate Course Assistant]-led problem sessions were both extremely helpful. I did psets in a group with 3-4 other people. Would've been impossible if I had worked alone." — Loki Lin (PHY, Class of 2022)

"Attaching myself to a friend who showed me the ropes was absolutely invaluable." — Anonymous (PHY, Class of 2018)

"Doing problem sets with friends was definitely the best thing to do for me. It's not like at office hours or tutoring because nobody knows the answer! But in my opinion that makes it so you learn the material better." — Sam Cohen (PHY, Class of 2021)

"Finding a group of friends to compare answers with is a must (they'll last you years to come) but I recommend working on the P-Sets alone so you know what you actually understand." — Jonah Herzog Arbeitman (PHY, Class of 2019)

OFFICE HOURS

Office hours are organized by the course staff and a schedule of the hours and attending professor/preceptor are published either in the course syllabus for a given semester or announced in lecture. Typically these are informal meetings where students can turn up within the time slot with particular questions or to discuss general concepts, directly interacting with a single professor or graduate student preceptor. It's a format that lends itself to more deeply understanding a concept or exploring tangential ideas beyond the more general bare-bones coverage provided in lecture.

"Go to office hours" is one of the most common pieces of advice students give. The utility of office hours can be highly dependent on the supervising professor or preceptor. Past students give good suggestions on which ones are lifesavers and which are "okay"; you can also try a few different ones. Office hours are also the easiest way for you and the professor to get to know each other. Not only is this a good opportunity to build connections for future recommendation letters, but getting to know your professors can expose you to completely new research areas that previously you didn't know existed.

"I would say not to worry if you feel like you have no idea what you're doing. You will eventually. TALK TO YOUR PROFESSORS. GO TO OFFICE HOURS. I wouldn't have done nearly as well as I did [in PHY 105] if I didn't get extra help at office hours." — Michelle Baird (PHY, Class of 2020)

"PHY105 has a lot of office hours, but you should use these wisely. If you overuse them and go to too many, then you run the risk of not learning the content properly. I'd advise working through the problems properly on your own and then visiting office hours briefly for advice." — Anonymous (PHY, Class of 2023)

"Office hours are extremely helpful, especially when you know which TA's are most helpful (the only way of knowing this is to attend office hours run by different TA's and decide for yourself—people tend to have differing opinions on the helpfulness of TA's). Also, finding a Pset buddy/group is pretty much essential if you want to do well. That being said, don't stress about trying to find one right away. Just try to work with others in office hours and your group will naturally come together." — Anonymous (PHY, Class of 2023)

MCGRAW CENTER

McGraw Center tutoring is frequently cited as a helpful resource that is free and available to anyone enrolled in the course. More than 50% of students take advantage of tutoring; it is not necessarily a sign that one is struggling. Tutoring can help reinforce and explore concepts.

Group study halls are drop in hours that create a study group environment supervised by a few tutors. This is a good space to come with specific questions, get help working through a problem, or collaborate with others on problem sets while having access to immediate feedback / aid. These are most commonly offered for introductory courses such as: MAT 103/104/201/202/203/204, PHY 103, etc. MAT 201/202 and 203/204 students will especially preach the importance of McGraw Group Study Hall for getting problem set's done.

"The McGraw center has tutoring for MAT 203 and it saved me every week. It was the only reason I finished any of the P-Sets for that class." — Camille Liotine (AST, Class of 2020)

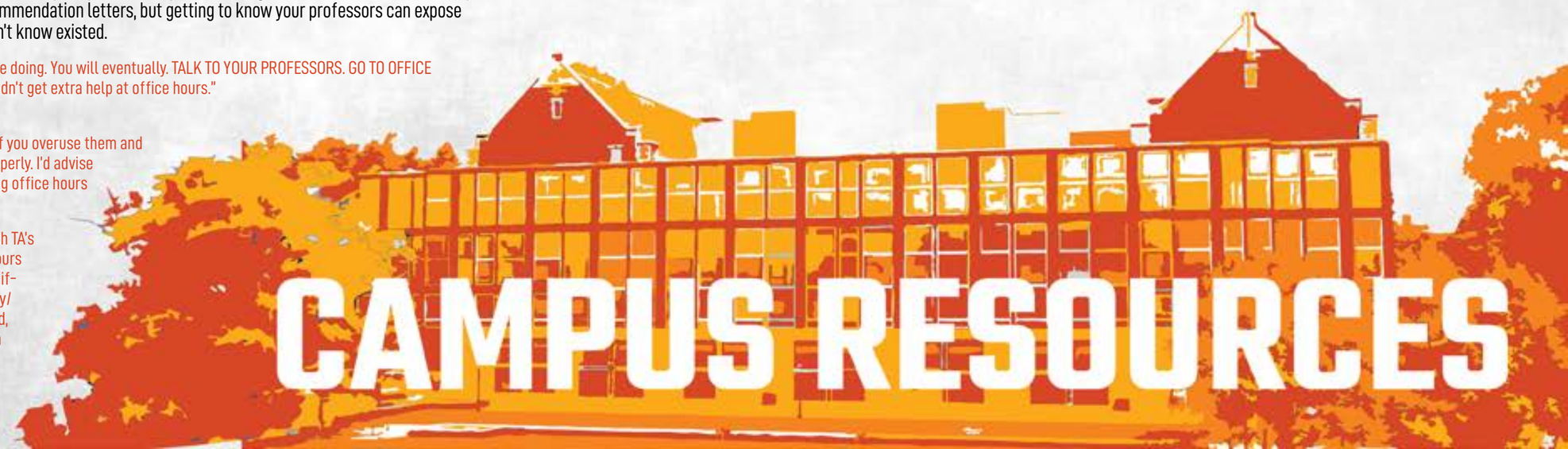
Individual peer tutoring is appointment-based and allows for more focused and individualized assistance. These are particularly good for those who need more involved guidance working through problems, want to enhance their foundational knowledge of course material, identify areas of weakness, or have a broader range of concepts to discuss. Availability is shown on the McGraw Center website during each term. Tutoring is offered mainly for introductory courses, but is not limited to just the courses offered for group study halls (e.g. PHY 105 is not included in McGraw Study Hall, but students in the past have made use of 1-on-1 tutoring through the McGraw Center).

In addition to tutoring, McGraw hosts academic strategies workshops which aid students in learning and applying strategies for purposeful and efficient learning, exam preparation, planning, etc. Princeton students can also make appointments with McGraw learning strategies consultants.

For full descriptions of the McGraw Center resources, visit the website.

PHYSICS DEPARTMENT PEER TUTORING

The physics department also offers peer tutoring for physics courses not supported by McGraw, including PHY 105 and 207 in the fall. This program is a great way to get individual or small-group help consistently throughout the semester, with most groups meeting 1-on-1 once a week, and to develop a tutor/mentee relationship with one peer tutor. To sign up for tutoring with the department, keep an eye on your inbox or look for an announcement on Canvas for a sign-up link.



CAMPUS RESOURCES

INSTITUTIONAL SUPPORT

Freshman year can be a difficult transition period for many, and this process is complicated by Princeton's rigorous academics. The University offers many support systems to connect students who might be having similar experiences in addition to professional counselling for those who want to talk through their problems.

RESIDENTIAL COLLEGES

The pastoral care from your Residential College is often the first point of support. Residential College Advisors (RCAs) are upperclassmen students who understand Princeton's challenges as an incoming freshmen, and have undergone extensive training to help you as much as they can. Likewise, Peer Academic Advisors (PAAs) are trained to answer academic-related concerns such as: degree/major requirements, academic planning, or adjusting to coursework. Peer Health Advisors (PHAs) are also open for conversation around any concerns or stresses you are experiencing and can point you to further resources if you wish, including those in CPS (see below). Of the Residential College staff, the Director of Studies and Director of Student Life deal most directly with student concerns. Feel free to check in with your Academic Advisor through the semester, who is often associated with your residential college.

Residential colleges also offer peer tutoring, which is a less frequently used resource, and supply and demand varies more widely between courses. To request residential college tutoring, make an appointment or meet with your college dean / director studies.

CARL A. FIELDS CENTER

The Carl A. Fields Center (CAF) is Princeton University's unique Cultural Center. CAF strives to empower members of the University community as they seek to learn about self, understand the breadth of cultural and social differences among us, and build the skills needed to create and lead a more just world.

GENDER & SEXUALITY RESOURCE CENTER

The Gender + Sexuality Resource Center (GSRC) fosters a supportive and inclusive campus community for women, femme, trans, and queer Princetonians through collaborative programming, education, advocacy, and mentorship. Located on the 2nd floor of Frist Campus Center, the GSRC puts on a range of programming such as speaker events, socials, workshops, and dialogues. The GSRC is a great resource, the center itself is always open to anyone who wants to come hang out or chat with the great counselors on staff.

CPS

Counseling and Psychological Services is free and available to all students. It is easy to set up an initial appointment through the web portal, phone, or visiting McCosh Health Center. Princeton's challenging academic environment can feel isolating; CPS counselors are experienced with such problems and sometimes simply talking through such thoughts can help. CPS also offers group counseling. You do not need to have a diagnosed mental illness to take advantage of CPS counseling; counsellors are trained to handle problems ranging from the short term to the long term, and this definitely includes any issues you may be facing related to academics.

STUDENT GROUPS

Student organizations can provide a great community, advice, and source of information about research and opportunities. Also, these events often come with free food! There are three main student groups most directly concerned with physics/astrophysics: Towards an Inclusive Community for Undergraduate Physicists (TiCuP), the Princeton Student Physics Society (PSPS), and the Princeton Astronomy Club (PAC).

TICUP

The goal of TiCuP is to offer mentorship, academic enrichment, and a welcoming community to students majoring in physics or related fields. We invite all students, regardless of gender identity/expression, race, socioeconomic background, and/or sexual orientation, to become members. As a joint collaboration between students in physics and the astrophysical sciences, we aim to provide guidance in order to aid students in their strides to achieve their academic, personal, and professional goals.
To join the TiCuP email list-serv please email uwip@princeton.edu, or fill out this form.

PSPS

The Princeton Society of Physics Students (PSPS) is the Princeton chapter of the national Society of Physics Students, "a professional association designed for physics students and their advisers". Along with hosting talks by physics faculty, the PSPS aims to provide a broader perspective of physics by hosting talks from faculty members of other departments who perform applied or mathematical physics research. It also aims to aid with the academic and professional development of physics majors at Princeton by hosting professional development events by peers about summer and on-campus research opportunities, certificates that complement the physics degree well, provide peer mentoring, and more. We look forward to meeting you all and welcoming you into the PSPS and broader Princeton physics community.

PAC

The Princeton Astronomy Club (PAC) is an organization striving toward inclusivity within the technically dense field of astrophysics by creating a gateway for those not studying astrophysics to learn about and appreciate the universe and its complexities. Beyond our trademark study breaks and stargazing parties designed to involve students in a relaxed environment, we also hope to pursue venues through which everybody can learn something new about astrophysics. Given that, the club will not only continue to host its study breaks and stargazing parties but will also introduce various projects designed to educate its audience such as Instagram explainer posts, meet an astronomer events, wintersession events, and more!

MATH GROUPS

The Math Club (listserv Nullset) and the Noetherian Ring may also be of interest to physics students.

The Math Club (website, FB) is active in hosting colloquia from various Princeton professors, typically from the Mathematics but also Physics and Computer Science departments. Its course selection information events can also be relevant to physics/astrophysics majors, as are the social events. They also advertise recruiting events from software, trading, and other companies geared towards STEM majors on Handshake, a Princeton App.

The Noetherian Ring (website) is focused on women in math, particularly in creating mentor/mentee relationships. Many of its resources are helpful to all and even more so for math-leaning physics & astrophysics majors.

USEFUL LINKS

PHYSICS (PHY)

Director of Undergraduate Studies:	Prof. William Jones (wcjones@princeton.edu)
Undergraduate Program Administrator:	Karen Kelly (kkaras@princeton.edu)
General Info about Undergraduate Program:	https://phy.princeton.edu/undergraduate-program
Major Requirements:	https://ua.princeton.edu/academic-units/department-physics#

ASTROPHYSICS (AST)

Director of Undergraduate Studies:	Prof. Neta Bahcall (neta@astro.princeton.edu)
Academic Program Administrator:	Polly Strauss (pstrauss@princeton.edu)
General Info about Undergraduate Program:	https://web.astro.princeton.edu/academic/undergraduate-program
Major Requirements:	https://web.astro.princeton.edu/academic/undergraduate-program/_major-requirements

MATH (MAT)

Director of Undergraduate Studies:	Prof. János Kollár (kollar@math.princeton.edu)
Undergraduate Placement Officer:	Ana Menezes (amenezes@math.princeton.edu)
Undergraduate Program Administrator:	Michelle Matel (mmatel@princeton.edu)
General Info about Undergraduate Program:	https://www.math.princeton.edu/undergraduate
Info on Introductory Math Courses:	https://www.math.princeton.edu/undergraduate/placement/lower-division

INTEGRATED SCIENCE CURRICULUM (ISC)

Program Coordinator:	Jennifer Brick (jbrick@princeton.edu)
Head Professor:	Prof. Joshua Shaevitz (shaevitz@princeton.edu)
General Info about Program:	https://lsi.princeton.edu/integratedscience
Official FAQ:	https://lsi.princeton.edu/integratedscience/faq

STUDENT GROUPS

Towards an Inclusive Community of Undergraduate Physicists (TiCuP):	uwip@princeton.edu https://ticup.princeton.edu/
Princeton Society of Physics Students (PSPS):	psps@princeton.edu https://psps.princeton.edu/
Princeton Astronomy Club (PAC):	aclub@princeton.edu
Princeton Math Club:	princetonmathclub@gmail.com https://blogs.princeton.edu/mathclub/
Noetherian Ring:	http://web.math.princeton.edu/noetherian/index.html

TOOLS FOR COURSE SELECTION

Official Course Offerings:	https://registrar.princeton.edu/course-offerings/
Princeton Courses (student-built course platform):	https://www.princetoncourses.com/
Recal (student-built course schedule planner):	http://recal.io/

CAMPUS ORGANIZATIONS

Counseling and Psychological Service (CPS):	https://uhs.princeton.edu/counseling-psychological-services
Carl A. Fields Center:	http://fieldscenter.princeton.edu/
Gender + Sexuality Resource Center:	http://gsrc.princeton.edu/
The McGraw Center for Teaching and Learning:	https://mcgraw.princeton.edu/

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