Carnegie Mellon University

Academic Year 2026 – 2027

Mellon College of Science

Department of Physics

Doctoral Student Handbook

Degree Program Covered by this Handbook:

Ph.D. in Physics

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SECTION 1: Welcome & Introduction

Welcome to Carnegie Mellon University and the Department of Physics within the Mellon College of Science! Graduate students are an integral part of the educational and research mission of the department. Attracting and training talented graduate students is vital to Carnegie Mellon's mission and essential to the research success of the department. A thriving research program is, in turn, necessary to attract students and to provide the environment they need to reach their potential as scientists when leaving the university with a higher degree.

This handbook presents general information for all doctoral students in the Department of Physics at Carnegie Mellon University and summarizes the rules and degree requirements governing the Ph.D. in Physics. While this handbook is specific to your academic experience in the department, it is just one element of the Graduate Student Handbook Suite. There are several other resources within the suite that you should consult when needed:

- The Mellon College of Science does not have a dedicated graduate student handbook, but several graduate student related issues, in particular MCS-level degree policies and awards, can be found as sub-sections in the MCS faculty handbook.
- The university-wide Graduate Student Handbook (curated by the Office of Graduate & Postdoctoral Affairs), is accessible here.
- The "Carnegie Mellon Student Handbook" (formerly known as "The Word") contains information and resources to help you create your Carnegie Mellon experience and embrace your role as a valued member of our university.

Our own Physics Ph.D. handbook presents the rules and requirements governing the Physics Ph.D. Program in the Department of Physics at CMU and offers resources for students available within the department, college and the university. This document shall be updated annually to reflect new rules and future requirements that flow from university policies, and changes in the Physics Ph.D. program will be approved by the faculty of the Department of Physics.

Major changes in the Physics Ph.D. program were developed by a Graduate Program Working Group during the 2016–2017 academic year and approved by the physics faculty on May 4, 2017 and ratified by the MCS College Council on May 11, 2017. The Written Qualifying Exam was replaced by an enhanced procedure for final exams in the core courses, and students were immersed in research starting with the first semester. Research readiness became an essential part of the requirements for passing a student on to Ph.D. candidacy, and correspondingly the Oral Qualifying Exam was modified to serve as an oral exam with emphasis on the assessment of the student's research aptitude and readiness.

Additional changes were made in the Spring of 2025, with a vote on April 24, when Classical Mechanics was added as a required core course, Mathematical Methods was removed from the course offerings, the set of available Astrophysics/Cosmology breadth courses was overhauled, and research was no longer required during the first semester. Some of these adjustments were motivated by the creation of a new Astronomy and Astrophysics Ph.D.

degree in the Department, as well as a new Masters in Modern Physics, both of which served as a good occasion to review the structure of the Physics Ph.D. program.

This version of the Physics Ph.D. Program Handbook reflects all these changes.

SECTION 2: Program Vision, Mission, and Values

2.1: Vision

To be leaders in the quest to advance humanity's understanding of the physical world and a nexus for science at Carnegie Mellon.

2.2: Mission

To achieve this Vision, we will

- Enhance our areas of research strength while thinking boldly in order to seize new opportunities.
- Combine the unique contributions of Physics with the strengths of CMU.
- Educate and mentor future generations to succeed in a wide spectrum of careers.
- Increase appreciation of the contribution that Physics makes to CMU, the wider community, and the world at large.

2.3: Values

As a dynamic and collegial community, we value:

- Blue sky thinking, collaboration, excellence, and agility.
- Diversity.
- Fostering the talents of all our members and supporting their ambitions.
- Gaining a deeper knowledge of our world—both for the sake of pure understanding and as the source of technological innovation.

The Department of Physics within the Mellon College of Science (MCS) welcomes all incoming and returning graduate students to a new academic year at Carnegie Mellon University (CMU).

Through its research and educational activities the Department of Physics strives to create knowledge of our physical world by applying the skills that constitute a physicist's unique approach to problem solving, and to disseminate knowledge to our professional community and society. We enable our students to become scientists with the knowledge, skills, and experience necessary to succeed in their chosen professions and to contribute to society in meaningful ways as part of our role within the mission of CMU. We maximize our impact using strategic alliances within the department, across the University, and with the international physics community.

In 1906 the first students were admitted to the School of Applied Science, and six years later the institute changed its name from the Carnegie Technical School to the Carnegie Institute of Technology, as the first four-year degrees, including physics, were awarded. By the 1920s the Department of Physics had formed a research center that focused on the application of

physics and chemistry to the production of metals, established a tradition of interdisciplinary research and laid the foundations of what became our condensed matter program. In 1933, the second president of Carnegie Tech, Thomas Baker, traveled to Europe and successfully recruited several eminent scientists to Carnegie Tech, including Otto Stern, who had just discovered spin quantization in a magnetic field. Stern brought parts of his original equipment with him to his new Pittsburgh lab where he continued his studies of molecular physics and applied chemistry as the first full-time graduate students began their studies in the department. Our tradition in nuclear and particle physics was born in 1946 when Department Head Frederick Seitz, a condensed-matter theorist, oversaw the creation of the Nuclear Research Center and initiated the construction of the 450 MeV Saxonburg Cyclotron, which operated from 1951 to 1969. Other notable milestones occurred in 1948 and 1950, when Lincoln Wolfenstein and Julius Ashkin joined the faculty.

The department both attracted and trained many outstanding physicists. For example, Clifford Shull received his Bachelor of Science in 1937 and went on to win the 1994 Nobel Prize in Physics "for the development of the neutron diffraction technique." John Hall received his Bachelor of Science (1956), masters (1958), and doctorate (1961) and was awarded the 2005 Nobel Prize in Physics for his contributions to "the development of laser-based precision spectroscopy, including the optical frequency comb technique."

Today the Department of Physics employs over 30 full-time tenure-track faculty as well as teaching and research track faculty. Our faculty is engaged through world-class research groups in Astrophysics and Cosmology, Biological Physics, Condensed Matter Physics, Medium Energy and Neutrino Physics, and High Energy Physics.

The department houses the McWilliams Center for Cosmology & Astrophysics, and it is affiliated with the Pittsburgh Supercomputer Center, the Data Storage Systems Center at CMU, and the Molecular Biophysics and Structural Biology Graduate Program that has been established jointly between the University of Pittsburgh and CMU, to name a few.

More information about the department, its research portfolio and graduate degree programs can be found at https://www.cmu.edu/physics.

SECTION 3: Degrees Offered

There are several advanced degrees available for students entering the Physics Graduate Program at Carnegie Mellon, so the term *graduate student*—meaning anyone beyond the undergraduate level—encompasses multiple groups.

This handbook will use the terms "**Ph.D. student**" and "**doctoral student**" interchangeably to refer to students in either of the two Ph.D. programs the Department offers: (1) Physics and (2) Astronomy and Astrophysics.

The term "**Master's student**" refers to any student earning a Master's degree (specifically, a Master's degree in Science, or M.Sc.). This may be:

- the *en route* Master's degree, an interim milestone within the Physics Ph.D. program, or
- the stand-alone Master's degree in Modern Physics.

Since the stand-alone Master's degree is structured independently from the Physics Ph.D. program, any reference in this handbook to "the Master's degree" or "the Master's program" without additional clarification will refer by default to the en route Master's degree awarded as part of the Physics Ph.D. program.

Throughout the handbook, the term "**graduate students**" collectively refers to both Ph.D. students and Master's students.

3.1: Ph.D. in Physics

This department offers a Ph.D. (Doctor of Philosophy) in Physics, and it is this specific degree that the present handbook is concerned with. Students aiming for the Ph.D. in Physics can also elect to get their degree designated as *Applied Physics*. Doctoral thesis research that may appropriately be characterized as applied physics can be carried out either within physics or in conjunction with other branches of the University such as the Robotics Institute, the Data Storage Systems Center, the Materials Science and Engineering Department or the Electrical and Computer Engineering Department. Students in the applied physics program may find it necessary to prepare themselves in a technical area through courses in another department or through independent study. The requirements for obtaining a Ph.D. in Applied Physics are the same as those for obtaining the usual Physics Ph.D., but some flexibility is possible, at the discretion of the Director of Graduate Studies, to accommodate the various options in applied physics.

3.2: Ph.D. in Astronomy and Astrophysics

The Faculty of the Physics Department have also voted on April 17, 2025 to create a new independent Ph.D. degree in Astronomy and Astrophysics. After a "soft roll-out" in the Fall of 2025, students who applied to this degree during Fall 2025 and got admitted for the academic year starting in Fall of 2026 constitute the first official cohort for this degree. While many aspects of this program share similarities with the Physics Ph.D., it will get its own doctoral handbook in accordance with CMU guidance.

3.3: M.Sc. (Master of Science)

There are two different kinds of Master's degrees that can be obtained in the Department of Physics. The current handbook only outlines one of the two, since it is tightly linked to the Physics Ph.D. program itself.

3.3.1: Masters en route to the Ph.D.

Students enrolled in the Physics Ph.D. program can receive an M.Sc. degree en route to their Ph.D. if they have successfully taken 96 academic units. The details are described in Sec. 7.5.

3.3.2: Master's Degree in Modern Physics

Since 2025 the department also offers a stand-alone *Master's degree in Modern Physics*, which has a dual goal: helping students to successfully apply to Ph.D. programs later, while also equipping them with expertise and skills that make them competitive for the next generation

workforce. Students may choose to apply to this M.Sc. program or to both the Ph.D. program and the M.Sc program through a single integrated application process.

Details of this M.Sc. degree are not described here. Instead, there is a separate handbook specifically dedicated to this degree.

3.4: Joint degree programs with other schools

The Physics Department is part of the Molecular Biophysics & Structural Biology (MBSB) Graduate Program, which is a joint interdisciplinary initiative between Carnegie Mellon University and the University of Pittsburgh that crosses the boundaries of biology, chemistry, physics and other traditional disciplines. The Ph.D. degree offered through the MBSB program is separate from the degree described in this handbook, though, having its own requirements, prerequisites, regulations, funding model, and bylaws. More information can be found here: https://www.mbsb.pitt.edu/index.php.

3.5: Special note to international students

US immigration law is currently in flux, and we expect some significant changes that may impact an F-1 or J-1 student's ability to change their academic program, *even if allowed to by the program*. Students on F-1 or J-1 documents should proactively consult with OIE when considering a program change.

SECTION 4: Personnel

This section identifies some key people graduate students will get to know and interact with at some point throughout their career toward a Ph.D. in physics. A complete listing of all faculty, staff, post-doctoral researchers, and graduate students in physics can be found online at http://www.cmu.edu/physics/people/index.html.

The following list of people might be of particular importance to graduate students in physics:

- Dean of Mellon College of Science: **Barbara Shinn-Cunningham**.
  Mellon Institute MI 414, 412-268-7699, mcsdean@andrew.cmu.edu.
- Associate Dean for Faculty and Graduate Affairs: **Dejan Slepčev**.
  Wean Hall 7123, 412-268-2562, slepcev@andrew.cmu.edu.
- Associate Dean for Community Engagement: **Michael Young**.
  Wean Hall 6122, 412-268-2545, michaely@andrew.cmu.edu.
- Head of Department (DH): **Rachel Mandelbaum**.
  Wean Hall 7327, 412-268-6681, rmandelb@andrew.cmu.edu.
- Director of Graduate Studies (DGS): **Markus Deserno**.
  Wean Hall 6319, 412-268-4401, deserno@andrew.cmu.edu.
- Academic Program Manager: **Stephanie Bolla.**
  Wean Hall 7319, —, sbolla@andrew.cmu.edu.
- Business Manager: **Jeff Abels**.
  Wean Hall 7313, —, jabels@andrew.cmu.edu.
- Senior Administrative Coordinator: **Kristine Perez**.

Wean Hall 7329 (but usually remote), —, kperez2@andrew.cmu.edu.

- Administrative Coordinator: **Julianna Helt**.
  Wean Hall 7325, 412-268-8367, juliannh@andrew.cmu.edu.
- Officer Manager / Senior Administrative Supervisor: **Katie Spencer**.
  Wean Hall 7325, —, katiespe2@andrew.cmu.edu.
- MCS Director, Scientific Computing: **Florin Manolache**.
  Wean Hall 6218, 412-268-8486, florin@andrew.cmu.edu.
- MCS Director, Information Technology: **Al Scheuring**.
  412-268-4535, alberts@andrew.cmu.edu.
- Senior Systems Engineer: **Nuno Chagas**.
  nchagas@cmu.edu; but IT-related questions should be submitted using the MCS IT ticketing system: https://servicenow.cmu.edu/go?mcs-it-support .
- Graduate Student Assembly (GSA), Physics representatives:
  - **Dmitrii Vorobev**, dvorobev@andrew.cmu.edu.
  - **Aleesha Kallil Tharayil**, akallilt@andrew.cmu.edu.
- MCS Liaison for Graduate Affairs:
  - **Manfred Paulini**, paulini@cmu.edu.
  - **Gwen Stanczak**, gwens@cmu.edu.
  - **Michael Young**, michaely@andrew.cmu.edu.

  Wean Hall 6122, 412-268-2545,
- CMU-level Ombudsperson: **Monique McKay**.
  4615 Forbes Avenue, Suite 344, 412-268-2845, mmckay2@andrew.cmu.edu.

The operation of the Physics Ph.D. Program is the responsibility of the Director of Graduate Studies, working together with the Head of the Department of Physics and the Academic Program Manager. The Director acts as the advisor of the first-year students, monitors the progress and success of pre-candidacy students, works with students who are facing challenges to their progress in the program, and monitors the progress of post-candidacy students. The Director also draws up teaching assistant ("TA") assignments in consultation with the Department Head and the Director of Undergraduate Affairs. The Director reports to the faculty, about the status of the doctoral program in general, presents students eligible for Ph.D. candidacy following the Oral Qualifying Exam, candidates for the Physics Graduate Teaching Award, *etc*.

In addition to the Director and the Department Head, the other elements contributing to the operation of the Physics Ph.D. Program are the Graduate Admission Committee, the Oral Qualifying Exam Committee, and the Graduate Curriculum Committee.

SECTION 5: Departmental Resources

The Department of Physics offers a variety of resources that facilitate day-to-day operation. Here is an incomplete list of them:

- The mailroom, Wean Hall 7322. This room is open during usual business hours and accessible with a departmental key off-hours. It hosts a variety of important resources:
    - **Mailboxes**. Graduate students, faculty, and staff have mailboxes installed which they should check on a regular basis. There are also boxes for outgoing mail (which differ by whether it's campus mail, external mail that is already stamped, or external mail you request to be stamped by the department). Mailboxes are routinely updated on a yearly basis at the beginning of the academic year.
    - **Copy machines**. These can both produce physical copies or scan pages and send a pdf to a designated email. The number of physical copies made should be listed in the available record books together with the user or the course number for which the copies were prepared. If a machine jams, the user is responsible for either resolving the issue (in simple cases) or alerting departmental staff to more difficult issues. If a machine runs out of paper, packs of copy paper are available in the copy room and the current user should restock the copier.
    - **Web-Printers**. A b/w (host name: phys-storeroom-copier.lan.local.cmu.edu) and a color printer (host: http://weh-7322-bizhub-color.phys.local.cmu.edu) are located in the mail room. For help with installing drivers students can check the Departmental Canvas Resource Page or contact the MCS Director of Information Technology. If they run out of paper, the user should restock them; if toner is low, the user should alert departmental staff.
    - **Supplies**. A shelf holding a limited selection of frequently needed supplies (such as basic stationary, chalk, blue books) is located on the left side of the mailroom. A detailed list can be found here.
- Graduate students are given keys to their offices and other spaces they need access to (*e.g.*, graduate lounge, lab space, *etc.*) by departmental administrative coordinators. Some rooms (*e.g.*, departmentally controlled classrooms or meeting rooms) require keycard access, for which a person's physical CMU ID card is used. To grant access, a departmental administrative coordinator will add the respective ID to a list of permissible users. Anyone who believes they need access to a given room should contact the Department's Administrative Coordinator.
- Many regulations, policies, contact points, seminars, room availability, *etc*. are listed on the departmental webpages.
- The Department curates an extensive and up-to-date list of a wide variety of physical and online resources on a Departmental Resources Canvas Page. Students are encouraged to browse this site when they start at CMU to get an overview of what type of resources are available. Notice that this webpage also contains a section on current announcements and opportunities (such as jobs, courses, workshops, fellowships, postdoc opportunities, and summer schools).
- Purchasing and reimbursement for physical items should be discussed with the buyer. Note that the university has detailed and strict policies relating to the purchase of goods, services, equipment, *etc*. whether using a general ledger account, restricted

accounts and grants. There are also reimbursement policies, along with tax exempt considerations. Any graduate student who makes purchases should familiarize themselves with these policies and, in case of doubt, contact their advisor or departmental personnel.

- The physics graduate students determine (typically) two members to represent the department graduate student body at the Graduate Student Assembly (GSA). The GSA offers a variety of resources, including funding for graduate student events or conference travel support, and students are encouraged to explore that spectrum of opportunities.

SECTION 6: Advising

6.1: Role of an Advisor and Advisor Assignments

During their time in the Department, students have multiple resources in terms of advising and mentoring. This section lays out the basic framework.

The Director of Graduate Studies (DGS) acts as the *academic* advisor of all first-year Physics Ph.D. students, who monitors their academic success and progress and is available to discuss issues such as choice of classes, dealing with academic difficulties, finding a research advisor, or any number of problems that might arise during the transition into a graduate program.

Since students are expected to take three core classes in their first fall semester (33-757: Classical Mechanics; 33-755: Quantum Mechanics 1; 33-761: Electrodynamics 1) and typically also work as a course assistant (a TA or a grader), there is no expectation that they will also engage in research. However, if a student places out of a core course, they can choose to dedicate the freed-up 12 units to rotate with a *research advisor*, which formally means taking the 12-unit course 33-775. They might do the same if they find an advisor who agrees to cover their fall stipend and tuition, or if they have a fellowship covering those, as this removes their course assistant duties.

All students are expected to choose a research advisor no later than two weeks into the Spring semester of their first year. Students who already rotated with a research advisor in their first fall semester can choose to stay with this advisor in the Spring, or switch to a new advisor, for instance because they are not yet sure whether their initial choice will work out for them in the long run. Formally, this Spring research rotation means taking the 12-unit course 33-776.

In the summer, students generally do not take classes and instead devote all their time to research. First year students can continue to work with the advisor they have worked with so far or switch to a new advisor, again motivated by the goal to find the best fit for their long term thesis work. Either way, students need to sign up for the research class 33-997 and choose the correct number of units so that research plus any optional Summer class they might take adds to 36 units (to count as fully registered). Students should be aware that the Mellon College of Science does not charge tuition in the summer. However, graduate students taking additional summer coursework outside their program requirements, including

undergraduate courses, pay the per-unit rate set by MCS, and they should not assume that the Department or their advisor will cover those.

Whenever beginning work with a new advisor, students should meet with them to discuss expectations, which can differ between research groups, for instance regarding working hours, research locations, travel, and other job duties, as outlined in Sec. 7.1.2. Students should make sure they will be able to abide by these expectations, and should agree with their advisors on reasonable accommodations, before committing to a research group long-term.

Most doctoral students will have selected a thesis advisor by the beginning of their second year. If a doctoral student does not have a designated advisor by the start of the Spring Semester of their second year—*i.e.*, after the oral qualifying exam—they must meet with the Director of Graduate Studies to discuss their options for joining a research group. After completing all required coursework, a Ph.D. student's primary focus is research. At that stage, it is not possible to remain in the program without an advisor of record. In particular, satisfying the full-time enrollment requirement of 36 units through unrelated coursework is not an acceptable substitute for active research engagement. (Post-candidacy students must enroll in at least 24 units of research per semester; see Sec. 7.16.)

In rare circumstances it might happen that a chosen research topic or advisor turns out to be not as good a fit as a student had initially hoped. In such a case, the student may seek a new thesis advisor, even after their second year. To start this process, the student should consult with the Department Head and the Director of Graduate Studies and explore alternative options, which may include a limited transition period without an official research advisor of record.

6.2: Advisor/Advisee Collaboration

A Ph.D. student's advisor initially defines the general outlines of a research project the student will be working on and provides guidance to the field, the specific research tools and techniques, and constructive feedback on progress. The student in turn is expected to engage with the project at a high level of intellectual and physical effort. As time progresses, the outlines of the project will come into sharper focus, until at a student's first annual review a clear plan for a thesis exists and is presented to the annual review committee for feedback.

It is also possible that a student approaches an advisor with a project idea of their own. It remains at the discretion of the advisor whether this is something they feel comfortable advising (considering the advisor's expertise, background, and interest). A legitimate question is also whether such a non-standard project is something for which external funding could be secured. If the latter is unlikely, permission from the Head of Department should be sought before starting work on such a project.

While students typically join a research group and select a topic based on personal interests, their work soon becomes integral to the group's broader efforts—including collaborations, publications, and the advisor's ability to secure future funding. Students are expected to recognize this dual role: a thesis is both a journey of personal intellectual growth and an essential contribution to the success and vitality of their research group. Additional details about research expectations can be found in Sec. 7.1.2.

Individual Development Plans (IDPs) are meant to promote professional and personal growth by formally documenting goals and facilitating dialogue, collaboration, and accountability between advisors and advisees. Carnegie Mellon has developed a set of templates that can be used by doctoral students and their advisors to create an Individual Development Plan. These templates can be found here:

https://www.cmu.edu/graduate/resources/index.html

6.3: Review/Redress of Academic Issues

In almost all cases, concerns can be resolved informally. Students are encouraged to speak directly with course instructors or research advisors when they disagree with a decision (*e.g.*, a grade) or have concerns about teaching, mentoring, or supervision. Faculty should treat such conversations as part of a student's good-faith effort to seek clarity and resolution. Similarly, instructors or advisors may raise concerns with students when appropriate (*e.g.*, when they see issues with grading efforts).

Whenever possible, these discussions should be grounded in documents that clarify expectations and responsibilities—such as the course syllabus or the departmental guidelines on "Expectations and Responsibilities for TAs, Graders, and Course Instructors," available on the Departmental Canvas Resource Page.

Both parties are expected to engage in good faith. Faculty, in particular, should be mindful of the inherent power imbalance and take care to foster a safe and respectful space for open conversation. Concerns raised in these settings should be handled with discretion and sensitivity.

Students should be aware that the department also offers *anonymous* means for leaving feedback, for instance via an anonymous form checked regularly by the Head of Department, which that is accessible from the "Contact Us" tab on the Department's main website, or an anonymous form addressed to the Departmental Climate Committee that is also accessible on that committee's webpage.

If a mutually satisfactory resolution cannot be reached through direct discussion, either party may seek mediation by contacting the Director of Graduate Studies or the Head of Department. These individuals may facilitate further conversation or recommend possible paths forward. Retaliation for raising a concern or participating in mediation is not acceptable and should be reported. Recall that MCS has a Liaison for Graduate Affairs, and the university has an ombudspersons, who can help resolve conflict—see Sec. 4.

Students may also consult one of the designated MCS Liaisons for Graduate Affairs for additional support. Information about the liaisons and departmental guidance on navigating concerns can be found at: https://www.cmu.edu/mcs/grad/liaison.html.

If informal resolution proves unsuccessful, graduate students may initiate a formal review process. These matters must follow the procedures outlined in the university's official appeal and grievance policy:

https://www.cmu.edu/graduate/policies/appeal-grievance-procedures.html.

The procedures outlined in this policy apply to all graduate students across the university.

SECTION 7: Doctoral Degree Requirements

The requirements to attain the advanced degrees of Ph.D. and M.Sc. in Physics at CMU are detailed in this section. It also specifies program outcomes and research expectations.

7.1: Overarching framework

7.1.1: Physics Doctoral Program Outcomes

The Ph.D. Program in Physics is designed to provide an environment that will allow students to build on their prior education and acquire state-of-the-art core physics skills and knowledge through coursework and research-based activities, as well as grow from a student to a colleague. In brief, students in the Physics Ph.D. program will be able to demonstrate broad knowledge of physics, deep knowledge in some specific area of physics, and an ability to formulate and advance a scientific project that leads to publishable research. In the course of doing the above, students will acquire problem-solving skills as well as written and oral communication skills. In particular, upon graduation with a Ph.D. in physics, students will:

- Have acquired detailed knowledge in core physics subjects, in particular Classical Mechanics, Quantum Mechanics, Electrodynamics, and Statistical Physics, and be familiar with the structure of matter, as well as the corresponding interactions from the subatomic scale to cosmological distances.
- Have acquired high-level understanding in several domains, permitting them to creatively transfer ideas and techniques across disciplines.
- Be able to demonstrate mastery of advanced physics topics within their chosen subfield of research and apply experimental, observational, computational, and/or theoretical scientific methods to conduct independent research.
- Be able to understand, within a reasonable time frame, the needed background knowledge for a given scientific problem, while their physics knowledge base will allow them to recognize the physics fundamentals underlying a given problem.
- Have acquired problem-solving methodology and skills, including the analysis of uncertainties arising from the limitations of experimental data and models, as well as the critical use of scientific literature.
- Have developed skills to effectively communicate research results to professionals within their subfield and the broader physics community through both oral presentation and scientific publication.
- Have completed individually, or as a member of a team, an original research project that advances the understanding of nature.

7.1.2 Research Expectations

While engaged in full-time research toward a Ph.D. in physics, graduate students are generally supported as a Research Assistant (RA) or a Teaching Assistant (TA) and are expected to follow certain guidelines. In particular, students are expected to:

- Be curious and passionate about their research project, demonstrating creativity in applying scientific ideas to solve the research problems at hand.
- Be self-motivated and dedicated to hard work, becoming the active driver toward an excellent Ph.D. thesis in a timely manner.
- Focus their efforts on the work needed to complete their Ph.D.
- Communicate effectively with their advisor by proactively seeking advice, accepting constructive criticism, and being willing to adjust, as needed, their research methodology.
- Develop independence as their Ph.D. research progresses, taking it upon themselves to identify and find resources needed to solve problems.
- Assume responsibility for the advancement of the research group they join, recognizing that science is a collaborative effort.
- Take responsibility for developing professional presentation skills, allowing them to communicate research findings to professionals within their subfield and the broader physics community, as well as being capable of producing well-written drafts for publications.
- Display overall professional behavior and follow all guidelines issued by the university or funding agencies sponsoring their work regarding academic integrity and responsible conduct of research, as well as regulations governing safety and best practices in laboratory settings, in particular while operating equipment and handling potentially dangerous substances.
- Take responsibility for meeting field- or group-specific expectations as discussed with their research advisor and insofar as these expectations are consistent with university policy. Several common types of group expectations are listed below to guide these discussions:
    - Research modality (in-person on campus, or remote);
    - Core working hours;
    - Short-term or long-term travel for collaboration, conferences, or worksite visits (in some groups it is the norm to live at the experimental site for periods longer than 1 year);
    - Taking regular experimental shifts;
    - Group “service” requirements, *e.g*. maintaining lab supplies or computational resources; helping groupmates debug their code; presentations at group meetings;
    - Communicating with students, vendors, collaborators, technicians, *etc*.;
    - Mentoring or training more junior group members;
    - Physical job duties, *e.g*. light lifting; bending; working on ladders; fine adjustments; typing;
    - Additional coursework beyond the basic Physics Department requirements.

7.1.3: Performance Measures

While enrolled in the Physics Ph.D. program, students must demonstrate an appropriate level of progress toward graduation with a Ph.D. in physics, including the following performance measures:

- Demonstrate mastery of knowledge in the core physics subjects, including Classical Mechanics, Quantum Mechanics, Electrodynamics, and Statistical Physics, by performance on course exams and assignments.
- Demonstrate ability to apply skills acquired from core courses to research-field-specific problems through performance in special-topics and breadth courses.
- Demonstrate the ability to apply core and research-field-specific knowledge by suitable performance in research project courses.
- Demonstrate the ability to apply physics knowledge and problem-solving skills in research, including the ability to comprehend and critically analyze scientific literature, by suitable performance in the Oral Qualifying Exam.
- Demonstrate an appropriate level of understanding of their dissertation topic and make suitable progress on their research as part of research course work and, after advancing to candidacy, during their annual thesis reviews.
- Demonstrate the ability to create new knowledge in their chosen subfield of physics and to communicate effectively, both orally and in writing, through a Ph.D. dissertation and successful Ph.D. defense.

7.2: Core Courses

Students who wish to earn a Ph.D. in Physics are required to take the following five foundational core courses:

1. **33-757**: Classical Mechanics (Fall Course)
2. **33-755**: Quantum Mechanics 1 (Fall Course)
3. **33-761**: Electrodynamics 1 (Fall Course)
4. **33-756**: Quantum Mechanics 2 (Spring Course)
5. **33-765**: Statistical Physics (Spring Course)

The standard sequence is to take the first three core courses in the fall and the remaining two in the spring of the first year. These courses lay the intellectual foundation for all future work and should therefore be completed as early as possible—ideally within the first three semesters. Any deviations from the standard timeline require approval from the Director of Graduate Studies.

Students need to pass these courses with a grade of at least B– (“B minus”). A course that has not been passed must be taken and passed the next time it is offered. Failure to do so will trigger the same process as the failure to get off academic probation: the faculty will discuss the given case and vote on whether the student is allowed to continue in the Graduate Program in Physics.

In addition to their *foundational role*, these courses also serve as important *checkpoints for academic readiness*. Postponing them in order to devote more time to research, or technical coursework not mandatory for the degree, is therefore strongly discouraged, since this may shift potential academic difficulties to later years, when resolving them becomes more disruptive—both for the student and the department. Taking them at the recommended time helps ensure that concerns, if they arise, can be addressed while a wide range of options are still available.

Students may attempt to place out of any core course by taking a final-exam-style test, typically offered during the first or second week of the semester. These exams are intended to assess whether a student already possesses a solid, working understanding of the course material and would gain little additional benefit from formal instruction. Because one goal of graduate training is to ensure a deep command of foundational physics, a minimum score of B+ ("B plus") is required to place out. A lower score does not sufficiently demonstrate mastery and suggests that taking the course would still be valuable.

Students who place out of a course should be aware that, while the course will count toward their Ph.D. candidacy requirements, it does ***not*** count towards the 96 units required for the *en route* Master's degree. In short: a placed-out course advances *candidacy*, but not *unit-based degree progress*.

7.3: Electives

Before advancement to Physics Ph.D. candidacy—and typically by the end of the second year—students must complete two designated "breadth courses." This requirement reflects the fact that physics, as a discipline, is both broad and deeply interconnected. Exposure to areas beyond one's immediate research field helps cultivate the kind of flexible, cross-cutting thinking that drives scientific innovation. It also prepares students for a wide range of career paths, both in academia and beyond, where the ability to connect ideas across domains is often a key asset.

The list of breadth courses offered by the department is the following:

1. **33-658**: Quantum Computation and Quantum Information Theory
2. **33-659**: Modern Topics in Condensed Matter Physics
3. **33-731**: Stars and Black Holes
4. **33-732**: Galaxies
5. **33-733**: Cosmology
6. **33-767**: Biophysics: From Basic Concepts to Current Research
7. **33-779**: Introduction to Nuclear and Particle Physics
8. **33-783**: Solid State Physics

With special permission from the Director of Graduate Studies, other physics courses can on occasion be used to satisfy the breadth requirement, provided their main objective is fostering breadth, as opposed to a deep examination of a special topic. Courses outside of physics are not a substitute for a course from the list above.

Students need to pass two of these breadth courses with a grade of at least B– ("B minus"), but the choice of courses is subject to an additional "*breadth condition*": no more than one course can come from any given subfield, as categorized by the following table:

Astro	Bio	Cond. Matt.	Particle	Quant. Inf.
33-731 33-732 33-733	33-767	33-659 33-783	33-779	33-658

Individual research groups may impose further course requirements on their students, but these are independent of the requirements that determine candidacy.

7.4: Research

Besides class-based units, doctoral students conduct research. Past their first year this is in fact their main activity and accounts for the majority (if not all) of the 36 units they need to be registered for. To formally keep track of this, students will have to register for research, which in practice means taking one of the following "research courses":

- **33-775**: Introduction to Research 1. (12 units, Fall of their first year, if they do research)
- **33-776**: Introduction to Research 2. (12 units, Spring of their first year)
- **33-997**: Graduate Laboratory. (Up to 36 units, pre-candidacy)
- **33-998**: Thesis Research. (Up to 36 units, post-candidacy)

Experience has shown that these are the courses students are most likely to forget enrolling in, which may cause many types of problems, such as a hold on stipend payments or compromising student visa status. This handbook hence wishes to emphasize one more time that *maintaining full enrollment status*—including after the usual classroom-style course work has been passed—*is very important and the responsibility of the student*.

Doctoral students are not expected to do research in their first fall semester, but are required to do so starting with their first Spring semester. They need to choose a research project advisor ***latest*** by the end of the second week of that term, but ideally before the term even starts.

Students use the first year of research to explore which advisor they will ultimately do their thesis work with. Spending a Spring or a Summer term in a chosen group is called "*doing a research rotation*." Students can rotate with up to 3 different advisors in their first year (Fall, Spring, Summer). They do not *have* to switch between groups; the goal is rather to *offer an opportunity* for students to explore, thus making sure that their ultimate choice for a thesis advisor and project best fits their scientific interests and professional goals. However, students are asked to only do a rotation with an advisor if they genuinely consider joining that

group, not merely to broaden their experience in a field they know they will not pursue for their thesis work.

Students receive grades for their research from the advisor they are working with. To help establish consistency across the department, and to facilitate productive discussions about research expectations, the department has created two sets of *rubrics* based on which a semester grade should be assigned—one pertains to students before they have been passed on to candidacy, while the other applies to students post candidacy. These rubrics can be found on the Canvas page that collects Physics Department resources.

There are several other regulations that govern research at Carnegie Mellon University. Here is a list of them:

- Office of Sponsored Programs
- Office of Research Integrity & Compliance
- Intellectual Property Policy
- Policy on Restricted Research
- Human Subjects in Research Policy

7.5: Process for Completing a Master's Degree *en route* to a Ph.D.

A *Master of Science (M.Sc.) degree in physics* is awarded to students enrolled in the department's Physics Ph.D. program once *96 units of qualifying course work* have been taken (this typically requires two years). The detailed conditions are as follows:

1. Students must satisfactorily complete at least 96 course units with a B average (GPA of 3.0) or better. For these 96 units, the following requirements must be met:
    a. At least 48 units must be earned in **graduate level classes** (700-level and above) in the Department of Physics.
    b. Up to 48 units may derive from **upper undergraduate level coursework** (300/400/600-level) in physics.
    c. Up to 36 units may be fulfilled via **research** (33-775, 33-776, 33-997, or 33-998).
2. At the discretion of the DGS, work done during an internship can contribute up to 12 units towards the Master's Degree. Formally, these would be registered by enrolling in the course 33-996 ("Practicum in Physics"). See also Sec. 7.15 on internships.
3. Students must be at least one year in residence as a full-time student.
4. All of the 96 units have to be taken as a student enrolled at CMU.
5. No courses counted toward another degree at CMU (except for the original Physics Ph.D.) can be included for the M.Sc. degree in physics.
6. There is no mandatory subset of classes which need to be taken to earn the M.Sc.

If a student places out of a core physics course, this will satisfy the requirements for advancement to candidacy, but *placed-out units do not count towards the M.S. degree*.

There are no research or language requirements for the M.Sc. degree.

International students who are considering leaving the Ph.D. program with an *en route* Master's degree are encouraged to consult OIE early about the implications this may have for their visa status. In particular, they should not assume that this transition will qualify them for post-completion OPT or any other immigration benefit. Whether such options are available depends on the student's immigration record, timing, and current policies and regulations; OIE is the appropriate source for such guidance. Students are strongly encouraged to schedule an appointment with OIE and discuss their specific situation before taking any action that may be difficult to reverse.

7.6: Residency Requirements

The university requires Ph.D. students to have a minimum of one year in residency on a CMU campus.

U.S. government regulations require F-1 and J-1 international students to be enrolled in an in-person degree program, with in-person expectation coursework. Even though this immigration requirement is specifically for international students, residency requirements in a degree program must be consistent for both international and domestic students. As with all visa-related matters, international students should consult OIE whenever they are uncertain about specific requirements. Immigration regulations can change over time, and their interpretation often requires specialized expertise beyond that of Physics faculty and staff.

7.7: Expected Timeline

The standard path to candidacy is outlined in *Schedule 1* of the table below. Students take *Classical Mechanics*, *Quantum Mechanics I*, and *Electrodynamics* in the Fall of their first year, followed by *Quantum Mechanics II*, *Statistical Physics*, and a first *research rotation* in the Spring. The Summer is typically spent on research—either continuing in the same group or trying a new one. In the Fall of the second year, students complete two *breadth courses*, while continuing research. At the start of the Spring semester, they take the *oral qualifying exam*. If they pass and have made satisfactory research progress, they are eligible to advance to candidacy—something that happens by faculty vote.

Semester	Schedule 1	Schedule 2
Fall Year 1	Classical Mechanics Quantum Mechanics 1 Electrodynamics Teaching	Classical Mechanics Quantum Mechanics 1 Teaching
Spring Year 1	Quantum Mechanics 2 Statistical Physics Research	Quantum Mechanics 2 Statistical Physics Research

	Teaching	Teaching
Summer Year 1	Research Teaching or RA position	Research Teaching or RA position
Fall Year 2	Breadth Course 1 Breadth Course 2 Research Teaching or RA position	Electrodynamics Breadth Course 1 Research Teaching or RA position
Spring Year 2	Research **Oral Qualifying Exam** Teaching or RA position	Research **Oral Qualifying Exam** Breadth Course 2 Teaching or RA position
Summer Year 2	Research Teaching or RA position	Research Teaching or RA position

This timeline allows for some flexibility. A common variation is Schedule 2, in which one core course—almost surely *Electrodynamics*—is postponed from Fall of the first year to Fall of the second year. This often shifts the second breadth course to the Spring of the second year. Students may choose this option if they are concerned about the academic rigor of their first grad school semester, especially considering they will likely also have teaching responsibilities. Spreading the workload helps ease the transition into graduate school. Importantly, this shift usually does not delay candidacy: if a student is missing only one breadth course at the time of the Spring faculty review, they are typically *conditionally advanced to candidacy*, pending successful completion of that course. If the course is passed, candidacy becomes automatic without a second vote.

Other variations are possible. For instance, a student might follow *Schedule 1* but choose to take the **second breadth course** in the Spring of the second year, perhaps because a preferred course is only offered then. Again, as long as this is the only missing requirement, *conditional advancement* to candidacy can be granted.

Some students may wish to **join a research lab** in the Fall of their first year. If the PI offers such a so-called "RA position," the student has an external fellowship, this may relieve them of TA duties and free up time for research. Alternatively, if a student places out of a core course by successfully passing a place-out exam, they may have room in their schedule to begin research early, even without RA or fellowship support. However, *it is generally discouraged to postpone a core course solely to start research earlier*. As noted above, this may defer academic challenges to a later point in the program, when addressing them could prove more difficult.

7.8: Registration Process

Prior to each term (Fall, Spring, and Summer) students must register for their upcoming courses. *To count as "fully registered," a student must be enrolled for **36 units***. While students are regularly reminded to register for upcoming semesters, it is ultimately their responsibility to maintain full registration status.

Students can register for courses by **logging in to their SIO portal**. Some courses have prerequisites (for instance, QM-2 requires QM-1). Under certain conditions, these can be waived, which requires a permission by the course instructor and the Director of Graduate Studies.

Students may discuss options for course sequences, or possible choices for breadth courses, with the DGS. This includes situations in which they inquire about exceptions (for instance counting a different course as satisfying a breadth requirement). Following the standard course sequence "*Schedule 1*" as outlined in Sec. 7.7 does not require pre-approval by the DGS.

7.9: Required Units for Degree Attainment

There is no total number of units required for Ph.D. degree attainment, but at the time when a student is passed on to Ph.D. candidacy, the required core and breadth courses add up to a total of 84 units. In addition, the required research project courses in the Spring of the first year and the Fall of the second year result in 24 additional units of research, totalling in 108 units (this does not yet count any additional research units students acquire in the summer of their first year).

In contrast, the requirements for obtaining a Master's Degree (M.Sc.) *en route* to a Ph.D. are indeed unit-based and are spelled out in Sec. 7.5.

7.10: Department Policy on Double Counting Courses

- Courses taken in pursuit of the Ph.D. degree can double count towards the M.Sc. degree that is obtainable *en route* towards the Ph.D.
- No courses counted toward *another degree at CMU* (except for the original Physics Ph.D.) can be included for the M.Sc. degree in physics.
- A placed-out core course counts towards candidacy, but not towards the M.S. degree.
- A required Physics core course taken *at CMU* prior to matriculation into the Physics Ph.D. program satisfies the corresponding Physics Ph.D. degree requirement if passed with a grade of B− or higher.

7.11: Department Policy for Courses Outside the Department/College

Students who are *fully registered for 36 units* have the opportunity to *additionally* take one course per Fall or Spring term/semester not offered at Carnegie Mellon in any of the other nine Middle States accredited colleges and universities in Allegheny County. This opportunity exists courtesy of the "Pittsburgh Council on Higher Education (PCHE)", which consists of:

- Carlow University

- Carnegie Mellon University
- Community College of Allegheny
- Chatham University
- Duquesne University
- La Roche College
- Pittsburgh Theological Seminary
- Point Park University
- Robert Morris University
- University of Pittsburgh

Some general aspects of the PCHE cross-registration process can be found here. In practice, students need to fill out a PCHE cross-registration form, which they can obtain on CMU's PCHE page. This form needs to be signed by the student and the "Home Advisor" (typically the DGS), and then forwarded to uro-pche@andrew.cmu.edu. Students should make sure they understand which school's rules apply for issues such as deadlines, pre-reqs, or unit counts. For instance, academic calendars may not align across schools, and there might be other small differences in class start dates and times, exam dates, break dates, *etc*.

Different schools in the PCHE system use different metrics for measuring course effort. For instance CMU uses the "*unit*" system (core Physics graduate courses all have 12 units). Pitt, on the other hand, uses a "*credit*" system. According to this CMU HUB website, the conversion between credits and units is **1 credit = 3 units**. Students should check the applicable conversion rate before enrolling, to make sure that they end up having the correct number of units.

Many graduate-level courses with overlapping content are offered at both Carnegie Mellon and the University of Pittsburgh. For such courses to satisfy a requirement for the CMU Physics Ph.D. program, there must be a mutual agreement regarding syllabus and learning objectives. In several cases, such agreements are in place, and these have led to shared teaching schedules in which specific courses are alternately taught at CMU or Pitt. At present, the following five courses are part of this arrangement:

Course Content	**Course # at CMU**	**Course # at Pitt**
Nuclear and Particle Physics 1	33-779	3717
Nuclear and Particle Physics 2	33-780	3718
Introduction to Many Body Physics	33-769	3707
Quantum Field Theory (or Field Theory I)	33-770	3765
Field Theory II	33-771	3766

Of these, only the first course—"(Introduction to) Nuclear and Particle Physics (I)"—currently satisfies a requirement for the Physics Ph.D. program, specifically as a breadth course (see Sec. 7.3).

7.12: Course Exemptions

Students arrive at CMU with different levels of academic preparation. For instance, some students might have taken graduate-level courses during their undergraduate education, or might already have obtained a Masters Degree in Physics. To reflect this situation, and in lieu of an exemption, the graduate program offers students the opportunity to *place out of core courses*, as described in Sec. 7.2.

7.13: Protocol for Evaluation of Transfer Credit

In rare circumstances (for instance, when a student transfers from another physics graduate program into the one at CMU) the extent of existing course work may warrant a more direct transfer of credit. The student is then encouraged to discuss the situation with the DGS. While academic credit for courses that count towards candidacy can be granted, no transfer of credits towards the M.S. degree is possible.

Transfer credits towards candidacy are only acceptable from an accredited institution and will be evaluated on the following basis:

- The course content and learning outcomes (*e.g.* as described in the syllabus) must align sufficiently well with the content of the equivalent course at Carnegie Mellon for which a transfer of credit is requested. This alignment is evaluated jointly between the DGS and an instructor at CMU who commonly teaches this course at the graduate level.
- The grade earned at the other institution must be at least a "B" (3.0).

The DGS will make the determination whether a transfer credit is accepted. In that case, the Carnegie Mellon University transcript will reflect this situation as follows: Carnegie Mellon courses and courses taken through the university's PCHE cross-registration program will have grades recorded on the transcript and be factored into the QPA. All other courses will be recorded on this transcript indicating where the course was taken, but without grade. Such courses will not be taken into account for academic actions, honors or QPA calculations.

7.14: Teaching Requirements/Opportunities

Serving as a **teaching assistant** (*i.e.*, running a recitation section or a lab section) for one semester is a requirement for obtaining the Ph.D. degree, though not for candidacy. Merely grading or staffing a course center does not fulfill this requirement. The rationale is that clearly communicating scientific ideas, engaging in and carrying forward a technical discussion, and effectively addressing specific questions are essential skills for future careers in both academia and industry. Assignments to TA or grader roles carry a nominal weekly workload of up to 20 hours, but the department aims for 15 hours being the more typical load.

Incoming graduate students receive several hours of TA training during Orientation Week, focused on effective teaching during recitation sessions. Attendance is mandatory. Students

who have taken the training but not yet taught (*e.g.*, due to fellowships in early years) may opt to retake the training before assuming teaching duties. Moreover, during the 2026–2027 academic year, the department is introducing TA training for students beyond their first year, and doctoral students are expected to comply with the new requirements as they are rolled out.

The department maintains a document outlining the mutual expectations and responsibilities for TAs, graders, and course instructors, available on the Physics Department Resources Canvas page, which students working as TAs or graders should read carefully before starting in their assigned roles. The Eberly Center for Teaching Excellence & Educational Innovation is also a good resource for teaching development.

Assignment to a TA role does not automatically satisfy the teaching requirement. If a course instructor has persistent or serious concerns about a student's ability or willingness to meet the expectations and responsibilities the department has formulated for teaching assistants, as outlined in a guidelines document that is available on the Departmental Resources Canvas Page, the instructor should communicate these concerns in writing to the student, the student's research advisor, and the DGS. If, after being notified, the student fails to demonstrate meaningful improvement, the DGS may determine that the requirement has not been met and ask the student to repeat the assignment in a future semester. See Sec. 11.11 for impacts on funding support in this situation.

Graduate students must demonstrate a certain level of English fluency before teaching, as mandated by Pennsylvania's *English Fluency in Higher Education Act* of 1990. All instructional personnel—including TAs and interns—must be evaluated and certified by the institution. University policy on this matter can be reviewed here.

Language Support in the Student Academic Success Center evaluates instructional personnel, including through the International Teaching Assistant (ITA) Test, which is required for non-native English speakers. Language Support offered by the Student Academic Success Center also provides training to help non-native English speakers build fluency and cultural understanding for successful teaching. Additional details are available on their website.

7.15: Internship/Co-op Requirements and Opportunities

The Physics Ph.D. program does not require internship or co-op experience. However, students may choose to intern—typically during the summer—with an external organization (*e.g.*, a company, research center, or national lab) to develop complementary skills. In such cases, students may register for 33-996: Practicum in Physics. At the DGS's discretion, up to 12 units of this course may count toward the 96 units required for an M.S. degree.

International students must consult the Office of International Education (OIE) to confirm eligibility for off-campus work authorization before beginning or applying for internships, co-ops, or consulting roles. Because processing times may be long (weeks to months), students are strongly encouraged to review OIE guidance and begin the process as early as possible.

7.16: Thesis Research

After being passed on to Ph.D. candidacy, students begin full-time thesis research and typically sign up for 36 units (24 minimum) of 33-998, "Thesis Research." Recall that the minimum load to be considered a full-time graduate student is 36 units. Their thesis advisor continues to assign letter research grades for the student's research every semester, based on the post-candidacy rubric available on the Departmental Resources Canvas Page. The criteria outlined in the rubric follow the research expectations for doctoral students as outlined in Sec. 7.1.2. In addition to assigning research grades, the faculty advisors discuss the research performance with their students and give constructive feedback.

SECTION 8: Dissertation Preparation & Requirements

8.1: General outline of the dissertation process

The process of earning a Physics Ph.D. can be divided into two main stages, generally referred to as "*pre-candidacy*" and "*post-candidacy*".

During the pre-candidacy stage, students primarily focus on coursework, completing the five required core courses (see Sec. 7.2) and two breadth electives (see Sec. 7.3). Beginning with their second semester, students are also expected to engage in research, typically for 12 units during the academic year. The final step in this stage is the oral qualifying exam, in which students present a selected portion of their research to a faculty committee, followed by a discussion with the committee that explores both the research itself and its broader connection to the core areas of physics.

After passing all required courses and the oral qualifying exam, students are *advanced to candidacy* and enter the second stage of their Ph.D. From this point onward, their efforts are largely dedicated to research, conducted under the close mentorship of their chosen advisor. Shortly after advancing to candidacy, students form an *annual review committee*—typically the foundation for their future thesis committee. Each fall, students report their thesis progress to this committee and receive constructive feedback.

This research-focused phase, which typically lasts 3–4 years, allows students to become fully integrated members of their research group. They strive to make progress on their chosen research question, attend scientific meetings, present their work in a variety of venues, co-author publications, and may contribute to grant proposals or technical reports. The culmination of this stage is a *written dissertation* that presents the student's original contributions with scientific rigor and technical clarity, situates them within the broader scientific landscape, and makes clear what advances have been achieved. A Ph.D. requires a genuine contribution to the frontier of knowledge; merely summarizing the state of a field, however skillfully, is not sufficient.

Once the dissertation is complete, the student defends it before a *thesis committee* that emerged over the past few years from the annual review committee. This committee

evaluates whether the work is original, scientifically sound, clearly presented, and constitutes a meaningful advance in the field. If these criteria are met, the candidate passes the defense, though minor revisions may be requested. A final version of the dissertation—incorporating any requested changes—must then be submitted to the university in accordance with formatting requirements and submission deadlines. Upon approval, the candidate is officially certified for the Ph.D., a final academic action taken by the Dean.

The following sections describe the post-candidacy stages of this process in more detail.

8.2: Oral Qualifying Exam

The Physics Ph.D. program no longer includes a traditional written qualifying exam that tests students' mastery of core coursework as a prerequisite for Ph.D. candidacy. Instead, students need to pass an *oral qualifying exam* (also referred to as the "oral qualifier" or simply the "orals"), in which students present the research they have conducted up to that point along with its connection to basic physics to the oral qualifying exam committee. The presentation is followed by a substantive Q&A session to assess the student's ability to communicate technical work clearly and to engage with broader physics concepts.

In the run-up to the oral qualifying exam, students are given more detailed information on purpose, exam structure, presentation style, Q&A format, evaluation criteria, and pre-exam write-up guidelines through a Canvas course page dedicated to the exam. The present section merely outlines the essentials.

The **purpose** of the Oral Qualifying Exam is to assess the student's ability to:

1. apply knowledge from coursework to research they have conducted;
2. deliver a coherent presentation to physicists outside their research area; and
3. respond effectively to questions about their research and the underlying physics concepts.

Physics Ph.D. students are required to take the Oral Qualifying Exam during their second year. The exam mode is "in person," and it is scheduled by the department to take place typically in the week preceding the start of Spring Semester classes. It is administered by a committee appointed annually by the DH and composed of faculty from across the department's research areas to reflect its disciplinary breadth. Because passing the oral exam is usually the final step before advancing to Ph.D. candidacy, the results are discussed at a faculty meeting at the end of the exam week, during which advancement to candidacy is also voted on. Students are then informed of the outcome—usually by their advisor—shortly after this meeting.

Each December, the chair of the oral qualifier committee sends a message to all students scheduled to take the exam, outlining its purpose, format, and logistics. Students get access to the Canvas course page of the exam, which contains detailed instructions.

To help the committee prepare questions that are fair, consistent, and appropriate for students at this stage of their graduate training, students are asked to submit a brief write-up on the research and basic physics they plan to present during the oral qualifying exam. This report is due approximately a week before the day the exam period starts and should include

both an overview of the research conducted and a discussion of how it connects to the core graduate coursework. Details on the required content and formatting specifications, as well as guidelines on how much space to dedicate to required subsections, will be provided on the Canvas course page.

While the scientific quality of the report is not part of the oral exam evaluation, students are expected to make a good-faith effort both to address the scientific intent of the report and to follow the provided structure. Reports that do not demonstrate such effort—either through lack of substance or disregard for the format—may be returned for revision. These reports are also subject to CMU's standards of academic integrity.

During the exam, students will give a 30-minute presentation (use of slides is allowed) on the research they have performed during their first through third semesters. The presentation should highlight the most important and interesting aspects of their work. Students who have changed research topics may choose which project to present, but they are encouraged, if at all possible, to select a topic aligned with their anticipated long-term research direction.

To assess whether a student's thinking and explanations are grounded in fundamental physics principles, they should devote approximately 10 minutes of their presentation to discussing how their research draws on basic concepts from areas such as classical mechanics, quantum mechanics, electrodynamics, or statistical physics. The goal is not to cover all of these topics, but rather to demonstrate an ability to connect one's research topic to the foundational ideas most relevant to it.

Students must prepare for their oral qualifying exam independently and may not seek help with any aspect of its preparation—such as feedback on slides, talk structure, the initial write-up, or anticipated questions—from their advisor, other faculty, or peers. Since the exam focuses on their research, students may of course continue discussing scientific aspects of their work with their advisor. However, these discussions must not include advice on how to frame, present, or otherwise shape the work for the exam.

Following their presentation, the committee will engage the student in a question period (typically lasting 30 to 60 minutes) focusing on both the presented research and foundational physics concepts relevant to the topic.

The committee will have access to the student's course grades and previous evaluations. The student's research advisor is expected to attend as a silent observer and may be consulted by the committee prior to their deliberations (for instance to give their view on whether the committee's questions were fair, clear, and appropriate), but they will not be part of the deliberations and hence also not have voting rights.

The oral qualifying exam is a **pass/fail** exam; no letter grade is assigned, but all committee members who attended the presentation submit their assessment, which can take the form "clear pass", "marginal pass", "marginal fail", and "clear fail." Students who do not pass the exam on their first attempt may take it once more at the next offering. Failure to pass on the second attempt triggers the same mechanism as a twice-failed core course: the student's continuation in the Ph.D. program is discussed in a faculty meeting. The default outcome of a second no-pass is dismissal from the program, but faculty may determine that sufficient mitigating circumstances were present that warrant a third attempt. If so, the DGS and the DH

develop a document that clearly outlines the next steps and the expectations for remaining in the program and then discuss this with the student.

8.3: Criteria for Advancement to Candidacy

Passing on to Physics Ph.D. candidacy requires passing each of the five core courses (see Sec. 7.2) with at least a B– (“B minus) grade, passing each of the two chosen breadth courses (see Sec. 7.3) with at least a B– grade, and passing the Oral Qualifying Exam. After a student has fulfilled those requirements, a meeting of the faculty is held to review the student’s academic record and qualifying exam performance. Progress in research, finding a research advisor, and the research aptitude of the student are part of that discussion. After a positive vote by the faculty, the student is passed on to Physics Ph.D. candidacy and begins full-time thesis research. Completing one semester of TA work (see Sec. 7.14) is a requirement for *graduation*, but not for passing on to *candidacy*. Students are expected to engage in active research each semester, as well as during the summer unless they are on an internship

Students are encouraged to familiarize themselves with the University Policy for Doctoral Student Status. |. This policy sets forth a definition of All But Dissertation (ABD) status, time limits on doctoral candidacy status, a definition of being In Residence and In Absentia for candidates, and the tuition and fees charged for candidates in each status. The ABD Status Agreement Form can be found at: https://www.cmu.edu/hub/docs/abd-status-agree.pdf.

8.4: Annual Research Reviews

After passing the Oral Qualifying Exam, the student forms their annual review committee. Each fall semester, the student assembles this committee to hold an *annual research review*, which provides an opportunity to

- practice presenting scientific progress;
- discuss research with scientists beyond the student’s research group;
- receive feedback on scientific progress, timing, and future research plans;
- build relationships with the committee members, who typically become members of the student’s future thesis committee.

The first annual review should be scheduled in the fall semester after a student advanced to candidacy. The annual research review is then repeated each fall, allowing the student’s annual review committee to provide feedback on research progress toward a timely thesis defense. If a student’s Ph.D. defense is planned for the fall, it is not necessary to also hold a final annual review in that same fall semester prior to the defense.

To facilitate annual reviews, each student and their advisor must submit a list of tentative committee members, constituting a quorum, by the end of the semester in which they advanced to candidacy. The composition of the annual review committee is similar to that of the ultimate thesis committee (see next Sec. 8.5), except that no outside member needs to be chosen at this stage. In the exceptional case that students are not able to complete the annual review for the current academic year, students need to indicate that they have taken steps to

schedule their review and provide the proposed date for the review. The annual research review includes:

- A short (few pages) write-up by the student, sent to the committee about a week prior to the report and intended to quickly bring everyone up to speed on content, stage, and direction of the thesis project.
- the presence of at least 3 of the tentative future thesis committee members.
- a presentation by the student that includes
    - a discussion of research progress over the past year. (This part typically takes about 30 minutes, but conventions in different research groups may vary. The student should consult with their advisor about this.)
    - a discussion between the student and committee members on the progress;
    - a plan for continuation of the student's research toward a Ph.D. thesis. (This part typically also takes about 30 minutes—again with some variability between groups.)
- an opportunity for the student to converse with their thesis committee *without their advisor present*.
- an opportunity for the advisor to converse with the thesis committee *without the student present*.
- documentation of the annual review by the advisor, through the completion of a form that can be obtained from the Academic Program Manager or the Annual Review Canvas site.
    - The thesis advisor completes and signs the form and then forwards a copy to the student.
    - The student uploads this copy on the Annual Review Canvas Site.
    - The submitted form can be accompanied by a 1–2 page progress report prepared by the student or a copy of the student presentation.

8.5: Thesis Committee: Composition and Responsibilities

The purpose of the doctoral thesis committee is to evaluate the validity, originality, significance, and proper presentation of the candidate's doctoral thesis. The committee reviews the written thesis, conducts the final public oral defense, may request revisions or clarifications (before or at the time of the examination), and ultimately certifies to the Dean its finding on the acceptability of the thesis in its final form.

The formation of a valid thesis committee and the execution of a thesis defense are also governed by the MCS Doctoral Degree Policies as detailed in the Mellon College of Science Faculty Handbook.

8.5.1: Committee Appointment and Membership

The thesis committee is typically proposed by the research advisor in consultation with the Ph.D. candidate. The committee must be approved by the Department Head (or their

designate, such as the Director of Graduate Studies), who bears ultimate responsibility for ensuring that the committee complies with university and departmental policies.

The committee must consist of **at least four members**, subject to the following requirements:

- **Chair:** One committee member must be a regular faculty member in the Physics Department (with the rank of Assistant Professor or higher) and will serve as chair. If eligible, the thesis advisor typically assumes this role.
- **Departmental Representation:** At least half of the committee members must be regular or research faculty in the Physics Department. This count includes the chair.
- **Visitor:** At least one member must serve as an *external visitor*, meaning they are not affiliated with the Physics Department nor with any department involved in the Ph.D. candidate's research. The visitor may be from another CMU department, another university, or from outside academic institutions altogether. The visitor should be familiar with academic standards and especially qualified to evaluate some aspect of the dissertation. The advisor may not serve as the visitor.
- Special Case: If a Ph.D. candidate's primary research advisor is not a regular or research faculty member in the Physics Department—for example, they may be from another department or even outside of Carnegie Mellon—then a **departmental sponsor** must be appointed by the DH or DGS, in consultation with both the Ph.D. advisor and the Ph.D. candidate. The departmental sponsor must be a regular or research faculty member in the Physics Department and is responsible for ensuring that the student's progress, thesis quality, and program compliance meet departmental expectations. The sponsor is typically a member of the thesis committee and may serve as chair if needed.

8.5.2: Committee Logistics and Timing

- The thesis committee should be formally appointed **at least two months** before the expected defense date.
- The Ph.D. candidate is responsible for keeping the committee informed of their progress throughout the final stages of thesis preparation. The committee may specify whether this should be done individually, or collectively by formal or informal presentations. Through this process, the candidate and committee should develop a shared understanding of when the thesis is ready to proceed toward submission and defense.
- Once the advisor (and sponsor, if applicable) agrees the dissertation is ready, the Ph.D. candidate submits it to the committee. The final thesis defense should be scheduled at least **two weeks** past that point to allow for proper review by the committee.
- The final defense may proceed only if the committee members present would, by themselves, constitute a valid thesis committee according to the preceding provisions. Remote participation via video conferencing is allowed if in-person attendance is not feasible.
- If the committee meets quorum but one or more members are unable to attend the defense (*i.e.*, the full committee has more than the minimum four members), those

absent members may, if they wish, submit a written evaluation or recommendation for consideration by the rest of the committee.

8.5.3: Vacancies and Changes

- A vacancy on the committee (*e.g.*, due to illness or departure) must be filled only if the remaining members no longer satisfy the rules for a valid committee.
- When a vacancy is filled, care shall be taken that the new committee member has the time and opportunity to participate effectively in the performance of the committee's functions.
- If a student raises a serious concern about a committee member after the committee has been appointed, the advisor may discuss the concern with that member and, in consultation with the DH and DGS, request a replacement. Any revised committee must still meet all formal requirements.

8.6: Public Thesis Defense

In the last step towards a Ph.D., the candidate must publicly defend their thesis in front of the thesis committee. This defense shall be publicly announced at least *two weeks in advance*, by posting it on the departmental calendar and sending an email to the entire department. The modality for the defense (*i.e.*, in person or remote) follows the default instructional modality for the university at any given time. Requests to depart from this default should have a strong practical motivation that is discussed and approved by the Director of Graduate Studies prior to proceeding.

While the exact format of a Ph.D. thesis defense may vary slightly between research groups, it typically follows this structure:

- **Public Presentation:** The defense begins with a public session open to all attendees, including faculty, students, and guests such as family and friends.
- **Candidate's Presentation:** The candidate gives a formal presentation summarizing the major findings of their research, placing their work in the broader context and historical development of their field. This presentation generally lasts between 30 and 45 minutes. The candidate is expected to align with the conventions of their research group or disciplinary area.
- **Public Q&A:** After the presentation, members of the audience may pose questions to the candidate in an open discussion.
- **Committee Examination:** Following the public questions, the thesis committee engages the candidate in a more in-depth technical discussion. The goal of this phase is to evaluate whether the candidate has achieved the level of scientific understanding, rigor, and context-awareness expected at the Ph.D. level. The committee may also offer feedback on parts of the written thesis that could benefit from clarification. The candidate may choose whether this portion of the defense is held in public or in private (*i.e.*, with the general audience excused).
- **Committee Deliberation:** After the examination concludes, the committee deliberates privately to determine whether the candidate's thesis and defense meet the standards

required for awarding the Ph.D. It is not uncommon that the committee requests some **minor revisions** to the written thesis. These revisions are typically to be completed in the following weeks, after which the committee confirms to the Dean that the revised thesis can be formally certified.

In rare cases, the thesis committee may conclude after the defense that the submitted dissertation does not yet meet the standards required for awarding a Ph.D., and that **major revisions** are necessary. This could be due to significant errors in the work or because essential conclusions cannot be drawn without additional efforts—such as control experiments or further calculations. (This outcome should be avoided in most cases through the student and advisor planning the thesis content in consultation with the thesis committee through the Annual Review process, and through the committee reviewing the draft thesis to identify such situations and request major revisions prior to scheduling the thesis defense.)

In such cases, the committee will determine that the candidate is **not yet ready to be certified** for the Ph.D. but will be given the opportunity to revise and resubmit the dissertation. The committee must provide a written report outlining the rationale for this decision and specifying the required revisions. This report will be shared with the Ph.D. candidate and the Department Head. The requested revisions must be *clearly defined*, *limited to the major concerns* identified by the committee, and *not constitute a demand for open-ended new research*. A second defense must take place within one year of the initial defense, and the scope of the revisions should be realistic with that timeframe in mind.

During this period, the Ph.D. candidate **remains in good standing** and continues to be enrolled in the graduate program. Their funding, mentorship, and academic support should continue as before. If the period before the second defense exceeds three months, it is strongly recommended that the committee schedule an informal mid-point meeting with the candidate to assess progress, offer feedback, and provide encouragement.

If the second defense is successful, the Ph.D. will be awarded without any notation that a second defense took place; specifically, this information is written neither on the Diploma nor the transcript. However, if the committee determines that the revised dissertation and follow-up defense still do not meet the required standard, the Ph.D. will not be awarded.

As with any academic action, **students have the right to appeal** through the standard process described in the University-Wide Graduate Student Handbook, which can be found here.

SECTION 9: Department Policies & Protocols

9.1: Petition Procedures

9.1.1 Feedback Mechanisms

Students are encouraged to share requests or concerns—whether with advisors, course instructors, the Director of Graduate Studies (DGS), the Department Head (DH), or any other person—either through direct communication or (if appropriate) at events such as town halls.

In addition, the department maintains two mechanisms for submitting anonymous feedback: one web form routes messages to the DEI Committee, and another web form goes directly to the DH. Both forms are available on the departmental website.

9.1.2 Resolving Contentious Issues

When disagreements arise, the department encourages resolution through respectful and good-faith conversation between the involved parties. The DGS and DH are available to help mediate if requested. Other university resources, such as ombudspersons, may also assist in reaching a mutually agreeable solution (see also Sec. 6.3).

If informal resolution efforts fail, the department follows the university's official procedures for graduate student appeals and grievances, as outlined in the CMU Graduate Education Handbook: https://www.cmu.edu/graduate/policies/appeal-grievance-procedures.html.

9.1.3 Course Substitutions and Transfer Credit

Policies regarding requests for substitutions or waivers of core or elective courses are described in Sec. 7.2 and Sec. 7.3, respectively. Transfer credit policies are addressed in Sec. 7.13.

9.1.4 Transferring Between Graduate Programs

Students who wish to transfer to a different Ph.D. program within Carnegie Mellon must formally apply to that program. In the case of students seeking to transfer from the Physics Ph.D. program to the Astronomy and Astrophysics Ph.D. program, a formal application is still required. However, the fact that the student was previously admitted to a Ph.D. program through a competitive process will be taken into account and weighed in their favor. Prior withdrawal from the Physics Ph.D. program is not required before applying to a different program.

International students should be aware that *visa regulations may limit their ability to switch between academic degree programs*, even within the same department. As always, they should first consult with OIE to receive clarity on the current policies.

9.2 Course Withdrawal and Related Changes

Departmental procedures for withdrawing from a course, requesting an incomplete grade, or changing to an audit or late audit follow the same university guidelines as those for undergraduate students. However, if the course in question is required for timely progress toward the Ph.D., the student must consult the DGS to discuss the implications and explore appropriate next steps.

9.3 Background Requirements for Students Without a Bachelor's Degree in Physics

The department imposes no additional coursework or preparatory requirements for students who enter the Physics Ph.D. program without a prior undergraduate degree in physics. All admitted students are evaluated holistically by the admissions committee, which assesses readiness for the program regardless of undergraduate major.

9.4 Master's Degree *en route* to the Ph.D.

Details on the process for earning a Master's degree as part of the Ph.D. trajectory are provided in Sec. 7.5.

9.5 Policy Changes and "Grandfathering"

When graduate program policies or requirements are changed, it is because the department believes the new rules offer an improvement. Any significant changes that are meant to apply to already-enrolled students will be discussed with the graduate students at a town hall meeting prior to implementation.

Students who are already enrolled at the time of a policy change may choose to follow the version of the policy that was in effect when they began their program. If a change affects course availability (*e.g.*, a required course is no longer offered), the department will work with the student to find a reasonable path for satisfying the original requirement.

9.6 Time Away from Academic Responsibilities

The transition from undergraduate to graduate school entails not only a step up in scientific rigor and academic responsibility but also a significant shift in expected schedules for supported efforts in research and/or teaching responsibilities. Graduate students should not assume that time away from such responsibilities follows the academic calendar of courses. Instead, doctoral students who receive a stipend are generally expected to continue their research during academic breaks, including the summer months, with the exception of official university holidays.

University holidays are also student holidays. However, students engaged in time-sensitive research (*e.g.*, experiments requiring continuous monitoring) should consult with their advisor to determine whether special arrangements are necessary. In some cases, students may be asked to take an equivalent amount of time off at a different date.

Carnegie Mellon's U.S. campuses currently observe the following 11 official holidays:

New Year's Day	January 1
Martin Luther King Day	Third Monday in January
Memorial Day	Last Monday in May
Juneteenth	June 19
Independence Day	July 4
Labor Day	First Monday in September
Thanksgiving Day	Fourth Thursday in November

Day after Thanksgiving	Day after Thanksgiving Day
Day before Christmas	December 24
Christmas Day	December 25
Day Before New Year's Day	December 31

(Note: when a holiday falls on a Saturday, it is observed on the preceding day. When the preceding day is also a holiday, both holidays are observed on preceding days. When a holiday falls on a Sunday, it is observed on the following work day.)

Beyond these 11 University Holidays, every stipend-supported graduate student in a 12-month program is entitled to 10 additional days per calendar year of paid time away from academic responsibilities, in alignment with Carnegie Mellon's goal to holistically support Doctoral student experience. To facilitate planning within research groups, students must obtain prior approval from their advisor before scheduling such a break. Upon returning, students may be expected to complete time-sensitive tasks that accumulated during their absence, particularly if they possess unique expertise needed for those tasks.

Students wishing to take a longer period of personal time off may petition to do so without financial support and must obtain advisor approval at least two weeks in advance. The advisor will then notify the department's business office so that appropriate adjustments to the student's support package can be processed.

9.7: Other Policies and Protocols

N/A

SECTION 10: Grading & Evaluation

10.1: Grading Scale/System

The Department of Physics follows the University Policy on Grading, which is outlined online at https://www.cmu.edu/policies/student-and-student-life/grading.html. This policy offers details concerning university grading principles for students taking courses and covers the specifics of assigning and changing grades, grading options, drop/withdrawals and course repeats. It also defines the graduate grading standards using the following letter grades:

A+, A, A–, B+, B, B–, C+, C, C–, D+, D–, or R.

Translations of these letter grades into a numerical score (such as "A+" = 4.33, "A" = 4.0, "A–" = 3.67, ...) can again be found in the university guidelines.

10.2: Department Policy on Grades for Retaking a Course

Students must pass all required physics core and breadth courses with a grade of B– (B-minus) or higher before being admitted to Physics Ph.D. candidacy. Exceptions can be made only if a student demonstrates proficiency in the subject matter of a particular course and receives prior approval by the DGS. Students who receive a non-passing grade of C+ or lower in a required course have a second attempt to pass that must be taken the next time the course is offered.

10.3: Department Policy on Pass/Fail, Satisfactory/Unsatisfactory

All core and breadth courses must be taken for a grade; pass/fail is not an option for the advancement to candidacy. The oral qualifying exam is the only requirement towards candidacy that is taken at the pass/fail level.

10.4: Department Policy for Incompletes

The Department of Physics follows Carnegie Mellon's university-wide policies on the assignment of Incomplete grades, as outlined in the CMU grading policy referenced in Sec. 10.1. Briefly:

- An Incomplete grade ("I") may be assigned by the instructor when the following conditions are met:
    - The student was unable to complete course requirements within the academic semester due to circumstances beyond their control;
    - The work completed to date is of passing quality (note: this does *not* mean the cumulative points must already constitute a passing grade);
    - Granting the incomplete does not confer an unfair advantage over other students.

  A typical example would be a medical emergency that prevents the student from taking the final exam.
- The instructor must specify what work remains and indicate the default grade the "I" will convert to if no further work is submitted. This is done using an official CMU form called the "Incomplete Grade Agreement."
- The student and instructor must both sign and date the Incomplete Grade Agreement.
- Students must complete the required coursework no later than the end of the following academic semester, or earlier if required by prior agreement.

It is important to note that *an Incomplete is intended for unforeseen interruptions*, not for situations where a student falls behind due to poor time management or overcommitment. For instance, if, during the semester, it becomes evident that a student is overwhelmed by their workload, the appropriate course of action is to drop a class—not to postpone the work until after the semester ends.

While CMU provides deadlines for dropping a course, a *late drop option* exists in exceptional cases. This requires the use of a dedicated form and the signatures of the student, their advisor, and the DH.

Historically, Incomplete grades have had low completion rates: CMU data collected between Fall 2015 and Spring 2020 show that approximately 60% of Incompletes convert to the default grade. The structured use of the Incomplete Grade Agreement is intended to help improve this outcome. Setting deadlines that are as soon as is feasible (rather than the latest possible option, the end of the subsequent semester) has also been shown to increase the chances of success, and is strongly encouraged. Instructors are also encouraged to maintain regular communication with the student to support the timely completion of outstanding work.

10.5: Independent Study/Directed Research

The Physics Ph.D. program does not have Independent Study or DIrected Reading classes as part of their graduation requirements.

10.6: GPA Requirements and QPA Requirements for Graduation

The semester GPA is important to monitor whether a student's performance (either in course work or in research) is satisfactory, and poor performance may trigger academic probation (for more details see the following Sec. 10.7). However there is no required minimum cumulative point average for graduation.

10.7: Satisfactory Academic Standing

Students must remain in good academic standing to continue in the Physics Ph.D. program. A student may be placed on *academic probation* when they fail to meet core expectations for progress toward the degree (see in particular Sec. 7.1.2 on Research Expectations). Common triggers for probation include:

- A semester GPA below 3.0;
- Receiving a research grade below B–;
- Failing the Oral Qualifying Exam;
- Losing one's research advisor after the second year and not securing a new group within six months;
- Failing to complete the annual research review within the expected timeframe.

When a student is placed on probation, they will meet with the DGS and the DH to discuss the situation. Following this meeting, the DH will issue a formal letter outlining a set of concrete requirements and a realistic timeline for returning to good standing. This letter, developed in consultation with the student's primary advisor and the DGS, aims to clarify expectations and, when appropriate, to offer support in identifying and addressing underlying causes—for instance, weak academic preparation, time management challenges, or other obstacles that may affect progress.

If the student meets the stated requirements within the specified timeframe, they will be removed from probation and will receive written confirmation from the DH stating this.

If the student fails to meet these conditions, their case will be brought to a closed faculty meeting for review. After the DGS has outlined the main points of the specific case, the faculty will discuss whether the student can reasonably be expected to return to good academic standing and successfully complete the Ph.D. program. This evaluation is holistic and may consider broader aspects of the student's record and circumstances—but with important boundaries; for instance:

- Information about approved academic accommodations is not part of the discussion, as these are designed to equalize opportunity and are in any case meant to be confidential (except where needed for their actual implementation).
- Information the student had shared with the advisor, DGS, or DH in confidence will not be disclosed. These could for instance be personal affairs or medical issues. Such issues are by default kept confidential, but students may request that the DH/DGS/advisor disclose such information if the student prefers that it be a part of the faculty discussion.

Following this discussion, faculty vote on whether the student may continue in the program:

- If the vote is **yes**, the student remains on probation but will receive an updated letter with revised conditions and timeline for being taken off probation.
- If the vote is **no**, the student must leave the Ph.D. program. In such cases, a short grace period is typically granted to allow the student to make appropriate arrangements for the next steps in their career.

There is no limit to the number of times a student may be placed on academic probation. A student who has successfully returned to good standing may later re-enter probation if new concerns arise.

Like with any academic action, dismissal from the Ph.D. program may be appealed. To initiate an appeal, the student must submit a formal letter—with appropriate documentation—to the Dean of the Mellon College of Science within seven (7) business days of receiving the written notice of dismissal.

The Dean may delegate review of the appeal to another individual or committee, including (but not limited to) an Associate Dean, the College Council, or a specially constituted grievance committee. This committee will review the case and make a recommendation to the Dean. The Dean or the Dean's designee will render a final decision and communicate directly with the student.

The appeal letter must address the following points:

- Outline the specific nature of the academic problems.
- Identify the causes of the academic problems.
- Articulate the specific strategies that they will employ to address the causes of the academic problems.
- Indicate their academic and non-academic support systems.

Additional levels of appeal are identified in the Summary of Graduate Student Appeal and Grievance Procedures which may be found in the University-Wide Graduate Student Handbook, specifically here:

https://www.cmu.edu/graduate/policies/appeal-grievance-procedures.html.

10.8: Regular Reviews and Evaluations by Department

To ensure a Physics Ph.D. student stays on track towards completing their Ph.D. thesis in a timely fashion, they are required to hold annual research reviews in front of a committee they form shortly after passing the Oral Qualifying Exam. Details on the *purpose* and *logistics* of these annual reviews are outlined in Sec. 8.4.

SECTION 11: Funding & Financial Support

11.1: Statement of Department Financial Support

The Physics Department provides substantial financial support for doctoral students throughout their Ph.D. program: stipend, tuition, student fees, and Student Healthcare Insurance Program (SHIP). Students must make satisfactory academic progress and fulfill the requested teaching or research associated with a funded TA or RA position to be eligible for financial support.

11.2: Stipend

Doctoral students supported by the department or from a faculty member's external funding receive a stipend for 12 months throughout the year, payable on the 15th and the last working day of each month. All doctoral students supported by the department (*i.e.*, students not holding external fellowships) receive the same stipend, regardless of the year entering the program, teaching responsibilities, or laboratory assignment (see also Sec. 11.13). The department does not equalize differences in tax withholding. Please note that the first paycheck arrives on August 31; thus, each incoming student should bring enough money to pay for any deposits or incidental costs.

The amount of the annual stipend is decided at the college level.

11.3: Tuition

Doctoral students also receive complete tuition remission for the fall and spring semesters. 18 equal tuition payments will automatically post to students' accounts throughout the academic year. Students who are not taking courses in the summer are not charged tuition in the summer. Payment of tuition for any summer classes, including those audited, is the responsibility of the student.

Additional tuition information is available on the Office of Enrollment Management website.

11.4: Health Insurance Requirement

All full-time students who are physically located in the U.S. are required to meet CMU's health insurance policy each academic year. To fulfill this requirement, students must have insurance that meets university requirements for the duration of their time as an enrolled student, either through enrolling in the Student Health Insurance Plan (SHIP), or obtaining a SHIP waiver (for instance because they are still on their parents' insurance). More details can be found on Carnegie Mellon's policy webpage specifying the Medical Insurance Mandate.

Carnegie Mellon covers 100% of the individual premium cost for medical coverage through the Student Healthcare Insurance Program (SHIP). Doctoral students who have not waived SHIP by August 15 will see a credit of 100% of the insurance plan fee applied to their student account by the end of August. Be aware that this applies only to the *individual premium for medical coverage*; vision and dental benefits are excluded, but students can also obtain coverage for those through SHIP (at the students' own expense). Furthermore, while the 100% individual premium support only applies to doctoral students, their *family members can still enroll in the university health plan as long as they are prepared to pay the SHIP costs for those family members*.

Students should be aware that the health insurance credit is a *non-qualified scholarship*, and *it is considered taxable income by the Internal Revenue Service (IRS) to all students who receive it*.

For international students, the university has an IRS reporting and tax withholding obligation on non-qualified scholarship payments for students who are considered non-resident aliens for tax purposes. If you do not qualify for tax treaty benefits, a 14% tax will be withheld from your health insurance support credit and remitted to the IRS. In this scenario you will see the full Ph.D. Insurance Support credited to your student account along with an IRS Tax Withholding charge equal to 14% of the support. This 14% of the SHIP cost will therefore appear as a financial obligation (account fee) for the student to pay.

CMU offers a monthly payment option, via Nelnet ($40 enrollment fee each semester), that allows a student to create a payment plan for their account fees. This option is available at the beginning of each semester.

For general questions regarding SHIP, please reference the HUB's Student Account-Related Health Insurance FAQs.

11.5: Fees

Carnegie Mellon charges some additional fees (notably Technology, Student Activities, and Transportation), as outlined in the University-Wide Graduate Student Handbook, accessible via the resources webpage maintained by the Office of Graduate and Postdoctoral Affairs. The Department of Physics does *not* charge any specific fees in addition to those.

Departmentally supported students are responsible for all other charges not covered by the department. These include, but are not limited to, federal withhold tax (applied to SHIP), library fines, optional insurance coverage, summer housing, and other miscellaneous charges.

11.6: Travel/Conference and Research Funding

Costs for conference travel are typically covered by the student's advisor. However, there are alternative sources of funding available, which might be especially valuable when the funding situation of the student's advisor is tight:

- The MCS Dean's office offers supplemental conference travel funding with up to $600 per student. The year is divided into four (overlapping) half-year periods, with corresponding deadlines for applications to each of them. Awards are made on a quarterly basis.
- Students can apply for Conference Funding via the Office of Graduate and Postdoctoral Affairs. Currently these funds are limited to $750 per individual student, with a maximum amount of up to $1,500 per group. The year is divided into four (non-overlapping) quarter-year periods, with corresponding deadlines for applications to each of them. Awards are announced approximately three weeks after each application deadline. Priority is given to students who present their work at the chosen conference.
- Besides conference funding, the Office of Graduate and Postdoctoral Affairs also offers Professional Engagement Funding. The main difference is that presentation of original research is *not* expected; it suffices if a student wishes to pursue professional engagement or networking opportunities.
- The Office of Graduate and Postdoctoral Affairs also offers Scholarly Project Funding (formerly called "GuSH Research Grants"). Small awards of $750, intended to further a student's research related to their programs of study, are made in cases where personal or departmental resources have been exhausted.
- Conferences often offer travel support for student attendees, and graduate students are encouraged to make use of such possibilities.
- Many funding agencies and scientific societies have specialized conference, research, and fellowship opportunities. Graduate students are encouraged to explore available options in their particular field of research. Be aware that some of these might require US citizenship, so students should carefully consult published eligibility criteria.

11.7: Funding Payment Schedule

This is discussed in Sec. 11.2.

11.8: Additional Sources of Internal & External Financial Support

There are a number of resources available to students to search for externally supported research fellowships, and scholarships, and other opportunities:

- Grants.gov acts as a web-based central repository for information on over 1,000 grant programs across 26 US federal agencies. This resource is available to anyone.
- CMU's University Libraries maintain a subscription with two funding opportunity search engines available to students with an active andrew account. Students may need to establish an account with these subscription services:
    - Pivot

    - Grants Forward
- CMU's Office of Sponsored Programs has a resource page that provides links to additional external opportunities.

11.9: Availability of Summer Employment

If summer support is provided, then students are expected to adhere to the policy for outside employment described in Sec. 11.10. If summer support is not available, the student may seek outside employment in consultation with their thesis advisor and the DGS. International students who wish to explore this option should consult with CMU's Office of International Education (OIE) to learn how it may impact their visa status prior to accepting any outside employment. This policy does not apply to departmentally approved internships.

11.10: Department Policy on Outside Employment

Since students are expected to be enrolled in the doctoral program as full-time students, seeking outside employment is strongly discouraged. Any students who wish to explore the possibility of outside employment must consult with their advisor, the DGS, and the DH in advance to make sure it does not impact their academic and research progress and fulfillment of any other obligations associated with their source of funding support (*e.g.*, a TA role). In addition, international students should consult with CMU's Office of International Education (OIE) to learn how outside employment may impact their visa status. This consultation should occur prior to accepting outside employment.

11.11: Requirements for the Continuation of Funding

Service as a course assistant (TA or grader) is a serious responsibility that impacts the educational experience of other students in the department. Students with a course assistant position must demonstrate professionalism and a commitment to this responsibility in order to remain eligible to hold funded course assistant positions in future. (It is understood that students may sometimes experience unpredictable personal or academic issues that could impact their ability to fulfill course assistant responsibilities. As long as they coordinate with the course instructor to mitigate the impacts of these issues, their eligibility for future positions will not be affected.) Instructors should convey concerns about TA/grader performance as outlined in Sec. 7.14.

If these concerns are conveyed at least 4 weeks before final grades are due and are deemed to be of sufficient severity and/or persistence, the DGS and Department Head may at their discretion make future course assistant positions for this student contingent on demonstrated improvement during this semester. This must be conveyed verbally to the student and in writing to the student and their research advisor. If concerns are conveyed closer to the end of the semester, the student may have insufficient time to demonstrate an improvement, but the DGS and Department Head will record the situation and impose appropriate consequences if the issues recur in subsequent semesters.

11.12: Procedure for Written Notification of Change in Financial Support

Every effort is made to provide continuous support to students in good standing, within the limits of the available resources. The Department places a high priority on maintaining continuous financial support for graduate students and provides notice to students on changes in their financial support, with a 3-month written notification, where possible, in the event of a change in the funding. If a student's funding is lost or reduced unexpectedly and continuous funding proves difficult to arrange, the student should first consult the DH.

If a student is terminated from the Ph.D. Program, the student's first notice of a possible change in financial support will normally be when they are initially placed on probation. The probationary period will typically last 3–4 months. If conditions for reestablishing good standing are not met within that time, a student may, depending on departmental resources and available positions, receive a terminal semester in the department with funding through a TA position during the academic year or other employment during the summer.

11.13: Department Policy on Graduate Student Equitable Support

As part of the admissions process, any student receiving external financial support for their PhD program via a scholarship, fellowship, or other means will need to disclose such support with sufficient details to allow the Physics Department to understand the financial impact. This includes details regarding the following:

- Type of support: Graduate fellowships versus research fellowships
- Annual level of student stipend, tuition, student fees, and SHIP support
- Duration of external support

Disclosing this information will help the department to understand whether three common issues apply to the student for the duration of their external support: (1) inequity in stipend support, (2) incomplete coverage of other costs (tuition, *etc*.), (3) any support restrictions. These situations and other issues related to external fellowships are described below.

Stipend inequity occurs when the external fellowship support provides a stipend below the one determined by Mellon College of Science (MCS), which applies to all department supported PhD students. This situation may make it challenging for the student to cover their living expenses. When a student's externally provided stipend is found to be below the Mellon College of Science's stipend level, a formal agreement will be made between the department and student outlining the additional level of support the student may be offered, and the conditions under which additional support is provided.

The externally supported student's advisor and the Physics department will agree on how the additional support is covered for the entirety of the student Ph.D. program. The advisor is expected to make reasonable attempts to cover that additional support through grant funding where possible.

A student receiving external support will provide CMU reasonable notification, in advance, when the terms of that support change.

SECTION 12: ADDITIONAL DEPARTMENTAL INFORMATION

12.1: Orientation Program

Entering doctoral students are required to attend an orientation program held during the week preceding the beginning of classes (which is typically in the middle of August). International students need to arrive one week earlier, as they will receive additional orientation organized by the Office of International Education (OIE). During the week of physics orientation students attend talks introducing them to the department, meet with the Director of Graduate Studies to plan their course work for the first and second semester, discuss the responsibilities of teaching assistants, undergo mandatory TA training, meet with current graduate students, and enjoy informal social events.