Doctor of Philosophy in Physics

Why study physics and astronomy?
Because understanding the physical universe starts here.

Admission to Graduate Studies
An applicant seeking to pursue graduate study in the College may be admitted as either a degree-seeking or non-degree seeking student. Policies and procedures of Graduate Studies govern the process of Graduate admission. These may be found in the Graduate Studies (http://catalog.ku.edu/graduate-studies) section of the online catalog.

Please consult the Departments & Programs (http://catalog.ku.edu/liberal-arts-sciences) section of the online catalog for information regarding program-specific admissions criteria and requirements. Special admissions requirements pertain to Interdisciplinary Studies degrees, which may be found in the Graduate Studies section of the online catalog.

Graduate Admission
Ordinarily, admission requires an undergraduate grade-point average of at least B (3.0 on a 4.0 scale), overall and in the major. A baccalaureate degree with a major in physics is desirable but not required. Recommended preparation consists of courses in mechanics, electromagnetic theory, thermal physics, introductory quantum mechanics, advanced laboratory, and at least one course in mathematics beyond differential equations. Working knowledge of computers and of an advanced programming language is helpful. A student with less than the recommended preparation may enroll in these courses for graduate credit.

Submit your graduate application online (http://www.graduate.ku.edu). Send all other requested application materials to the department:

The University of Kansas
Department of Physics and Astronomy
Graduate Coordinator
Malott Hall
1251 Wescoe Hall Dr., Room 1082
Lawrence, KS 66045-7572

Ph.D. Degree Requirements
The departmental web page with some additional information, e.g., milestones, can be found online (http://www.physics.ku.edu/~physics/graduate/about.shtml).

Residence
To become a Ph.D. candidate, i.e. to take the comprehensive exam:
The student must spend at least 2 semesters, which may include 1 summer session, in resident study at the University of Kansas.

To earn a Ph.D.:
The student must spend at least the equivalent of 3 full academic years in graduate study at this or another approved institution or laboratory. During this period of residence, the student must be involved full-time in academic or professional pursuits, which may include an appointment for teaching or research if the teaching/research is directed specifically toward the student's degree objectives.

Graduate students with half-time assistantships usually require at least 4 years to complete all requirements. Maximum enrollment for students with no other departmental obligations is 16 hours a semester. In addition to satisfying the residence requirement, a student with a half-time assistantship must be enrolled for at least 6 hours each semester. A maximum of 12 hours is permitted if the student's duties consist of research that partially fulfills degree requirements. A fellowship holder or full-time student with private support must be enrolled for at least 9 hours.

Time Limits
See the University's policy on time limits (https://documents.ku.edu/policies/Graduate_Studies/docprogramtimeconstraints.htm).

Graduate Teaching Assistantship Eligibility
To be eligible for teaching assistantships, all graduate students who are not native speakers of English must achieve a minimum score of 50 on the SPEAK test. International students must pass an oral examination to demonstrate English fluency. Students who fail this examination should take courses from the Applied English Center.

Every student who receives a GTA appointment will be required to complete PHSX 702 Introductory Physics Pedagogy at the first offering of the course starting with the semester of the student's initial GTA appointment. Failure to complete this class at the first opportunity may affect consideration for subsequent GTA appointments.

Preliminary Candidacy
To be admitted to preliminary candidacy, each graduate student must satisfy department requirements:

1. Undergraduate knowledge of physics must be certified at the department undergraduate level (600-level KU courses). The ways to achieve this certification are outlined above under Course Requirements. A candidate for a Master's or Ph.D. degree who has not had the equivalent of 6 credit hours of advanced undergraduate laboratory course work (Junior/Senior level) is required to take 1 of the 3 advanced laboratory courses offered in the department.

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHSX 516</td>
<td>Physical Measurements</td>
<td>4</td>
</tr>
<tr>
<td>PHSX 536</td>
<td>Electronic Circuit Measurement and Design</td>
<td>4</td>
</tr>
<tr>
<td>PHSX 601</td>
<td>Design of Physical and Electronic Systems</td>
<td>4</td>
</tr>
</tbody>
</table>

2. Achieve a minimum core course grade point average of 3.2. The core course GPA is computed from the following 5 equally weighted elements:
   • Grade obtained in PHSX 711 Quantum Mechanics I
   • Grade obtained in PHSX 811 Quantum Mechanics II
   • Grade obtained in PHSX 821 Classical Mechanics
   • Grade obtained in PHSX 831 Electrodynamics I
   • Average grade of 2 other PHSX lecture courses numbered 700 or higher, excluding PHSX 815 (computational physics) and PHSX 717 (graduate seminar)
   a. Students may repeat 1 of the 4 core courses (PHSX 711, PHSX 811, PHSX 821, and PHSX 831) once for the purpose of improving the core GPA. In calculating the core GPA, the Department will use only the better of the 2 grades.
b. The 2 "other PHSX lecture courses numbered 700 or higher" must be taken at KU, but students entering with graduate credit from other institutions may petition the Graduate Committee for transfer credit for any of the 4 named core courses. For the purposes of the core GPA, grades (of "B" or better) from the previous institution may be used for at most 3 of the 4 named courses. For the remaining course the student must obtain written certification of "B" performance or better from the instructor of the course at KU. Such certification may be obtained by taking the course, taking the final exam of the course (if there is one), or other means which the instructor may determine. An appropriate higher-level course may also be used to obtain certification in a core course (for example for PHSX 711 or PHSX 811, PHSX 931 for PHSX 831.)

c. Graduate students are normally expected to complete all core courses by the end of their second year of enrollment. Students who are required to complete an undergraduate physics certificate must be at an advanced undergraduate level (600-level KU courses). The certification must be achieved within 12 months (extension possible with recommendation of the graduate admission committee) of entering the program and may require additional coursework. Extensive Applied English Center (AEC) courses, prolonged illness, or extended military service might provide exceptional circumstances.

**Decision on Preliminary Candidacy**

Once Undergraduate requirements have been certified and sufficient information has been received regarding the required courses, the Graduate Committee will decide whether or not to admit the student to preliminary candidacy. This decision will be based upon the certification and on their core course GPA. The Graduate Committee Chair will report their decision to the Graduate Faculty.

**Course Requirements**

What follows are the default set of requirements for all Ph.D. candidates.

1. An undergraduate knowledge of physics. This must be certified by the department to be at an advanced undergraduate level (600-level KU courses). The certification must be achieved within 12 months (extension possible with recommendation of the graduate admission committee) of entering the program and may require additional coursework. Extension is possible with recommendation of the graduate admission committee. Certification can be achieved in several ways:
   a. A GRE physics score greater than or equal to 650; or
   b. THE DETERMINATION BY THE GRADUATE DIRECTOR AND GRADUATE ADVISOR, BASED ON the diagnostic exam given on entering the program combined with the student's undergraduate record, that the student understands all major elements of undergraduate physics; or
   c. Successful completion with grade of B or better on all undergraduate courses that the graduate director and/or advisor recommends based on the results of (2). The student who has not succeeded in certifying their undergraduate physics knowledge in 1 of the above 3 ways could, within 12 months of starting the program, petition the Graduate Committee for an oral exam on undergraduate physics. The oral exam will be administered by a committee of 6 faculty members assigned by the department.
   d. A candidate for a Master's or Ph.D. degree who has not had the equivalent of 6 credit hours of advanced undergraduate laboratory course work (Junior/Senior level) is required to take 1 of the 3 advanced laboratory courses offered in the Department.

2. Core courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>PHSX 711</td>
<td>Quantum Mechanics I</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 811</td>
<td>Quantum Mechanics II</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 821</td>
<td>Classical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 831</td>
<td>Electrodynamics I</td>
<td>3</td>
</tr>
</tbody>
</table>

3. Other required courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHSX 718</td>
<td>Mathematical Methods in Physical Sciences</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 815</td>
<td>Computational Methods in Physical Sciences (satisfies Research Skills requirement)</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 871</td>
<td>Statistical Physics I</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 931</td>
<td>Electrodynamics II</td>
<td>3</td>
</tr>
</tbody>
</table>

4. 2 additional PHSX lecture courses numbered 700 or above. This excludes PHSX 815 (computational physics) and PHSX 717 (graduate seminar). The 2 courses must be in different sub-fields of physics and they may not be used to simultaneously satisfy other degree requirements in force. (For example, if PHSX 911 is being used to satisfy the PHSX 811 core requirement, it may not also be used to satisfy the requirement for 2 lecture courses at the 700 level or above.)

5. 1 additional advanced PHSX lecture course (numbered 800 or above; excluding PHSX 815)

6. 1 credit hour of Colloquium is required (PHSX 700). See “Colloquium and Graduate Seminar for an explanation.”

7. All graduate students, after their first semester, will deliver at least 1 oral presentation per semester. See “Communication Skills” for an explanation.

The courses listed above comprise the Department course requirements common to all students except those pursuing a multi-disciplinary plan of study, which is described below. There is no foreign language requirement. Subsequent work, consisting of advanced courses in appropriate fields and seminars, will be selected by the student and the advisor on the basis of the student's need and intended field of specialization. There is no prescribed minimum number of hours for the Ph.D. degree. The student's dissertation committee will determine the adequacy of the student's courses and seminars and will specify the total course requirements. Neither the Graduate School nor the Department has a requirement for a minor.

Students who wish to pursue a more multidisciplinary plan of study may incorporate coursework from up to 2 other natural science, engineering, or mathematics (SEM) departments at KU by substituting non PHSX courses at the 600 level and above from these other disciplines for the 3 additional electives described in items c) and d) above. The research advisor, or in the absence of one, the Departmental Graduate Advisor (who is the default advisor for all students without a research advisor), shall approve all such outside course choices and provide documentation for the student file on the approved courses and their rationale.

Students who wish to take courses in the social sciences, humanities, or professional schools must submit a detailed plan of study that must be
**Suggested Course Schedule**

A sample academic schedule for a student who has a half-time teaching or research assistantship during the first 4 semesters is shown below. It includes the core courses for admission to preliminary candidacy (described in a subsequent section) and a set of lecture courses that meet the Ph.D. course requirements. It is the schedule for a full-time resident student with the normal preparation described above and who is working toward the Ph.D. degree. Students admitted with less preparation should begin with less advanced courses. Courses numbered 500 and above carry graduate credit.

The electives listed below, e.g. PHSX 741, PHSX 781, PHSX 795, PHSX 911, are purely an illustrative option. Students have the freedom to choose which non-required courses satisfy their elective requirements. Note that this sample schedule may also not apply for a student pursuing a more multidisciplinary plan of study.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PHSX 711</td>
<td>3</td>
<td>PHSX 811</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>PHSX 821</td>
<td>3</td>
<td>PHSX 815</td>
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<td>PHSX 717</td>
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<td>3</td>
</tr>
<tr>
<td></td>
<td>PHSX 702</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHSX 718</td>
<td>3</td>
<td></td>
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<td></td>
<td></td>
<td>11</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Year 2</td>
<td>Fall</td>
<td>Hours</td>
<td>Spring</td>
<td>Hours</td>
</tr>
<tr>
<td></td>
<td>PHSX 781</td>
<td>3</td>
<td>PHSX 741</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>PHSX 911</td>
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<td>PHSX 795</td>
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<tr>
<td></td>
<td>PHSX 931</td>
<td>3</td>
<td>PHSX 871</td>
<td>3</td>
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<td></td>
<td></td>
<td>9</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

**Total Hours: 38**

**Communication Skills**

All graduate students, after their first semester, will deliver at least 1 oral presentation per semester. The talk should be at least 20 minutes long. For students not yet associated with a research group, the Graduate Seminar can serve as a venue. For more advanced students the seminar of their research group would be a natural venue. The student does not need to be enrolled in the seminar to present a talk for this purpose. Off-campus venues such as collaboration meetings and physics conferences can also serve this purpose. When giving presentations, students should fill out a form available on the department web site and have it signed by 2 witnesses, 1 of which must be a Physics or Astronomy faculty and other a Ph.D. doing research in the department. The completed form must be handed to the office staff. Faculty members who sign off on the talks are expected to provide constructive feedback to the student. The graduate advisor will monitor student compliance with the requirement.

**Post-Comprehensive Requirements**

Upon passing the comprehensive examination, the student becomes a candidate for the Ph.D. degree. The Graduate Division will then designate the candidate's dissertation committee based on the recommendation of the Department. Each candidate must complete a research project that

and attend the graduate seminar (PHSX 717) in order to familiarize themselves with research programs in the Department and gain experience in oral presentations.

**Research Skills and Responsible Scholarship**

By the end of 1 year after being admitted to preliminary candidacy, the student must complete PHSX 815/ASTR 815, Computational Physics and Astronomy, with a grade of "B" or higher in order to satisfy the Research Skills requirement. Note that this course has significant prerequisites in undergraduate Computer Science. The Responsible Scholarship requirement is fulfilled via completion of PHSX 717.

**Computing Skill**

Students must complete PHSX 815 Computational Methods in Physical Sciences/ASTR 815 Computational Physics and Astronomy with a grade of A or B, preferably within 1 year after admission to preliminary candidacy. This course has significant prerequisites in advanced undergraduate computer science and requires completion of a substantial computer program to solve a physical problem.

**Note:** Contact your department or program for more information about research skills and responsible scholarship, and the current requirements for doctoral students. Current policies on Doctoral Research Skills and Responsible Scholarship are listed in the KU Policy Library.

**Comprehensive Examination**

Graduate College requirements for the Comprehensive Examination can be found at [https://documents.ku.edu/policies/Graduate_Studies/ doccomprehensiveorals.htm](https://documents.ku.edu/policies/Graduate_Studies/doccomprehensiveorals.htm).

After completing a major portion of the required course work and satisfying the computing skills requirement, the student must pass the comprehensive examination. The Department recommends at least 5 people for committee membership to the Graduate Division, which makes the final appointments. Committee members must come from outside of the Department to serve as a representative of the Graduate School. Requests to take the examination must be made to the Graduate Coordinator at least 3 weeks in advance of the date of the examination.

The student will write a 2000 to 4000 word paper on a topic in their chosen sub-field that is relevant to their thesis work. This paper must be presented to the committee at least 1 week in advance of the scheduled oral exam. The student will make a presentation at the oral examination based upon this paper, and will be examined on the contents of the talk, the paper, and works listed in the paper's bibliography. The bibliography must include at least 1 recent article from a peer-reviewed journal not authored by the student or the student's advisor. In addition, the committee may ask questions at the oral examination that cover the entire field of physics plus any related material (such as mathematics or chemistry) considered relevant by the examining committee.

In order to pass the comprehensive exam, the student must receive passing grades on both the written and oral components of the exam. The overall grade on this examination, determined by the examining committee, will be "Honors," "Satisfactory," or "Unsatisfactory."

**Note:** Students with a grade of A or B, preferably within 1 year after admission to preliminary candidacy, the student must complete PHSX 815/ASTR 815, Computational Physics and Astronomy with a grade of "B" or higher in order to satisfy the Research Skills requirement. Note that this course has significant prerequisites in undergraduate Computer Science. The Responsible Scholarship requirement is fulfilled via completion of PHSX 717.
has been approved by the committee. The committee establishes the candidate's course requirements and directs the research.

Unless granted a leave of absence, the candidate must be continuously enrolled full-time, including summer sessions, until all requirements for the degree are completed. During this time, the candidate must enroll in a minimum of 6 hours a semester and 3 hours a summer session until the completion of the degree or of 18 hours of post-comprehensive enrollment, whichever comes first. (Post-comprehensive enrollment may include the semester in which the comprehensive examination is passed.) After 18 hours of post-comprehensive enrollment, the candidate must continue to enroll each semester and each summer session until all requirements for the degree have been met. If the student petitions, they can enroll for only 1 hour of credit in spring, summer, and fall and still maintain their GTA or GRA status. For more information, see the Graduate Studies policy on GTA/GRA Certification of Eligibility to Enroll in Fewer than Six Hours (http://policy.ku.edu/graduate-studies/doctoral-GTA-eligibility-fewer-six-hours).

At least once each year after passing the comprehensive examination, the student should schedule a meeting with his or her dissertation committee to discuss progress towards the completion of the dissertation and any other concerns. A report of the committee's consensus of the meeting should be prepared by a member of the committee other than the student's advisor and placed in the student's file. Copies are to be given to the Departmental Chairman, the Graduate Committee Chair, the Graduate Advisor, the Departmental Director of Graduate Studies, and the student.

For more information, please view the Graduate Studies policy on post-comprehensive enrollment (http://policy.ku.edu/graduate-studies/doctoral-candidacy).

**Final Oral Examination**

The final oral examination will proceed according to the regulations of Graduate studies. These can be found at https://documents.ku.edu/policies/Graduate_Studies/docfinaloral.htm.

We refer to these requirements below, as they appeared on September 24, 2010, and we have inserted some modified requirements for those students who wish to pursue a more multidisciplinary dissertation topic.

It is the responsibility of the student to make sure that they satisfy the current university requirements.

Completion of the dissertation is the culminating academic phase of a doctoral program, climaxed by the final oral examination and defense of the dissertation. In all but the rarest cases, tentative approval of the dissertation is followed promptly by the final oral examination. When the completed dissertation has been accepted by the committee in final draft form, and all other degree requirements have been satisfied, the chair of the committee requests the Graduate Division to schedule the final oral examination. This request must be made in advance of the desired examination by at least the period specified by the Graduate Division (normally at least 3 weeks). The submission of the request must allow sufficient time to publicize the examination so that interested members of the university community may attend. At least 5 months must elapse between the successful completion of the comprehensive oral examination and the date of the final oral examination.

The committee for the final oral examination must consist of at least 5 members (the members of the dissertation committee plus other members of the Graduate Faculty recommended by the committee chair and the department and appointed by the Graduate Division). The Chair of the committee and 3 of the other 4 members must have appointments of some type within the Physics and Astronomy department. 1 member must be from a department other than the Physics and Astronomy department. The outside member represents Graduate Studies and must be a regular member of the Graduate Faculty. Before the examination, the Graduate Division provides a list of responsibilities to the Graduate Studies representative. The Graduate Studies representative is a voting member of the committee, has full right to participate in the examination, and provides a written report on any unsatisfactory or irregular aspects of the examination to the committee chair, department chair, Graduate Division, and Graduate Studies.

For students (and only those students) who are pursuing a multidisciplinary plan of study -- as defined by their substitution of courses from other departments for PHSX electives as described in the Course Requirements section -- up to 2 members of the committee, including the 1 required outside member, may be faculty from other SEM departments with regular, adjunct, or courtesy appointments at KU. The Chair must have an appointment of some type within the Physics and Astronomy department. (Exception: if the primary appointment of the Chair is outside the department, then only 1 additional committee member may be outside the Department of Physics and Astronomy.)

NOTE: It is assumed that these research projects may involve interaction between physics and 1 or more other SEM disciplines; therefore, the external faculty members may come from up to 2 different departments. The Graduate Division ascertains whether all other degree requirements have been met and if reports of any previously scheduled final oral examinations have been submitted and recorded. Upon approval of the request, the final oral examination is scheduled at the time and place designated by the Graduate Division. This information must be published in a news medium as prescribed by the Graduate Faculty. Interested members of the university community are encouraged to attend these examinations. For every scheduled final oral examination, the department reports to the Graduate Division a grade of Honors, Satisfactory, or Unsatisfactory for the candidate's performance. If an Unsatisfactory grade is reported, the candidate may be allowed to repeat the examination on the recommendation of the department.