

# CHEMISTRY - DOCTOR OF PHILOSOPHY (PHD)

The Department of Chemistry is internationally recognized for its research and education. As part of a commitment to continuing this tradition of excellence, the department provides a graduate program that integrates opportunities for cutting-edge creative research and study across a wide range of areas, including analytical, atmospheric, astrochemistry, biochemistry, biophysical, chemical physics, environmental, organic, materials and nanoscience, and physical chemistry.

Graduate students enjoy extensive scientific collaboration with chemistry faculty; with other departments, such as Physics, Biochemistry, Molecular, Cellular and Developmental Biology; and with research institutes and agencies, such as the Cooperative Institute for Research in Environmental Sciences (CIRES), Joint Institutes of Laboratory Astrophysics (JILA), the National Oceanic and Atmospheric Administration (NOAA), Renewable & Sustainable Energy Institute (RASEI), Laboratory for Atmospheric and Space Physics (LASP), and Materials Science and Engineering (MSE).

The coursework for this program is tailored to the individual student's research interests and needs. Although course offerings vary each year, approximately 40 graduate-level courses are offered annually, covering topics of important and contemporary interest in all areas of chemistry. Students are also given the chance to familiarize themselves with faculty research by attending seminars by faculty on their research and research group meetings, and by individual meetings with faculty members.

PhD program students complete a number of other requirements, including a Comprehensive Examination, which consists of a original Research Proposition, an Oral Examination, and a research proposal. Most students graduate with their PhD in approximately five to six years.

## Requirements

### Examination Requirements

Each PhD student is required to satisfy divisional preliminary examinations and pass a series of Comprehensive Examinations to be advanced to candidacy. The candidate must then pass a final thesis defense examination to be awarded the PhD degree. Interdisciplinary students should adhere to specific program requirements.

### Preliminary Examinations

The Graduate School requires that the department administer preliminary examinations in order to "satisfy itself (by examination or other means) that students who signify intent to undertake the PhD degree are qualified to do so." The format of the departmental preliminary examination of each student will be a responsibility of the division that admits them. The preliminary examination will be completed before the end of the second semester of study. Students will be required to follow the format of the preliminary examination of the division that admits them. Students who are uncertain of their division or who are considering an interdivisional major should consult the graduate advisor for advice on the preliminary examination requirement.

### Language Requirements

The Graduate School rules state that "a student who is noticeably deficient in the written and/or oral use of the English language cannot obtain an advanced degree from CU Boulder." The department assesses

the English language proficiency of each PhD student in the Oral Comprehensive Examination.

The department does not require proficiency in a foreign language for the PhD degree.

### Comprehensive Examinations

The comprehensive examinations are made up of three parts: a thesis research proposition, an oral examination and evaluation of a research proposal. The oral examination and the research proposition evaluation shall be conducted by a five-member examining board, according to the rules of the Graduate School. One member of this board shall be the student's research advisor, and one member shall be from outside the primary field of study of the student. The membership of this board shall be selected by the Graduate Advisor, in consultation with other faculty members as necessary. The comprehensive examinations are considered passed when the requirements of all parts have been met. Students must be registered during the semester that the comprehensive examinations are considered passed.

### Research Proposition

At least one week before the oral examination date, students will present a short thesis research proposition (approximately five pages) of their thesis research plan to each committee member. This overview will outline clearly the direction of the student's thesis, will provide the committee with some advance idea of the thesis research area and will describe promising research results (if any). Students might be asked at the time of the exam to describe and defend alternate experimental approaches to their research goals.

### Oral Comprehensive Examination

Students must take the Oral Comprehensive Examination no later than the end of the fourth semester. Master's degree students in this department who wish to continue for a PhD degree must take the Oral Examination no later than the end of the fifth semester even if they have not completed the master's degree.

This examination will include questioning on (i) the student's research, and (ii) general topics. Students are expected to demonstrate a clear understanding of their thesis research and fundamental knowledge in chemistry, and show the ability to think creatively. Students are strongly advised to spend time reviewing material from chemistry and biochemistry courses they have taken as undergraduates and graduates, since this material is often the subject of questioning during the examination.

The oral examination committee consists of three of the five faculty members appointed to the examining board selected by the Graduate Advisor. The student's research advisor, while a member of the examining board, may not be a member of this committee. The decision of this committee shall be determined by a simple majority of the members. The committee shall determine whether the student is capable of (a) PhD degree work, (b) master's degree work, or (c) no advanced degree work. The committee may require that the student repeat the examination, and/or may require the student to take additional courses. The committee may require that the student complete a thesis master's degree before continuing on to the PhD; in this case the committee will decide if it is necessary for the student to repeat the Oral Comprehensive examination at some time during the completion of the master's degree research. The committee may also require that a student complete a master's degree (thesis or coursework MS), and then leave the graduate program. As described in the Graduate School rules, students who fail the examination have the right to request a second attempt; in this case the student should contact the Graduate Scholastic Committee. Students are

responsible for arranging the examination date with their committee and should notify the graduate secretary two weeks prior to the scheduled date.

### Research Proposal

Each student shall submit a research proposal to the two members of the examination board who were not members of the oral examination committee. The proposal may have been submitted as part of a graduate fellowship application, may be written as a part of any graduate course in the department where written proposals are required, or may be written as a part of a group meeting activity. The proposal must obtain the approval of both the members of the research proposition committee. In the event of a dispute between the two members, the proposal will be referred to the full examination board for a decision.

Upon satisfactory completion of all three examination requirements, the five members of the examination board shall recommend the student for advancement to candidacy for the PhD degree.

### Final Examination

This examination is primarily a defense of the candidate's thesis. The examining committee consists of the student's thesis advisor as chair and four other faculty members, at least one of whom is rostered outside of the department. These committee members are selected by the graduate advisor upon request and after consultation with the student. The student must arrange for one of these other committee members to be the "second reader" of the thesis. The second reader will carefully review the thesis with the candidate. The student is responsible for arranging the date of the examination and notifying the Graduate Program Administrator at least two weeks prior to the date, and is responsible for distributing copies of the dissertation to the committee members — after it has been approved by the thesis advisor — at least two weeks before the examination. Failure to meet this latter deadline is a legitimate reason for any thesis committee member to postpone the examination.

## Course Requirements

### General Requirements

Sixty credit hours of courses are required, consisting of 30 hours of research in CHEM 8991, at least 15 hours in formal courses (see next section), and the remainder in other courses, such as summer courses, seminar courses, group meeting courses and research in CHEM 6901.

A minimum grade of B- is required in all courses counting for the PhD degree; students should also be aware that they must maintain a cumulative grade point average of 3.0 in all formal courses and an overall grade point average of 3.0, or they will be placed on academic probation. Students may also be placed on probation if they are not making satisfactory progress in their research. Probationary status must be removed within two semesters or a student will become ineligible to receive a PhD degree from the Department of Chemistry. Students on probation will not have a high priority for financial support.

A degree plan of courses taken and yet to be taken must be filed with the Graduate School by the end of the student's third semester.

### Selection of Formal Courses

All students will be required to take a minimum of 15 credit hours of formal courses. Formal courses are regularly scheduled, examined and graded; courses such as summer courses, seminar courses, group meeting courses and research in CHEM 6901 are not considered formal courses. Each student's program plan for coursework must be approved by the student's research advisor and the departmental graduate advisor.

These formal courses must be approved prior to the end of the second semester, and students are encouraged to complete formal course requirements within their first three semesters.

## Transfer of Credit

Up to 10 credit hours of graduate-level, formal coursework may be transferred from another higher education institution, subject to demonstrated proficiency in the subject(s) and written approval by the graduate advisor. Forms for this purpose can be obtained from the Graduate Program Administrator.

## Formal Application of Admission for Candidacy for the PhD Degree

All students must submit a formal application for admission to candidacy for the PhD degree by the end of the third semester on forms that can be obtained from the Graduate Program Administrator. This Graduate School requirement should be fulfilled even though students have not completed all their formal coursework. After filling in the form indicating graduate courses taken and to be taken, it should be approved and signed by the student's research advisor and then the graduate advisor.

PhD students shall have passed their Cumulative Exams and the Oral Comprehensive Examination before they may be admitted to candidacy for the PhD degree. Students should note that the approved research proposal must be filed in order for a student to be advanced to candidacy.

## Research Requirements

The results of a completed research program are submitted as a thesis for the final examination described above. Some students may pursue their PhD research in a laboratory outside of the department (e.g., JILA, NOAA, etc.) with the approval of the graduate advisor. In this case, the student must find a surrogate advisor in the department who agrees to monitor the activity of the student. It is recommended that meetings between the surrogate advisor, student and day-to-day advisor be frequent, perhaps in the form of a group meeting.

## Time Limit

Students should note the time limit specified in the Graduate School rules: "All doctoral students are expected to complete all degree requirements within six years from the date of the start of coursework in the program." Information on extensions is available in the Doctoral Degree Requirements (<https://catalog.colorado.edu/graduate/degree-requirements/doctoral-degree-requirements/#timelimittext>) section.

## Learning Outcomes

By the completion of the program, student will be able to:

- Demonstrate familiarity with the core theoretical frameworks utilized within the chemistry subdiscipline (PCHEM/ ANYL/ MN /ORG).
- Effectively engage with undergraduate students.
- Effectively communicate and present research to academic audiences in both written and oral form.
- Design and propose high-quality original research.