

Case Western Reserve University
Department of Chemistry

**INFORMATION FOR GRADUATE STUDENTS IN CHEMISTRY
2008-2009**

Preface

This booklet presents information of interest to graduate students in the Department of Chemistry. It is produced by the Committee on Graduate Affairs and revised annually. The Committee chairman would appreciate receiving suggestions for revisions of the booklet.

Questions not answered in this booklet should be directed to Ms. Zedeara Pratt, Academic Affairs, Clapp Hall 212, (216) 368-3621 (e-mail: zcd@case.edu).

The rules and regulations presented here are not meant to be inflexibly administered. Students may petition for waiver. Petitions must be in writing and should be submitted to the Graduate Affairs Committee via the Academic Affairs Office, Clapp Hall 212.

In addition to the material in this booklet, graduate students should become thoroughly familiar with the information and regulations published by the School of Graduate Studies in the General Bulletin of the University.

The Department Committee on Graduate Affairs for 2008-2009 consists of:

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INFORMATION FOR GRADUATE STUDENTS IN CHEMISTRY

A. GENERAL INFORMATION

The Chemistry Department offers graduate programs leading to the degrees of Master of Science and Doctor of Philosophy. Only full-time graduate students are admitted to the doctoral program and the Master's degree program with thesis. Graduate work may be carried out on a part-time basis for the Master's degree without thesis (course-work Master's). A course-work Master's degree program may be converted to a program for the doctorate or thesis Master's with the approval of the Chemistry Graduate Affairs Committee. Thesis research may be undertaken only by full-time graduate students.

For bulletins, rosters, and application forms for graduate study in Chemistry call or write

Academic Affairs
Department of Chemistry
Case Western Reserve University
Cleveland, OH 44106-7078
Telephone: (216) 368-3621
FAX: (216) 368-3006
e-mail: zcd@case.edu

1. Admission. Graduates with strong records (usually as chemistry majors) from universities and colleges of recognized standing are admitted selectively to graduate study in the Department of Chemistry. Applicants for admission are required to take the Verbal, Quantitative, and Advanced Chemistry Tests of the Graduate Record Examination. Information concerning these Examinations can be obtained from the Graduate Studies Office at Case Western Reserve University (216-368-4390), or the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey.

Applications for admission to graduate work in chemistry should be submitted at least several months in advance of the start of the semester in which the student expects to begin graduate study. See Section A-4 for information concerning application for graduate appointments carrying stipends.

2. Placement Examinations. Upon matriculation each entering graduate student takes three placement examinations covering undergraduate level subject matter in: 1) Inorganic Chemistry, 2) Organic Chemistry, and 3) Physical Chemistry. The grades on the placement examinations are not made a part of the student's transcript.

One purpose of these examinations is to evaluate a student's background and ability so that a program of graduate study can be planned to his or her best advantage. Depending on the outcome of the placement exams taken during the orientation period, students may enroll in advanced undergraduate (300 level) courses. Upon petition 300 level courses may be applied to course work requirements for graduate degrees in chemistry. The second purpose of these examinations is that it provides one mechanism for establishment of the departmental competency requirement (see Section B-2).

The three placement examinations, which are standardized American Chemical Society (ACS) examinations, are given during the week preceding the beginning of the academic semester in the Fall. The Department will issue an announcement concerning the date, time, and place of these examinations to all new graduate students before the start of the fall semester.

3. Tuition and Fees. See the General Bulletin of Case Western Reserve University for information on tuition and fees.

4. Appointments. First-year Chemistry Graduate Assistants receive a monthly stipend plus full tuition. Assistants are required to participate in the undergraduate instructional program to the extent of 6-8 contact hours per week. This assignment fulfills the departmental requirement of 12 contact hours of teaching for the Ph.D. degree.

Continuing Graduate Assistants with no mandatory teaching duties (i.e., those supported by grants or contracts) receive a monthly stipend plus full tuition.

Those continuing Graduate Assistants who are supported by the Department have teaching assignments of 9 contact hours per week. They receive a regular monthly stipend and full tuition.

For the summer months, June 1 through August 31, most students will hold research appointments. A few teaching appointments will also be available.

Stipends and tuition for Graduate Assistants will have federal, state and local taxes withheld. FICA taxes are also withheld for those not enrolled in a class.

Graduate students holding appointments in the Department shall not hold any other type of appointment or employment simultaneously on or off campus, or take courses at another college or university without the written permission of the Department. Requests for such permission should be directed to the Graduate Committee.

Ordinarily, the appointment for a graduate student that is administered by the Department may be renewed up to a maximum of four years provided the student's progress is satisfactory as judged on the basis of course grades, research, oral qualifying examination, cumulative examination scores, and how satisfactorily the student fulfills the teaching and/or research responsibilities of his appointment. Graduate students will usually be notified concerning the renewal of their appointments by May 1 of each year following the annual review of the progress of all graduate students (see Section A-14).

Graduate students with strong academic records are encouraged to apply for various fellowships which are available on a national competitive basis (e.g., National Science Foundation). The deadline for the submission of applications depends on the fellowship. Information concerning such fellowships can be obtained from the Department Office of Student Affairs.

5. Participation in Undergraduate Instruction. Teaching is an important part of graduate education. Therefore, all graduate students are required to assist in undergraduate instruction for a cumulative total of 12 contact hours as part of the requirement for the Ph.D. (A contact hour consists of one hour per week of teaching for a semester.) This Ph.D. requirement will usually be fulfilled by full-time graduate students during the first academic year of graduate study. Students who have done teaching in English at another university while working on a Master's degree may petition the Graduate Committee to waive up to 6 hours of this 12 hour requirement.

Graduate students will be informed by campus mail of their assignments in undergraduate instruction or related work. (If possible new graduate students will be informed by mail.) Graduate students are encouraged to indicate their preference of assignment on the Teaching Preference Form which will be sent out before the assignments are made.

The graduate student's performance in undergraduate instruction will be evaluated at the end of each semester by the faculty member responsible for the undergraduate activity. The evaluation is available to the student upon request and will be taken into account in making the annual awards (in the spring) to graduate students for outstanding contributions to undergraduate instruction.

Chemistry graduate students may participate as tutors in the University tutorial program for up to a maximum of 6 hours a week provided they have the approval of their research adviser, the instructor of the tutee's course, and the Department Chairman.

6. Schedule. Chemistry Graduate Assistants are limited to registration for 9 (or exceptionally 10) semester hours during the Fall and Spring semesters and one semester hour during the Summer Session. To be classified as a full-time student by the Graduate School, a student usually must be registered for at least 9 semester hours during each semester of the academic year and 6 hours during the summer.

7. Orientation Program for New Graduate Students. All full-time first-year graduate students are required to attend an orientation program which begins approximately one week before the start of fall-semester classes and includes the placement examinations (see Section A.2). Incoming students are notified of the orientation schedule by letter from the Department Chairman about one month in advance.

8. Course program. The graduate course program of the Chemistry Department follows the semester system in which the fall and spring semesters are each of 14 weeks length (excluding recesses) followed by a final examination period of one week.

During the Fall and Spring semesters of the first year, full-time chemistry graduate students will ordinarily take 10 semester hours of course work per semester selected from the following group:

Fall Semester

- Chem 406 Chemical Kinetics and Dynamics (3 credit hours)
- Chem 408 Advanced Physical Chemistry (3)
- Chem 410 Instrumental Analytical Chemistry (3)
- Chem 412 Advanced Inorganic Chemistry I (3)
- Chem 421 Advanced Organic Chemistry I (3)
- Chem 428 Introductory Biochemistry (3)
- Chem 435 Synthetic Methods in Organic Chemistry (3)
- Chem 446 Quantum Mechanics and Computational Chemistry (3)
- Chem 605 Chemistry Colloquium (1) (see Section A.9)

Spring Semester

- Chem 407 Chemical Thermodynamics and Statistical Thermodynamics (3)
- Chem 413 Advanced Inorganic Chemistry II (3)
- Chem 422 Advanced Organic Chemistry II (3)
- Chem 425 Physical Methods for Determining Organic Structure (3)
- Chem 429 Chemical Aspects of Living Systems (3)
- Chem 450 Molecular Spectroscopy (3)
- Chem 605 Chemistry Colloquium (1)

After the first academic year primary emphasis in graduate work for the Ph.D. is on research. Graduate students usually take one or two advanced graduate courses during each semester of the second year. Graduate students working for either the Ph.D. or Master's degree in the Chemistry Department usually do not take a minor outside the Department. They are encouraged to take courses in other departments when these courses are relevant to the students' professional interests and particularly their thesis research. However, four of their overall courses must be in the Chemistry Department. Course semester-hour requirements for the Master's degree are designated under Master's Degree Requirements. For the Ph.D. degree, students entering with a Master's degree need 23 coursework hours of which 12 must be letter graded; students entering with a Bachelor's degree need 36 coursework hours of which 24 must be letter graded. Chem 601 (Graduate Research) is a pass fail course and can be counted toward the total requirement of 23 or 36 coursework hours. Students then need 18 hours of Chem 701 (Graduate Research). Once Chem 701 is begun, the student must enroll for 701 until graduation.

9. Colloquia and Seminars. An important part of graduate study is attendance and participation in colloquia and seminars. The Chemistry Department Colloquium, listed as Chem 605 (1 semester-hour credit per semester) is held every week during the Fall and Spring semesters and includes the Frontiers in Chemistry Lectures which are held in place of the weekly Chemistry Colloquia over several weeks in the Fall and Spring semesters. Speakers in the colloquium series are chemists of national stature, mostly from outside the Cleveland area. All full-time first-year chemistry graduate students are required to register for Chem 605 during the Fall and Spring semesters and to attend the lectures. Chem 605 also includes a one-hour class meeting each week where the preceding and upcoming lectures are discussed. Whether registered or not, all graduate students are encouraged to attend colloquia. Graduate students are also encouraged to attend other lectures and seminars in areas of chemistry corresponding to their

fields of specialization. The colloquia and seminars also prove helpful to graduate students in preparing for the cumulative examinations. (See Section B.5.)

10. Registration for Research Work. Research may be undertaken with the approval of the graduate student's adviser (see Section A-11) under the listing Chem 601, Graduate Research or Chem 701, Ph.D. Dissertation Research.

Students pursuing a Master's degree with a thesis (Plan A) take Chem 651, Thesis (M.S.), but should keep in mind that semester-hours for Chem 651 cannot be credited toward a Master's degree with course work only (Plan B) (see M.S. Degree Requirements, Section C).

11. Advisers. Several faculty members, designated by the Department, serve as advisers for new full-time students and continue in this capacity until the selection of a faculty member as a research adviser has been approved by the Chemistry Graduate Committee and Department Chairman. The choice of a research adviser is extremely important and should be made only when a student has become well acquainted with the faculty and research work in progress in the Department. A booklet which describes faculty research interests is available. Following a series of brief research presentations by the faculty, first-year graduate students are required to interview at least five faculty members before indicating their preferences for research adviser. Each full-time first-year graduate student will then complete a Research Adviser Selection Form indicating his or her preferences of thesis adviser during November of his or her first year. The card must be signed by each faculty member with whom the student discusses research interests.

The Research Adviser Selection Form is obtained from the Chemistry Office of Academic Affairs (Clapp 212C) and should be returned to that office. The Chemistry Department Chair, considering the recommendations of the Chemistry Graduate Committee and Faculty at large, will give final approval to the selection of research advisers and normally notify the student of such by December 15, subject to approval by the faculty member selected as thesis adviser. The research adviser, once selected, is responsible for guidance in the student's selection of courses, in research, and in meeting degree requirements.

In situations where a chemistry graduate student selects a research adviser outside the Department of Chemistry (or if the adviser leaves the Department), the Chairman of the Ph.D. Dissertation Advisory Committee will play a more active role in guiding the student by means most appropriate to the particular situation. Several faculty members also serve as advisers to all part-time graduate students in matters of course selection and schedules.

An advanced graduate student who wishes to change research advisers will follow the same procedure used by a new student selecting their first adviser. The student should first meet with the Chair of the Graduate Affairs Committee or the Associate Chair of the department to explain the reason for requesting such change.

12. Research Notes and Data. All research notebooks and various forms of recorded data obtained as part of the thesis research are to be left with the thesis adviser upon termination of the research. Students are urged to make carbon copies of all notes and data which they may want to retain.

13. Grades and Quality Point Average. The following grades are used for courses for graduate credit:

A - Excellent	(4 quality points)
B - Good	(3 quality points)
C - Passing	(2 quality points)
D - Poor	(1 quality point)
F - Failure	(no credit toward degree)
P/NP (for 601)	(not counted in quality point average)
S - Satisfactory (for 651 or 701)	(not counted in quality point average)
U - Unsatisfactory (for 651 or 701)	(no credit toward degree)
IN - Incomplete	(no credit toward degree)
AD - Audit	(no credit toward degree)
W - Withdraw without grade	(no credit toward degree)
Z - Instructor did not turn in a grade	

CHEM 601 (Graduate Research) is assigned the grades of P (Pass) or NP (No Pass). CHEM 651 (Thesis - M.S.) and CHEM 701 (Dissertation Research) are assigned the grades of S (Satisfactory) or U (Unsatisfactory). (A letter grade is never given for CHEM 601, 651, or 701.) A grade of NP or U will result in a review of the student's work and the factors impeding his or her progress in thesis research in order to establish whether the prospects for completion of degree requirements justify continuation of a graduate appointment in the Department. This review will be conducted by the Department Graduate Committee with the help of the Ph.D. Oral Qualifying Committee and the thesis adviser, and will be carried out as soon as possible after the award of the unsatisfactory grade (usually one month).

The grade of I (Incomplete) may be given for a course when, in the opinion of the course instructor, there are valid reasons for the failure of a student to complete the work of a course before the end of the grading period. In order to receive credit for a course marked I, the student must complete the work by the date specified by the instructor but not later than the end of the next regular semester (Fall or Spring) in which the student is enrolled. If the student fails to remove the Incomplete within the specified time, he or she forfeits the privilege of completing the course for credit and the grade becomes a permanent I unless the instructor elects to give the grade of U.

The grade of W will be given if a student officially withdraws from a course two calendar weeks after the start of a semester. A student after consultation with the appropriate dean may withdraw from a course not later than the end of the 11th week of the semester and receive a grade of W. After this date, a student who withdraws from a course normally will receive a grade of F unless, in the judgment of the Dean of Graduate Studies, there are valid reasons for recording the grade of W. Students will be permitted to change their registration in a course from credit to audit (AD) only during the first two calendar weeks of the semester (the drop/add period). According to Graduate School rules, a student who receives a grade of U in CHEM 651 or 701 will be placed on probation and must remove himself/herself within one year to continue graduate study. Removal from probation will require repetition of the number of hours that received the U until the acceptable grade of S is attained.

The School of Graduate Studies and the Department of Chemistry set additional standards for the maintenance of good standing. Specifically, a student shall be separated from the University if he or she fails to achieve a grade-point average of at least 2.25 after one semester, 2.50 after two semesters, or 2.75 after four semesters of full-time graduate study (excluding summers).

In order to be awarded the degree of Master of Science, the University regulations require that a minimum quality point average of 2.75 be maintained. The requirement for the Ph.D. degree is 3.0.

14. Review of Student's Progress. The progress of graduate students who are encountering difficulty will be reviewed by the Department Graduate Committee. For students involved in thesis research and past their first year, the Department Graduate Committee will consult with the student's research adviser and the Chairman of the Ph.D. Dissertation Advisory Committee. If a student's progress is evaluated as unsatisfactory, he or she may be put on probation by action of the Chemistry Graduate Committee; this probationary status may carry a reduction in stipend. The student will receive a statement from the Department Graduate Committee as to the outcome of this evaluation if it involves his or her being put on probation.

In carrying out this evaluation, the Chairman of the Ph.D. Dissertation Advisory Committee, and in some instances the entire Committee, may wish to meet with the student, particularly in the case of students in their third year or longer of full-time graduate work in the Department.

15. Part-time Graduate Study in Chemistry. The following features of the graduate program in chemistry should be noted by part-time students:

- a. The Department accepts part-time students working for the Master's degree (Plan B, see Section C) but not for the doctorate. The first year of course work for the Master's and doctorate are essentially the same. Consequently, a graduate may start work on a part-time basis and then transfer to work for the Ph.D. upon approval by the Department.
- b. Research under Chem 601 (Graduate Research), Chem 651 (Th M.S.) and Chem 701 (Dissertation, Ph.D.) may be initiated only by full-time graduate students. Only the Master's degree under Plan B (course work only, see Section C) can be obtained entirely on a part-time basis.

B. REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is awarded to those students who demonstrate a mastery of subject matter at an advanced level and the ability to carry out original and fundamental research. The Master's degree is not a prerequisite, although some students choose to obtain this degree in the course of their doctorate work, particularly if their graduate study is likely to be interrupted. (See Section C, requirements for the Master of Science Degree.) Graduate students may start graduate course work in the Department as non-resident students and subsequently transfer to resident status to work for the Ph.D. upon approval by the Department Graduate Committee.

1. Time Requirements and Limitations on the Program of Study for the Ph.D. The rules of the Graduate School specify that ordinarily a minimum of three full academic years or the equivalent past the bachelors degree are required for the Ph.D. The time normally needed to complete the Ph.D. requirements in chemistry is four to five full years (including summers) starting from the baccalaureate level. The Graduate School ordinarily expects graduate students to take a minimum of 36 coursework credit hours. See Section B.3. regarding transfer of graduate course credit.

According to Graduate School rules, all requirements for the Ph.D. must be completed within a total period of five consecutive calendar years after a student is admitted to Candidacy (see Section B.3), including periods of leaves of absence. Students whose leaves of absence are for duty in the Armed Services, however, will have the time limitation extended by their period of service. A student who fails to complete the requirements within five years must be formally re-admitted as a full-standing student in order to continue his or her studies for the degree and must submit a petition to the Graduate School Council through the Graduate Dean for permission to do so.

2. Competency Requirements. All students must score a minimum of 70 percentile in the ACS standardized examinations in organic, inorganic, and physical (overall) chemistry, respectively. These exams are given during the first two days of orientation week in August. A different set of standardized exams will be given following the end of finals in the fall and in the spring. Alternatively, students may satisfy the competency requirement by scoring a B or better in a graduate level course in that area of chemistry. Students are expected to have demonstrated competency in all three areas of chemistry by the end of the first year, and cannot be considered for advancement to Ph.D. candidacy until they do so.

3. Course Distribution Requirement for the Ph.D. A minimum of 18 semester-hours of graded graduate course credit is a requirement for admission to Ph.D. Candidacy, as specified in Section B.5. Within or beyond this course work, each doctoral student is required to pass with a grade of A or B at least one approved graduate-level course each from three of the five chemistry areas listed below. Grades of A or B in courses taken to fulfill the competency requirement can simultaneously satisfy the distribution requirement. Of the graduate level lecture courses (a minimum of six) which must be taken for a grade, four of these must be chemistry department courses.

ORGANIC CHEMISTRY

CHEM 421 (Advanced Organic I)
CHEM 422 (Advanced Organic II)
CHEM 435 (Synthetic Methods)
CHEM 436 (Complex Molecular Synthesis)

PHYSICAL CHEMISTRY

CHEM 446 (Quantum Mechanics and Computation)
CHEM 406 (Kinetics and Dynamics)
CHEM 407 (Thermodynamics and Statistical Thermodynamics)
CHEM 408 (Advanced Physical Chemistry)

INORGANIC CHEMISTRY

CHEM 412 (Advanced Inorganic I)
CHEM 413 (Advanced Inorganic II)
CHEM 415 (Group Theory and Crystallography)
CHEM 502 (Metal Ions in Biological Systems)

CHEM 445 (Electrochemistry I)
CHEM 511 (Electrochemistry II)
CHEM 450 (Molecular Spectroscopy)

BIOLOGICAL CHEMISTRY

CHEM 428 (Introductory Biochemistry)
CHEM 429 (Chem.Aspects of Living Systems)
CHEM 430 (Adv. Methods in Structural Biology I)
BIOC 407 (Biochemistry)
BIOC 434 (Enzymes and Proteins)
BIOC 486 (Protein Structure & Folding)
BIOC 412 (Phys. Properties Biomacromol.)

ENGINEERING CHEMISTRY

ECHE 462 (Chemical Reaction Engineering)
ECHE 465 (Catalysis)
EMAC 470 (Polymer Synthesis)
EMAC 472 (Physical Chemistry of Polymers)
EMSE 401 (Transformation of Metals and Alloys)
EMSE 402 (Glassy State)

4. Transfer of Credit. Transfer of credit toward the doctorate is limited to graduate-level courses taken in excess of degree requirements at the other university and must be approved by the student's adviser, the Department Graduate Committee, and the Dean of Graduate Studies. Such courses must have been taken within five years of matriculation at Case Western Reserve University and passed with grades of B or better. No credit for the doctoral dissertation may be transferred from another university. All requests for transfer of credit should be made in writing to the Chairman of the Graduate Affairs Committee. Transfer of credit forms can be obtained in the Graduate Studies Office, 121 Baker Building.

5. Admission to Candidacy for the Ph.D. Admission to Candidacy signifies that the student has been judged intellectually qualified and basically prepared to earn the Ph.D. degree by completing a suitable research problem and writing a dissertation. In accordance with the regulations of the School of Graduate Studies, the decision of the Department to admit a student to Ph.D. candidacy is ordinarily made no later than one month after the completion of 36 semester-hours of graduate study, interpreted as 4 semesters (excluding summers) for full-time graduate students entering the Department with B.A. or B.S. degrees. The 36 semester hours must include at least 18 hours of formal course work (i.e., six 3-credit hour courses) and 2 hours of Colloquium.. A student denied admission to Candidacy may not undertake further study for the doctoral degree in the Department of Chemistry. Such a student may continue studies toward the M.S. degree with the recommendation of the Qualifying Oral Examination Committee and the Dean of Graduate Studies.

The following requirements must be satisfied for a student to be admitted to Ph.D. Candidacy in Chemistry: (1) an unconditional grade of Pass on the Ph.D. Qualifying Oral Examination, (2) the acquisition of at least 5 points on Cumulative Examinations, (3) a cumulative grade-point average for at least 18 semester-hours of graduate-level formal classroom courses of 2.75 or above, and (4) satisfaction of competency and course distribution requirements. Grades in Chem 507, 508 (Special Readings in Chemistry) are not counted toward requirement (3). Students may be enrolled in Chem 701 (dissertation, Ph.D.) before being advanced to candidacy.)

For students entering the Department with an M.S. degree, or equivalent, approved by the Graduate Committee, advancement to Ph.D. candidacy can come as early as the third semester in the department. At least 23 credit hours of course work must be taken, of which no more than 3 can be CHEM 601.

(After completion of 36 hours for those entering with a B.S./B.A. degree and 23 hours for those entering with a Master's degree, the student is required to complete 18 hours of CHEM 701 (research).

Please Note: the candidate for the Ph.D. degree must be enrolled in the semester in which he/she is to receive the degree.)

When a student has passed the Ph.D. Qualifying Oral Examination, the Examination Committee makes a prompt recommendation concerning Candidacy to the Graduate Affairs Committee. This recommendation is based on the student's satisfaction of requirements (2), (3) and (4) above, the student's performance to date in research, and an overall evaluation of the student's potential to complete a doctoral research program and the other requirements for the Ph.D. The decision on admission to Candidacy is made by the Graduate Affairs Committee, ordinarily in accord with the recommendation of the Qualifying Oral Examination Committee. Written notice of admission to Candidacy is sent promptly to the Dean of Graduate Studies and to the student by the Graduate Affairs Committee.

6. Ph.D. Qualifying Oral Examination. The Ph.D. qualifying oral examination shall determine if the student has achieved real understanding of the research problem and the strategy to be used in attacking it. In examining these qualities the Qualifying Oral Committee should also be sensitive to any general strengths and weaknesses in chemistry. It is desirable for the student's thesis adviser to be present at this examination, but he does not participate in it.

a. Content of examination. The examination is based on a presentation of the student's planned thesis project. Questioning by the Committee will focus on this project and the chemistry related to it. However, the student is expected to have breadth and depth of preparation in the chemical sciences in general, and questions related to all areas of chemistry will be possible.

The student is first given approximately 20 minutes to present the purpose and strategy of his or her research. In this presentation, details of methods used and research already completed should not be emphasized. The Committee will then question the student concerning the thesis problem.

A written summary of the student's thesis proposal, not more than about 1000 words in length (4-5 double-spaced pages) and including key literature references, should generally be organized along the lines of the following three components: Specific Aims, Background and Significance, and Research Design and Methods.

Specific Aims: Briefly describe what the proposed research is intended to accomplish and any hypotheses to be tested.

Background and Significance: Briefly sketch the background to the proposal, critically evaluating the limitations of existing knowledge that justify conduct of the proposed research.

Research Design and Methods: Describe the research design and the procedures to be used to accomplish the specific aims of the project. Potential pitfalls and safety concerns are issues which may be important to note.

This written summary is to be distributed to each of the committee members at least two weeks before the scheduled examination. Within the first week, faculty committee members have the opportunity to provide written notification to the student (within reason) of some particular component of the proposal, not mentioned in the written summary, that they would like to see the student discuss at the oral exam.

The adviser is expected to provide significant guidance to the student regarding development of the thesis proposal, including attendance at a "rehearsal".

- b. Criteria for evaluation of the oral examination. The Ph.D. Qualifying Oral Committee is responsible for deciding by majority vote whether the student has passed or failed the oral examination. The criteria for this decision are the soundness of the student's written and spoken presentation of the thesis research problem, and the strength of his or her response to questions asked in this area or on other subjects in chemistry, if the discussion should reveal these to be important. The focus in all cases is on the level of the student's actual understanding. The Committee's decision on the oral examination performance will be made independently of the student's record otherwise as a graduate student. Course grades, cumulative examination scores, and research achievements not related to thesis research are considered separately in the Ph.D. candidacy decision which follows if the student is judged as having passed the oral examination. If the passing grade is given for the oral examination, the Committee proceeds to consider admission of the student to candidacy for the Ph.D. degree, as described above. If the failing grade is given, the student is ineligible for candidacy. The student is entitled to repeat the oral examination a second time, generally 2-4 months later, but not later than compatible with the time limits set by the Graduate School for the decision as to admission to Candidacy (end of the second academic year; see Section B.3, Admission to Candidacy for the Ph.D.).
- c. Report on Ph.D. Qualifying Oral Examinations: The chairman will ordinarily inform the student immediately and informally of the committee's decision regarding the oral examination. If the judgment is adverse, the chairman will briefly explain why. The chairman then will submit a formal written report to the Graduate Committee on the results of the oral examination with copies to the student and the research adviser. If the failing grade is given on the first attempt, the formal report on the oral examination will provide a detailed assessment of the student's strengths and weaknesses and suggestions for remedial work.
- d. Appointment of Ph.D. Qualifying Oral Committees: Three chemistry faculty members are appointed by the Department Graduate Committee for each graduate student following the second semester after his or her admission to full-time graduate work in the Department. One of the three will be designated as chairman. The thesis adviser is not a member of the Qualifying Oral Committee. In appointing this committee, the Department Graduate Committee will ordinarily attempt to select two members with competence in an area reasonably close to the thesis problem of the student and the third usually in a less closely related area. These will normally be Chemistry faculty members, but the Graduate Committee may approve at most one CWRU faculty member outside the Chemistry Department as a member of the committee (not the chair). In the event of a repeat of the Ph.D. Qualifying Oral Examination following failure of the first attempt, the Department Graduate Committee will consider restructuring the Qualifying Oral Committee upon petition by the student.

- e. Scheduling of the Ph.D. Qualifying Oral Examination: The examination must be taken during the first semester of the second year of graduate study in the Department for full-time students who entered without prior graduate work in chemistry. It is recommended that the Qualifying Oral Examination be taken during the month of October, with the latest possible date being the day prior to the start of final exams. For graduate students who entered with prior graduate work, who started their graduate work on a part-time basis, or who entered the graduate program at a non-standard time of the year, the Department Graduate Committee will fix a date after consultation with the thesis adviser, Qualifying Oral Committee chairman, and the student. Students should stop in at the Department Office of Academic Affairs beginning August 1 to indicate their preference of dates for the Ph.D. Qualifying Oral Examination. Exams must be scheduled not later than October 15. If a student fails to schedule his or her examination to be held during the prescribed period, the examination will be scheduled by the Graduate Committee.
- f. Disputes regarding any of the above will be heard by the Graduate Committee Chair.

7. Cumulative Examinations. Cumulative exams are offered each month (except May and December). Examinations are given simultaneously in three different areas of chemistry. The student may attempt any or all of the examinations. The questions are typically based on the ability of the student to comprehend the essence of contemporary chemical literature selections.

The topics of the examinations together with leading literature references will be announced one month in advance. Not more than two weeks following each cumulative examination, the examiner will offer a brief review session on the exam questions at a time and place announced at the time of the examination. Each examination will be graded on the basis of 0 to 2 points with 1 point for an acceptable performance and 2 points for an excellent performance.

Each student must accumulate 10 points to fulfill the Ph.D. requirement. Students are expected to complete this requirement by the end of their second year of graduate study in the Department (August). Any student not finished by this time will be expected to take a cume exam each month to ensure completion of the 10 point requirement by the end of their third year. Progress of the student will be monitored, and absence from a cume exam will trigger a meeting with the student's thesis committee as well as documentation in the student's departmental record.

The faculty member appointed to organize the cumulative examinations reviews the program's guidelines, selects examiners and topics, and monitors the examinations and the resultant points awarded.

8. Annual Meeting of Student with Committee Chair

Advanced Ph.D. students (third-year and beyond) meet with their oral committee chair once a year. In most cases, the meeting will simply be a chance for the student to display his/her research progress to the committee chair, and generally stay in touch. It is also a chance for anyone involved (student, advisor, committee chair) to bring up any problems that seem to have arisen, or might be expected in the future, and take appropriate steps. The procedure is as follows:

The student will prepare a summary (not more than one page) of research progress, and give it to his/her advisor. Advisors will either sign off "satisfactory progress" or note any problems. The form will then be passed on to committee chairs via the Academic Affairs Office. The student will then schedule a meeting with the committee chair. If no problems are apparent, the student and chair will both sign the form and return it to the Academic Affairs Office. If the student or chair perceives problems, the chair will call a meeting of the full committee and the student (with or without the advisor, as appropriate) where the problems will be addressed.

9. Ph.D. Research and Dissertation. Each candidate for the doctorate must submit a dissertation as evidence of ability to conduct research at an advanced level. The dissertation must present a significant contribution to knowledge in chemistry and at least part should be suitable for publication as a full-length article in a recognized journal. The dissertation is based on original laboratory and/or theoretical research carried out by the student. Each student must prepare his or her own dissertation; joint dissertations are not permitted.

Instructions for the form of the dissertation should be obtained from the Office of the Dean of Graduate Studies (Room 117, Baker Bldg.). An abstract is to be included with the doctoral dissertation.

A minimum of 3 copies on bond paper are required (in addition to the above 4 and the student's copy). The original and one copy are given to the University for the University Library, and the third copy should be bound and given to the adviser. If the student's research is supported by a grant or fellowship from a non-University source, an additional copy of the dissertation is usually required. The final typed dissertation must be approved and accepted by the Office of the Dean of Graduate Studies not later than one month before the Commencement at which the degree will be granted. The cost of typing, preparing and reproducing all copies (including bindery charge) is the responsibility of the graduate student.

The Graduate School requires that the student guarantee the reproduction of his/her dissertation through University Microfilms, Ann Arbor, Michigan, before he/she can be certified for the doctorate. All dissertations are considered public documents upon acceptance by the Graduate School.

10. Research Plan for Industrial Leave of Absence Students. Every graduate student who intends to take a leave of absence from an employer in order to spend the minimum of 12 months in residency for the Ph.D. degree must present a detailed plan for that period to his or her oral committee for its approval prior to fixing the date for his or her residency period. This plan must contain realistic identification of how all remaining Ph.D. requirements are to be met within the one year of residency.

11. Final Oral Examination. This examination is a public defense of the Ph.D. dissertation. The Final Ph.D. Oral Examination Committee consists of at least five CWRU faculty members, including at least three with primary Chemistry appointments, at least four with appointments (primary or secondary) in Chemistry, and at least one with a primary appointment in another department. It includes the three members of the Qualifying Oral Committee and the graduate student's thesis advisor. The chair of the Qualifying Oral Committee will become the chair of the Final Ph.D. Oral Committee. Persons who are not members of the University faculty may serve as additional non-voting members of the committee. The selection of the required faculty member from another department is to be made by the student's research adviser and/or the Qualifying Oral Committee chairman, after consultation with the student. Selection of the out-of-department member should be done 3 to 6 months in advance of the Final Oral Examination.

The student must file with the Department Office of Student Affairs a copy of notification for scheduling the Final Oral Examination at least 3 weeks in advance of the examination. The student will then post an announcement of the exam.

Ten days prior to the scheduled defense, the student must give a finished copy of his or her thesis to each committee member. This copy must be accompanied by a signed, dated statement from the thesis advisor which acknowledges that the advisor has completed a thorough reading of the thesis and that all suggested changes have been incorporated into it.

The objective of the thesis defense is to determine if (i) the conclusions drawn are consistent with the research results, (ii) the thesis work constitutes a significant contribution to science that merits the award of the Ph.D. degree, and (iii) the thesis meets the structural requirements of the Graduate School.

The actual defense will consist of both an open and a closed session. The open session will begin with an approximately 45 min seminar-style presentation by the candidate. Following a question-answer period dealing with scientific issues of general interest, the committee members will question the candidate on other matters which the members believe would benefit from public airing.

At the completion of the open examination period, the committee chair will ask remaining members of the audience to excuse themselves. The closed session will consist of further scientific questions for the candidate, a discussion of any major organizational concerns about the thesis, as well as a private discussion of the candidate's performance (in the candidate's absence). The student will be certified as passing the Final Oral Examination if not more than one member of the committee dissents. The student may need to meet individually with one or more committee members after the thesis defense to obtain clarification of stylistic or minor organizational concerns.

Required thesis corrections should be indicated in the committee member's copy and provided to the student at the final defense. Any additional required alterations must be provided to the student in writing within 48 hours of the defense. Supervision of the thesis corrections will in general be the responsibility of the thesis advisor, who will notify the committee members in writing that the thesis has been properly corrected by the date set by the committee, normally within one month from the date of the final defense. At the completion of the exam, if the student is judged to have passed the final defense, each consenting committee member will sign the two white approval cards and the two thesis cover pages, unless there are substantive scientific concerns. In the latter event, faculty may withhold their signature to indicate their requirement to review the revised thesis. In this case, faculty should notify the student in writing of their approval of the thesis corrections as soon as possible, and in any case within 10 days of receipt of the corrected thesis.

12. Application and Fees for Graduation. The graduate student must file an application in person in the Graduate School Office (6th Floor, Nord Bldg.) at least two months in advance of the Commencement at which he expects to receive the Ph.D. The student should consult the Bulletin of the Graduate School or the Graduate School Office for information concerning graduation fees and registration in the semester in which the Final Oral Examination occurs.

C. REQUIREMENTS FOR THE MASTER OF SCIENCE (See University General Bulletin)

The Master of Science may be obtained under Plan A (course work and thesis) or Plan B (course work only). While work towards a Master's degree may be started under either plan on a part-time basis, only under Plan B can this degree be earned entirely on a part-time basis, since thesis research for the Master's degree can be undertaken only by full-time graduate students.

1. Time Limitation and Continuity of Registration Requirement. A student who interrupts his or her work for the Master's degree (i.e., does not register) for one or more semesters during the academic year should obtain a leave of absence from the Dean of Graduate Studies. Graduate School rules specify that except for work interrupted by military service, all requirements for the Master's degree must be completed within a total period of five consecutive calendar years including periods of leave of absence. A student who fails to complete the requirements within five years must be formally readmitted as a full-standing student in order to continue his or her studies for the degree. Courses taken more than five years prior to matriculation cannot normally be counted towards this degree.

2. Transfer of Credit. Transfer of credit from another university for the Master's degree is limited to 6 semester-hours of graduate-level courses taken in excess of degree requirements at the other university and must be approved by the student's adviser, the Chemistry Graduate Committee, and the Dean of Graduate Studies. Such courses must have been taken within five years of matriculation at Case Western Reserve University and passed with grades of B or better. Credits for research at another university cannot be transferred.

3. Plan A (Course work plus Thesis).

- a. Credits: The minimum requirement for the Master's degree under plan A is 27 semester-hours including at least 18 semester-hours of courses and credit-carrying colloquium and at least a total of 6 semester-hours of Chem 651 (Thesis, M.S.). At least 12 semester-hours of the 18 for courses and colloquia must be obtained at CWRU. The program during the first academic year is as indicated under Section A.8. In addition, up to 6 semester-hours of advanced undergraduate courses (Chem 300 courses) may be counted towards the course credit hour requirement.
- b. Thesis: Each student must prepare a thesis based on experimental and/or theoretical work of an original nature. The number of copies required and the regulations concerning form and time of submission are the same as for the doctoral dissertation. According to Graduate School rules, a graduate student must be registered for not less than 3 semester-hours in courses, research, or thesis during the semester in which the Final Oral Examination occurs.
- c. Final Oral Examination: This examination involves a defense of the Master's Thesis. If the student does not have a Ph.D. Qualifying Oral Committee, then the Chemistry Graduate Committee will appoint a Master's Thesis Examination Committee consisting of three Chemistry faculty plus the research adviser and will designate one of these three faculty members as chairman (other than the research adviser). If the student has a Ph.D. Qualifying Oral Committee, then this committee, plus the Master's thesis research adviser, will constitute the Master's Thesis Examination Committee. The agreement of three of the four members of the examination committee is required for passing the thesis examination.

4. Plan B (Course Work Only).

- a. Credits: The minimum requirement under Plan B is a total of 27 semester-hours, of which at least 21 must be earned at Case Western Reserve University. Of the 27 semester-hours, at least 18 must correspond to formal graduate courses. The remaining semester-hours may consist of Chem 605 (Department Colloquium), Chem 601 (Graduate Research), Chem 507, 508 (Special Readings), and up to 6 semester-hours of advanced undergraduate courses (300 level courses).
- b. Special Readings and Research: The Department requires for the Master's Degree under Plan B either of the following:
 1. Three semester-hours of Chem 507, 508 (Special Readings) with a report to be submitted to the Department Office of Student Affairs.
 2. Three semester-hours of Chem 601 (Graduate Research) with a resume to be submitted to the Department Office of Student Affairs.

In either case the report or the resume will be evaluated by the faculty member supervising the special readings or graduate research and designated as acceptable or unacceptable.

- c. Comprehensive Examination: Each candidate for the Master's degree under Plan B must pass a comprehensive written examination to be given no later than three weeks in advance of the commencement at which the student expects to receive the Master's degree. This examination will be three hours in length and consist of questions in the areas of organic, inorganic, and physical chemistry, reflecting the courses normally taken by graduate students during their first year. The examination will be prepared by the Chemistry Graduate Committee. If the student has either passed the Ph.D. Qualifying Oral Examination or acquired 8 points on the Ph.D. Cumulative Examinations, he or she will be considered as having met the comprehensive examination requirement for the Master's degree under Plan B and need not take the written comprehensive examination.
- d. Part-time graduate study (see Section A.15). Part-time graduate students working for a degree under Plan B are urged but not required to study full-time for at least one semester.

Part-time graduate students who are unable to obtain a leave of absence from their regular employment for one semester can complete all requirements for the Master's degree on a part-time basis. A reasonable schedule would consist of 4 semester-hours (one course plus Chem 605, Department Colloquium) for the first fall and spring semesters plus at least three semester-hours of Chem 507 (Special Readings) and additional courses in later semesters and summer sessions, yielding a total of 27 semester-hours.

D. SUMMARY OF CRITICAL DATES FOR 2008-2009
See: <http://www.case.edu/provost/registrar/registrar.html>.

E. GRADUATE STUDENT ASSOCIATION

The Graduate Student Association of the Department of Chemistry is devoted to the development and maintenance of effective communication between the faculty and the graduate student body. The Association strives for the continued enhancement of contact at all levels, social as well as professional between faculty members and graduate students. It is the purpose of the association to promote such a relationship between the faculty and graduate student body as will be most conducive to the greatest educational and scientific benefit of all. Membership in the Association is open to all Chemistry graduate students.

Activities of the Association include the following:

1. Nomination of graduate students to be members of the Department Graduate Committee, Undergraduate Committee, Admissions Committee, and various *ad hoc* department committees, and to represent the graduate students at faculty meetings.
2. Arrangement of social events.

Students requiring information regarding housing, departmental procedures, etc., may obtain advice by contacting a member of the G.S.A. by phone or by mail, in care of the Department of Chemistry, CWRU.

F. PROCEDURAL AND OTHER MATTERS

1. Keys. Graduate students must obtain a note from their research adviser requesting issuance of a key to the rooms for which they need access. This note plus a deposit of \$35 should be given to Mr. Jim Sill (Department Administrator) who will issue a key request form. (The deposit is returned when keys are returned.) All keys must be picked up by the individual requestor at the Security Office (Crawford 18). At the termination of appointment, these keys must be returned to the same office. If a key is lost, please report it immediately to the Security Office (x3333). A fee will be charged to replace a lost key. If a student fails to turn in any key, a hold will be placed on that student's transcript until the key is returned or a lost key charge is paid.

2. Ordering Equipment and Supplies. Orders are written out on a departmental order form and must be signed by the faculty research adviser or the faculty member responsible for the laboratory requiring the equipment or supplies. These forms are then submitted to the Department Financial Office (Clapp Hall 212) for processing. Usually at least two weeks are required to receive supplies after placing an order. Purchased supplies and equipment are delivered to the laboratories usually once a day. In emergency situations, requisitions must be hand carried to the Purchasing Department for a P.O. number, and items available in the Cleveland area may then be picked up by the graduate student.

3. Obtaining Supplies from the Fisher Stockroom. Supplies and minor equipment can be obtained from the Fisher Stockroom (Room G28, Millis Science Center). The faculty research adviser or faculty member responsible for the undergraduate laboratory must indicate to the graduate student the account number which should be charged. He must also file with the Department Office authorization for the graduate student to make such charges. The Department Stockroom is closed to graduate students except when stockroom personnel are on hand. The hours of the stockroom are:

Monday through Friday: 8:30 - 12:00 and 1:00 - 4:30
Closed on holidays, Saturdays and Sundays

4. Machine Shop and Electronic Store. The services of machinists and electronic technicians are available for the construction and repair of certain equipment. The Machine Shop is located in Room 107, Olin Building and the Electronics Store is in Glennan 309. Graduate students seeking the use of these shops must obtain an account number from their faculty member and have the requisition order signed by the Department Administrator (James Sill). Jobs requiring more than 30 minutes must be authorized in advance by the faculty member. Jobs are usually done in the order received, but personnel may use their own discretion in handling very short jobs and emergency repair work. For any machine shop work requiring new construction, relatively complete advance drawings are required. Students and faculty who are undertaking the design of relatively complex equipment requiring much shop time are urged to check with the head of the Machine Shop while the equipment is still in the design stage. The shop personnel will assist in the ordering of any materials and construction or components which they do not stock. The Electronic Stores carries small electronic equipment and batteries.

5. Photographic Services. The University maintains an interdepartmental photographic service and a slide preparation service in Room WG-60 of the Medical School. To use these services, a Department Order Form must be filled out and signed by a faculty member with an account number indicated and then signed by the Department Administrator in Clapp Hall 212. Drafting and art work are also performed by the Educational Media Department. A number of individuals on campus also perform such services, including photography.

6. Computers. Macs, PC's, a scanner and printers are available in the Frank Hovorka Information Center, Millis 200N. Software to aid in library searches is also available.

7. Copying-Reproduction Facilities. Copying and reproducing services are available within the Department in Clapp Hall. These facilities are available only for Department business. Graduate students needing such services in conjunction with undergraduate instruction or other Department business should request such through a faculty member.

8. Library Facilities. Kent Smith Library and Health Center Library (Medical School) have extensive chemistry collections and are available for use by graduate students.

Hours and phone numbers for all University Libraries are listed on the CWRU Website (www.CWRU.edu).

9. Telephones. The telephones are on the Centrex system and give direct access to outside lines. The last four numbers correspond to the University extension. To obtain inside phones, you must dial 368-XXXX. To dial outside numbers, dial first 9, then the outside number. Under no circumstances are long distance calls or toll calls to be made by graduate students without prior authorization from a faculty member. A written record must be kept for each long distance call on a form supplied by the faculty member. These forms must be turned in to the Departmental Financial Office (Room 206).

10. Emergencies. In emergencies during daytime hours dial the numbers listed below. Between 4:30 p.m. and 12:00 midnight Monday through Friday and between 7:45 a.m. and midnight Saturday, Sunday and holidays, telephone the University operator (dial O) and carefully state the emergency, where it is, and the type of assistance needed. After midnight until 7:45 a.m. if unable to obtain the University operator, telephone 368-3333, or:

Fire:	368-3333
Police: University Circle:	368-2222
Major injuries/illness:	368-2222 (requiring transportation)
Medical Services	368-2450
Chemical Spills	368-2907
County Emergency System	9-911 (inside campus phone only)
Building Maintenance:	368-2580
(Plumbing, electricity, ventilation):	

Also report all emergencies as soon as possible to your faculty adviser.

11. Stipend Checks: These are issued electronically on the last working day of the month. You may view your check deposit at www.case.edu/erp/hcm.
12. Mail. Mailboxes are provided for graduate students in the hallway outside of the Chemistry Department Administrative Office in Clapp Hall. Inside each door is a list of assigned boxes.
13. Vacations and Leaves. Starting at the time students are assigned to research groups (early December), students are entitled to two weeks of paid vacation plus all University holidays. Students must inform their advisers of planned time off well in advance. In special circumstances requiring longer times off, students may arrange an unpaid leave of absence in consultation with their advisor. Extended leaves of absences require notification of the Graduate Affairs Committee and/or Associate Chair.
14. Parking Lots. All parking facilities in the University Circle are under the control of University Circle, Inc. To obtain a parking permit, graduate students should visit Parking, Crawford 18, but should first have a valid Graduate Student Identification.
15. Safety Glasses. Safety glasses are available for all students. If prescription glasses are needed, the Department will pay for them. A form must be obtained from Mr. Sill.
16. Housing for Graduate Students. Incoming students are advised to contact one of the members of the G.S.A. for advice regarding housing in the University area. Brochures describing dormitory facilities are available from the On Campus Housing Office located in Yost Hall (x3780). In addition, the University maintains a Housing Bureau to assist students and University staff in finding apartments and houses. This is located in the Off-Campus Housing Bureau in Yost Hall (x3780).
17. The International Student Services. This office located in room 210 Sears (x2517) offers assistance to foreign students.
18. Health Care Programs. The University offers a comprehensive health care program which includes clinical services as well as insurance for a fee. The student is billed individually for this charge which is about \$437 per semester. (This is not covered by the graduate assistantship.) Students must pay this fee unless they can prove that they are covered by another plan. If a student has a plan other than that offered by CWRU, the student must fill out a health fee waiver. This is done by filling out the

form available in Student Accounts Receivable Office (Yost 115). The University plan does not include maternity benefits. Students with dependents may elect additional coverage for a spouse or for spouse and children.

19. Employment Service. The University maintains a Placement Office to assist students in finding positions. Throughout the year, but particularly in the fall, many companies visit the campus to interview graduate students for research positions. Graduate students who will be seeking industrial positions are urged to contact the Placement Office at least one year in advance of the anticipated graduation date. Academic positions and postdoctoral appointments are usually arranged with the help of faculty members, particularly the thesis research adviser.

G. LIST OF OFFICE AND SERVICE LOCATIONS.

	<u>Room</u>	<u>Building</u>	<u>Telephone</u>
Chair, Chemistry Department	208	Clapp Hall	368-3622
Associate Chairman, Chemistry Department	207	Clapp Hall	368-5099
Chairman, Chemistry Graduate Committee	G22A	Millis	368-3712
Department Main Number	212	Clapp Hall	368-3620
Academic Affairs	212	Clapp Hall	368-3621
Stockroom, Fisher	G28	Millis	368-3597
Machine Shop	207	Olin	368-4019
Electronic Store	309	Glennan	368-4074
Graduate School & Dean of Grad Studies	6 th Fl.	Nord	368-4400
University Career Planning & Placement	304	Sears	368-4446
University Health Service (24 hour Emergency) Clinic Appointments	2145	Adelbert Rd.	368-2450 368-4539
University Housing Bureau (On- or Off-Campus)	115	Yost Hall	368-3780
International Student Services	210	Sears	368-2517
University Circle Parking Authority Parking Assignments	12100 Euclid Ave. Crawford 18		368-3228 368-2724
EMERGENCIES			368-3333
SECURITY			368-3333