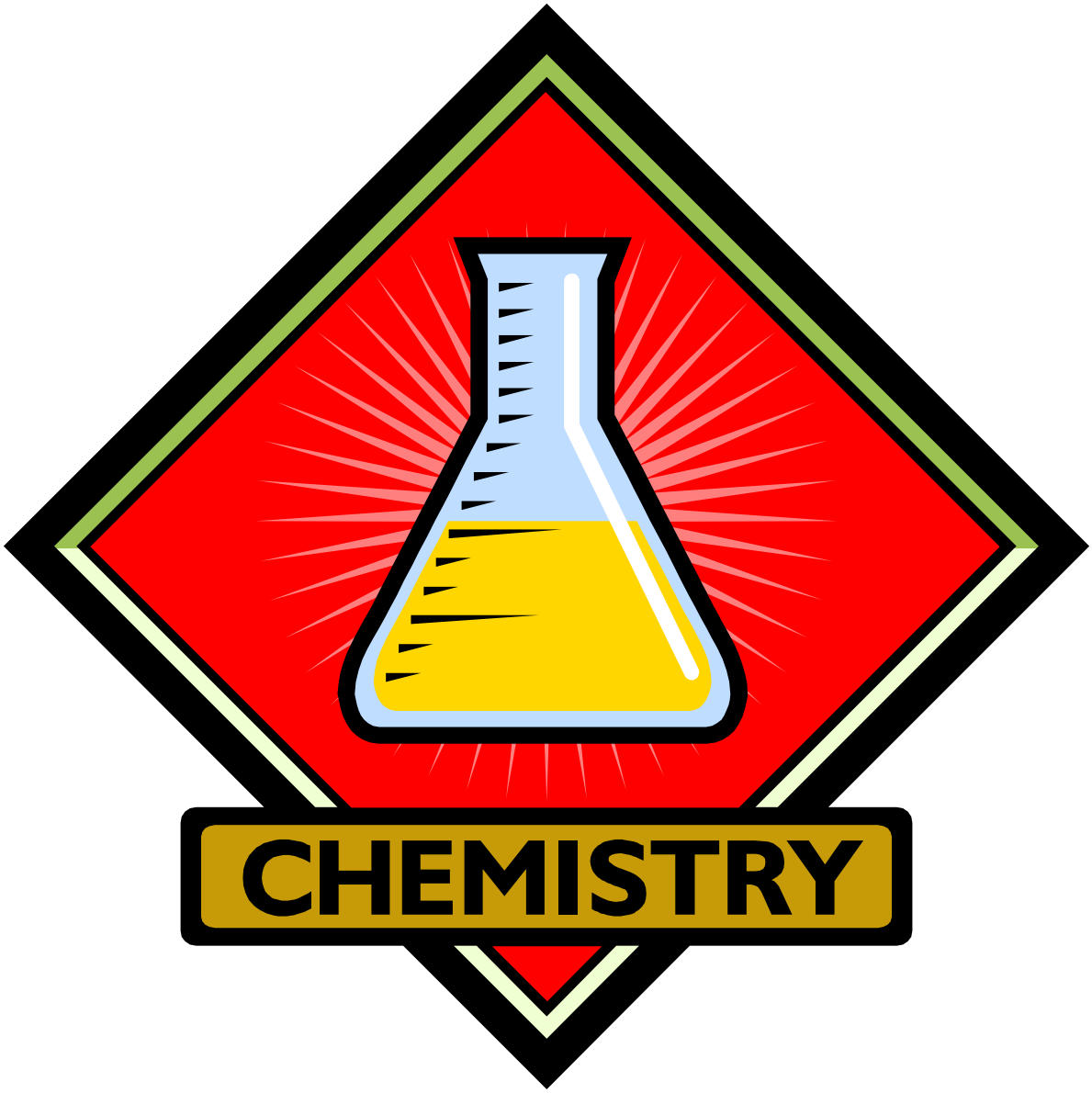
MICHIGAN STATE UNIVERSITY | Department of Chemistry



Graduate Program Guide 2014-2015

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"If we knew what it was we were doing, it would not be called research, would it?"

—Albert Einstein

THE CHEMISTRY GRADUATE PROGRAM GUIDE
2014-2015

DEPARTMENT OF CHEMISTRY
MICHIGAN STATE UNIVERSITY

I. Overview of the Graduate Programs in Chemistry

A. The Ph.D. Program

The Ph.D. program in Chemistry at Michigan State University is designed to provide sufficient experience in the performance of original research in a supervised setting to produce graduates who can carry out research independently and who can judge worthwhile research in a field. Such students have been a partner in the advancement of knowledge and can be expected to have a deep understanding of that extraordinarily important human activity. As a by-product, the training received is essential for a career in higher education and is required for many research positions in industry or government.

Performance of original research in Chemistry requires substantial background knowledge in Chemistry and in related scientific disciplines such as mathematics, physics, and biology. Therefore, the Ph.D. program in Chemistry at MSU includes course work in addition to that normally expected in the typical 4-year bachelor's degree course program in Chemistry. The program also includes examination procedures to insure that sufficient background is available to carry out the intended research. In addition to written examinations, these procedures include oral presentations of descriptions of previous work and a proposal for future research.

An essential component of original research is communication of the results of the research to the scientific community and to the world at large. Therefore, the Ph.D. program in Chemistry at MSU includes requirements for the writing of a dissertation that is a detailed description of the research performed and for the presentation of one or more manuscripts suitable for publication in refereed scientific journals.

B. The M.S. Programs

The Plan A M.S. program in Chemistry is designed to strengthen the knowledge and research competence of students entering after completion of the equivalent of the typical 4-year bachelor's degree in Chemistry. The program includes written examinations to determine whether the student has the knowledge necessary for enrollment in graduate courses and also has sufficient background to engage successfully in original research. In addition to the written examinations, a final oral examination is designed to test the student's understanding of the research performed. A written thesis is required to communicate the results of the research to the scientific community.

The Plan B M.S. program in Chemistry is an all-course program that is designed to strengthen the knowledge base of students who have completed the equivalent of the typical 4-year bachelor's degree in Chemistry. Courses are selected to improve understanding in the areas of weakness and to increase knowledge in the areas of interest of the student.

Ph.D. Program Requirements Time Line for Students Entering Fall 2014
(Plan A MS students do items 1-33 and 44-55)

Item#	Year#	Term No.	Term	Requirement	Description
1	1	1	FS14	Orientation Program	Sign Attendance Sheet. Attendance is required for the entire week, so please plan accordingly.
2	1	1	FS14	Placement Exam	The Placement Exam is normally given the first day of the Orientation Program.
3	1	1	FS14	E-mail Address Form	Set up an e-mail address with the Chemistry Dept. IT office; turn in e-mail address form to the Graduate Office.
4	1	1	FS14	Integrity Form	Read the Integrity Form, sign it, and turn it in to the Graduate Office.
5	1	1	FS14	Chemistry Photo	Have picture taken during Orientation by the IT people; check the Orientation Schedule for the time and place.
6	1	1	FS14	Enroll	If on Graduate Assistantship (TA or RA), 3 to 9 credits; if on fellowship, check with Graduate Office.
7	1	1	FS14	MSU-ID / Building Access	For FS13, go to 170 International Center to get your MSU-ID; give the numbers on your ID to Graduate Office so they can set up Building Access on your ID-card.
8	1	1	FS14	I-9 Form	Submit I-9 to Graduate Office (no I-9/no $). Domestic- get the form from the Graduate Office; International-get the from OISS.
9	1	1	FS14	Social Security Card	Bring Social Security Card to the Graduate Office. We must make a copy of it in order to be able to pay you.
10	1	1	FS14	ORCBS Certification	Certification required: training/certification is on last day of Orientation. Otherwise, contact ORCBS.
11	1	1	FS14	Room Key Form	Take room key form to the Sub-basement stockroom to get the key to the room where your desk will be located.
13	1	1	FS14	Faculty Seminar Series	Enroll in 1 credit of CEM 890 (Section 001), graded on attendance, only offered in Fall of first year. You'll be e-mailed dates/time/location; T/Th nights: Sept-Nov.
13	1	1	FS14	TA Requirement 1	You are required to do at least two TA assignments - most students do more than two.
14	1	1	FS14	Choose Advisor	Interview at least 3 professors; get signatures; turn in "Research Advisor Selection" form to Initial Advisor by Friday before Thanksgiving (end of November).
15	1	1	FS14	3 Cumulative Exams	Take all CUMEs offered until you have 6 points.
16	1	2	SS15	Enroll	If on Graduate Assistantship (TA or RA), 3 to 9 credits; if on fellowship, check with Graduate Office.
17	1	2	SS15	TA Requirement 2	You are required to do at least two TA assignments - most students do more than two assignments
18	1	2	SS15	3 Cumulative Exams	Take all CUMEs offered until you have 6 points.
19	1	2	SS15	Choose Guidance Committee	Submit Form: Selection of Guidance Committee
20	1	3	US15	Enroll	Graduate Assistantship, 3 to 4 credits; fellowship, check with Graduate Office; Student Payroll for summer, enroll for Fall but not for Summer.
21	2	4	FS15	Enroll	If on a Graduate Assistantship (TA or RA), 3 to 9 credits; if on a fellowship, check with Graduate Office.
22	2	4	FS15	1st GC Meeting / Rough Draft of GC Report	E-mail Graduate Office date/time/location a week in advance: have GC Report for meeting; leave in Report file.
23	2	4	FS15	3 Cumlative Exams	Take all CUMEs offered until you have 6 points.
24	2	4	FS15	Area Seminar 1	Literature Seminar: enroll 1 credit for your area (Fall/Spring: 918, 938, 958, 995, 998; Summer: 890 Section 004). If you get DF, must get a grade within two semesters after enrollment.
25	2	5	SS16	Enroll	If on a Graduate Assistantship (TA or RA), 3 to 9 credits; if on a fellowship, check with Graduate Office.
26	2	5	SS16	3 Cumulative Exams / Pass CUME's	Take all CUMEs offered until you have 6 points. Must pass by end of this semester or switch to MS Program.
27	2	5	SS16	Degree Program Change	Submit Degree Program Change Form (PhD to MS) to the Graduate Office if you didn't pass the CUMEs
28	2	5	SS16	2nd Year Oral	Submit announcement to Graduate Office through website. Prepare GC Report for GC to sign at meeting. Enroll in 1 credit of CEM 890 (Section 002).
29	2	5	SS16	Guidance Committee Report	Submit Report of GC Form found on website to Graduate Office: lists your required courses for degree - once submitted, it is your official requirements — requires form to change it.

Item#	Year#	Term No.	Term	Requirement	Description
30	2	5	SS16	Comprehensive Exams	The Graduate Office will prepare/submit Comprehensive Exam form when CUMES & 2nd Year Oral are passed.
31	2	5	SS16	RCR Completion	Responsible Conduct of Research workshops must be completed by the end of 2nd year. Record completion of each on web; notify Graduate Office when all are completed.
32	2	5	SS16	Degree Program Change	If you need to switch to the MS program after your 2nd Year Oral, submit this form to Graduate Office.
33	2	6	US16	Enroll	Graduate Assistantship, 3 to 4 credits; fellowship, check with Graduate Office; Student Payroll, enroll for Fall but not for Summer.
34	3	7	FS16	Enroll	If on a Graduate Assistantship (TA or RA), 3 to 9 credits; if on a fellowship, check with Graduate Office.
35	3	8	SS17	Enroll	If on a Graduate Assistantship (TA or RA), 3 to 9 credits; if on a fellowship, check with Graduate Office.
36	3	9	US17	Enroll	Graduate Assistantship, 3 to 4 credits; fellowship, check with Graduate Office; Student Payroll, enroll for Fall but not for Summer.
37	4	10	FS17	Enroll	If on a Graduate Assistantship (TA or RA), 3 to 9 credits; if on a fellowship, check with Graduate Office.
38	4	11	SS18	Enroll	If on a Graduate Assistantship (TA or RA), 3 to 9 credits; if on a fellowship, check with Graduate Office.
39	4	11	SS18	Area Seminar 2	Research seminar: 4th year or at Final Defense. Enroll 1 credit for your area (Fall/Spring: 918, 938, 958, 995, 998; Summer: 890 Section 004). Get grade for DF within 2 semesters.
40	4	11	SS18	Research Proposal	Present Research Proposal
41	4	11	SS18	Change in GC Report	Check Guidance Committee Report: if not all required courses were taken, submit Change in GC Report form.
42	4	13	US18	Enroll	Graduate Assistantship, 3 to 4 credits; fellowship, check with Graduate Office; Student Payroll, enroll for Fall but not for Summer.
43	5	13	FS18	Enroll	If on a Graduate Assistantship (TA or RA), 3 to 9 credits; if on a fellowship, check with Graduate Office.
44	5	14	SS19	Enroll	If on a Graduate Assistantship (TA or RA), 3 to 9 credits; if on a fellowship, check with Graduate Office.
45	5	15	US19	Enroll	Must be enrolled for at least 1 credit in the semester in which you defend - # of credits depends on type of support.
46	5	15	US19	Apply for Graduation	This can be done through our website.
47	5	15	US19	Check Graduate School Rules/Deadlines	The Graduate School has formatting rules for dissertations, and deadlines for graduating this term.
48	5	15	US19	Distribute Unbound Dissertation	Submit 2 weeks before defense: form for Distribution of Unbound copy of Dissertation/ Thesis to Graduate Office.
49	5	15	US19	Defense Announcement	Submit the Defense Announcement through our website which will include the date/ time/location.
50	5	15	US19	Final Defense / 2nd Seminar Grade	If 2nd Seminar is part of your Final Defense, your Advisor should write a grade on the Final Defense form. You must enroll for the 2nd Seminar — be sure to enroll for correct course.
51	5	15	US19	Book Plate	Have your Advisor sign your book plate for your dissertation or thesis.
52	5	15	US19	Dissertation Approval by Graduate School	Turn in unbound copy of Dissertation/Thesis with signed Book Plate and get it approved before School getting it bound.
53	5	15	US19	Get Dissertation hard-bound	Chemistry Graduate Office requires 1 copy. Local binders are quicker than the Graduate School.
54	5	15	US19	Check-Out and Placement Forms	Submit Check-Out and Placement Forms to Graduate Office: must have before processing degree; requires many signatures.
55	5	15	US19	Graduate Office copy of hardbound Dissertation	Submit hardbound copy of Dissertation/Thesis to Graduate Office: we must have it before processing Dissertation degree.
56	5	15	US19	Final Certification	Graduate Office submits form for degree when Check-out Form & hardbound copy of dissertation/thesis received.
57	5	15	US19	Pick up Chemistry Department Mug	The Graduate Office gives those who graduate a Chemistry Department Mug.

II. Degree Requirements

A. Ph.D. Degree

1. Introduction

The Ph.D. Program at MSU has a number of components that are described briefly in this section and in more detail in following sections.

a) Admission (Section 2)

The intent of the admission procedure is to admit only those students whose background and performance in undergraduate work is sufficient to ensure that they are able to complete the Ph.D. requirements at MSU in an acceptable time period. Students with course deficiencies may be admitted if warranted by an otherwise excellent academic record.

b) Placement Exams (Section 3)

All incoming graduate students must take placement exams in synthetic chemistry (Organic/Inorganic) and in Analytical/Physical chemistry. These exams are designed to test undergraduate knowledge in chemistry. The results will be used by your initial graduate advisor and eventually, your research mentor, to designate coursework that will best support your research.

c) Coursework (Section 4)

In order to further preparation for independent research, an individual program of coursework is prescribed for each student. The required courses include two seminars to be given by the student to improve skills in presentation of research.

d) Teaching (Section 5)

An important component of graduate education involves service to our undergraduate or graduate courses as teaching assistants.

e) Guidance Committee (Section 6)

The research, which is the essential component of the Ph.D. degree, is carried out under the supervision of a research advisor, who also serves as the Chairperson of the student's Guidance Committee, which consists of the research advisor and three additional faculty. The Guidance Committee administers the Second Year Oral Examination and the Final Oral Examination and also reads and approves the Dissertation.

f) Comprehensive Examinations (Section 7)

The Comprehensive Examinations consist of two parts: a Second Year Oral Examination to test the student's preparation for research; and a series of Cumulative Examinations to test the student's awareness of a wide variety of modern skills and fundamental knowledge.

g) Research Proposal and Research (Section 8)

The student will prepare and defend a Research Proposal to develop scientific independence. Upon completion of the research for the Ph.D. degree, each student must complete a dissertation and at least one manuscript for publication in the open literature. The student's understanding of the research is tested during the Final Oral Examination.

It is the intent of the Chemistry Department to support all Ph.D. students in good standing for a period of 5 years from the date of entry into the program. The rules for this are discussed in Section 9. The rules for changing research advisors and the relationship between the M.S. and Ph.D. programs in the MSU Chemistry Department are described in Section 10.

2. Admission

a) Admission Requirements

Each application for admission to the Ph.D. program is considered individually by the members of the Admissions Committee. It is expected that incoming students will have had the equivalent of: **a)** 1 year of organic chemistry, **b)** 1 year of physical chemistry, **c)** at least 1 course in inorganic chemistry, and **d)** at least 1 course in analytical chemistry/instrumental methods.

b) Removing Undergraduate Deficiencies

If applicants are admitted with a single deficiency, which will in most cases be **c)** or **d)** above, they must make up that deficiency by the end of their first year in the graduate program. Non-traditional students, students with undergraduate degrees in Physics, Mathematics, Biochemistry or a Biological Science, may have to make up multiple deficiencies in their undergraduate chemistry training and may be admitted provisionally pending satisfactory completion of the appropriate undergraduate courses. A deficiency may be removed by any one of the following:

i. Obtaining, prior to first enrollment, a score in the Advanced GRE Exam in Chemistry of 700 or better, or obtaining a score ranked at the 75th percentile or above;

ii. Demonstrating satisfactory placement exam performance in that area;

iii. Taking a designated undergraduate course, as follows:

Deficient Area	Course
Analytical	CEM 434 CEM 333
Inorganic	CEM 411
Organic	CEM 251 CEM 351
Physical	CEM 483 CEM 484

If International students are found by the English Language Center (ELC) to have deficiencies in the English language, they may be required to take ELC courses in their first year at MSU. It is expected that they remove these deficiencies by the end of the first semester.

c) Dual Major Degree

Students who wish to get their Ph.D. in Chemistry and at the same time get a Ph.D. or M.S. degree in another department need to set this up through the Graduate Office within one semester of its development and within the first two years of enrollment at MSU. The Chemistry Graduate Office must send a request for approval of the dual degree to the Dean of the Graduate School. The Guidance Committee Report must clearly define the course requirements for both degrees.

3. Placement Exams

All incoming graduate students are required to take Placement Exams that are designed to test their background in the traditional areas of Chemistry. The information obtained from these exams will be used to design a coursework plan for each student, to make initial teaching assignments and to measure the student's preparedness for research. Placement exams will normally be administered at the start of orientation week in the Fall semester. For students entering our graduate program at off-times, the exams must be taken prior to their first enrollment as a chemistry graduate student at MSU. Two exams will be given. The first will cover undergraduate training in synthetic chemistry and cover material traditionally taught in Organic and Inorganic chemistry. The second, will test background knowledge in Analytical and Physical chemistry. In certain cases, non-traditional students with multiple deficiencies in their undergraduate training may be excused from one of these exams.

Placement exam results will be reported to the faculty in terms of a numerical score, or ranking, and initial coursework recommendations. Overall, satisfactory performance on these tests will minimize the coursework required by the faculty to obtain an advanced degree. For example, in Physical chemistry, performance on the quantum mechanics portion of the Analytical /Physical placement exam will be used to decide whether students are prepared to take the advanced graduate level Quantum/Statistical Mechanics sequence, CEM 991 and 992. Unsatisfactory performance will result in the student having to take an introductory graduate-level quantum mechanics course, CEM 881, and will delay completion of the 99x courses that constitute "core" courses for physical chemistry graduate students. As a result, a physical chemistry student who places into the lower level 881-882 sequence will have to take more than the minimum six lecture courses during their time at MSU. Satisfactory performance on the organic placement exam will allow students to place into a more advanced graduate-level organic course and will result in a reduced course load over the first two years of study.

In addition to their use in initial advising and in making TA assignments, placement exam results will be used by your research advisor to select out-of -area graduate-level courses that must be completed to satisfy the Department's requirements for the Ph.D. or M.S. programs. Unsatisfactory performance may result in recommended initial coursework at the undergraduate level.

4. Coursework

All graduate students MUST meet the University Residency Requirement to qualify for graduation. In order to meet this requirement, a Ph.D. degree student must be enrolled for a minimum of six credits for two consecutive semesters. The optimum time for meeting this requirement is in the student's first and second semester in the Chemistry Graduate Program.

a) Course Requirements

All graduate students are expected to take:

i. Any designated undergraduate courses required to remedy an admission deficiency.

ii. At least 6 graduate-level lecture courses. One lecture course may be replaced with a 3 credit block of graded research, CEM 890 (Section 003 – Course Title: Chemical Problems and Reports). The individual areas have core courses for their students, and all students are strongly encouraged to take one or more Special Topics courses (CEM 913, 924, 956, 985, 987, or 988).

iii. **Two** seminar **credits**. The first seminar course (Literature) should be taken in the second year. The second seminar (Research) may be fulfilled at the time of your defense. The Area seminar course numbers for Fall and Spring enrollments are: 918, 938, 958, 995,

998. If Summer enrollment is necessary, then CEM 890 (Section 004) must be used instead.

iv. One credit of CEM 890 (Section 001) in the Fall semester of their first year. The grade for CEM 890 (Section 001) will be assigned for attendance at a series of seminars presented by the Departmental Faculty describing their research programs. Students from all areas are expected to attend all faculty presentations to gain a perspective on research in all areas within the Department. International students who are required to take English 097 during their first semester must enroll for CEM 890 (Section 001) in their second semester instead.

v. One credit of CEM 890 (Section 002 – Course Title: Chemical Problems and Reports) by the end of the fourth semester (excluding summers). The grade for CEM 890 (Section 002)will be assigned by the student's Guidance Committee based on performance in the Second Year Oral Examination, which must be held by the end of the fourth semester (excluding summers).

vi. Coursework in the Biological Chemistry Area will typically be a mix of courses from the Chemistry and Biochemistry Departments and will be chosen based on a student's interest in bioanalytical (BA), bioinorganic (BI), bioorganic (BO) or biophysical chemistry (BP). Guidelines for coursework are given below:

		BA	BI	BO	BP
FS1	BMB	803	803	803	803
	CEM	834	811	850	881
SS1	CEM	835	812	852	882
FS2	BMB	801	801	801	801
SS2	To be determined based on the student's Ph.D. research project.				

b) Enrolling for Research Credits

Ph.D. Students may enroll for research either by enrolling in CEM 890 (Section 003), for which a grade is given at the end of the semester enrolled, by the research advisor, or CEM 999, for which a deferred grade is automatically assigned by the Registrar's Office. The deferred grades in CEM 999 are changed to "pass" at the time of graduation. **All doctoral students must register for and accrue a minimum of 24 and no more than 36 credits of doctoral dissertation research (course number CEM 999)!**

Students entering in the Fall or Spring Semesters are expected to choose their research advisor by the first day of classes of their second semester (including Summer) in the program. A research advisor must be selected before a student enrolls in CEM 890 (Section 003) for graded research.

In their first two years of study, graduate students may enroll in CEM 890 (Section 003) for graded research for a maximum of 5 credits (in addition to the required credit for the second year oral examination described above). For this enrollment (or these enrollments), they will receive a grade from their research advisor based on research progress. Three credits (of the maximum of 5) of CEM 890 (Section 003) in a single semester may be used to replace one of the six required courses, as described above.

c) Enrollment for CEM 890

CEM 890 is used for a variety of reasons. Please be careful to enroll in the appropriate Section and for the appropriate number of credits. Section 004 cannot be used for both an Area Seminar and a different course during the same semester since students cannot receive two different grades for one enrollment.

Section 001: Faculty Seminar Series – for first year students (1 credit only)

Section 002: Second Year Oral Exam – for second year students (1 credit only)

Section 003: Graded Research – to be arranged through student's Advisor (usually 3 credits but 1-6 are possible for this section)

Section 004: Area Seminar –only if enrolled for in the summer (1 credit) Course to be arranged through student's Advisor

A Typical Course Schedule

A typical schedule for the first two years for a graduate student who is admitted in the Fall Semester with no undergraduate course or English language deficiency is as follows:

YEAR #1

FALL

CEM 890 (Section 001), 1 credit
Graduate Course, 3 credits
Graduate Course, 3 credits

SPRING

Graduate Course, 3 credits
Graduate Course, 3 credits or CEM 890 (Section 001), 0-1 credit
CEM 999, 2-3 credits

SUMMER

CEM 999, 1 or 4 credits (depending on the source of financial support)

YEAR #2

FALL

Graduate Course, 3 credits
Seminar, 1 credit
CEM 890, 0-1 credit
CEM 999, 1-2 credits

or

CEM 890 (Section 002), 3 credits
Seminar, 1 credit
CEM 999, 2 credits

SPRING

Graduate Course, 0 or 3 credits
CEM 890 (Section 002), 1 credit
CEM 999, 2 or 5 credits

SUMMER

CEM 999, 1 or 4 credits (depending on the source of financial support)

Students who are admitted with undergraduate course or English language deficiencies must adjust their schedules accordingly. They must complete at least two graduate courses in their first two semesters (excluding summer) and must complete their first seminar and the second year oral examination by the end of their first four semesters (excluding summer).

d) Seminar

All Ph.D. candidates must present at least two seminars and be enrolled for two credits of their area seminar course (*i.e.*, Analytical – CEM 938, Inorganic – CEM 918, Nuclear – CEM 995, Organic – CEM 958, Physical and Chemical Physics – CEM 998). The types of seminars given are determined by the guidelines of the seminar series in which the candidate participates. If a student has advisors in two different areas, the student may give one seminar in the seminar program of each area. The second seminar (Research) may be fulfilled at the time of your defense.

e) Deferred Grades (DF)

The required work must be completed and a grade reported within two semesters after the term of enrollment with the option of a single six-month extension. If the required work is not completed within the time limit, the DF will become U-Unfinished and will be changed to DF/U on the transcript even if the work is eventually completed. The University strictly enforces this policy, so it is best to avoid DF grade status if possible. This rule does not apply to graduate thesis or dissertation work (CEM 899 or CEM 999).

f) Minimum Grade Point Average

The University considers the maintenance of a 3.00 cumulative GPA as an academic standard for Doctoral Programs. Graduate assistantships are available only to graduate students who are actively pursuing graduate degree programs and who are making satisfactory progress toward their degrees, including maintaining at least a 3.00 GPA. If a graduate student in Chemistry accumulates grades below 3.0 in more than three courses, (s)he is removed from candidacy for the degree, and moved to non-degree status. Students with non-degree status are ineligible for TA or RA appointments.

g) Foreign Language

The Chemistry Department has no formal foreign language requirement. However, in some cases, a student's advisor and/or Guidance Committee may recommend that one or more courses in a foreign language be listed on the student's Guidance Committee Report, making the course(s) required for graduation. This decision would depend on the specific research project, and the student's prior foreign language training. In such cases, one or more semesters of an introductory foreign language sequence may be required. Alternatively, one semester courses such as German 400 - *Reading German for Graduate Students* - may be appropriate. For example, training in a foreign language may be required for specific students if part of their research program will take place outside of the U.S., or if their research will rely heavily on prior literature that was not published in English.

h) In-State Tuition Rate/Fellowships

Receipt of externally funded fellowships by students who have written their own grant applications and worth at least $20,000 (direct costs) now makes the students eligible for in-state tuition rate. The in-state tuition rate applies only to the semesters during which the student is supported by the fellowship. This policy applies only to grants funded through a competitive process by a US institution/agency/foundation. Funds obtained through non-competitive processes (e.g., need-based fellowships) or from international sources do not qualify the students for in-state tuition rates. For more information contact Melissa Del Rio (***mdelrio@msu.edu***) in 110 Linton Hall.

5. Teaching

All graduate students are required to serve as teaching assistants in Chemistry for a minimum of two semesters. One of these assignments must be completed in the first year of study. Students who hold a fellowship may elect to delay their assignments, but will still be required to complete two assignments as part of their advanced degree program. All international students must receive a score of 50 on the MSU SPEAK Test in order to be a Teaching Assistant and have instruc-

tional contact with undergraduate students. Although MSU accepts TSE scores as an alternative to the SPEAK test, the score report cannot have been issued more than two years prior to the student's appointment as a TA. The spoken section of TOEFL (IBT Section 4) does not substitute for the SPEAK test.

TA assignments are made by the Chemistry Graduate Office. Notification of TA assignments are sent by e-mail to the Teaching Assistants as well as by a letter in which the TA can decline or accept the position being offered to them (please refer to Article 10 of the MSU and the Graduate Employee Union contract located at the following URL: ***http://grad.msu.edu***). The current MSU-GEU contract for TAs, effective 2011-2015, is available online at (***http://grad.msu.edu/2011-2015GEUContract.pdf***). Due to unforeseen developments, a TA assignment may change after the initial assignment has been made and the TA will be informed of this change.

Students in their first year are appointed as Level 1 TAs. Students appointed as TAs in their second year are Level 2 TAs, and once they have completed their cumulative examination and second year oral exam requirements, they are appointed as Level 3 TAs. If there is a question relating to appointment level, the GEU contract should be consulted. Appointments for TAs at Level 3 must be made after 6 semesters of experience (including summers) and with a Master's degree or equivalent. The minimum number of 30 credits to earn a master's degree at MSU is used as the definition for "Master's or equivalent" for purposes of Level 3 appointments for TAs only.

At the end of the semester, the instructor for each course is asked to complete an evaluation of the Teaching Assistants assigned to their course. These evaluations are a Department of Chemistry form and are maintained in the student's TA file. TAs receive a copy of this evaluation. Teaching Assistants are also evaluated by the students in the recitation or lab sections they are assigned to as well. The student evaluations are a requirement of the University and are distributed to the TA's prior to the last week of classes for the students to complete. These evaluations are returned to the Teaching Assistant after the Registrar's Office have entered the data into their records.

6. Tutoring

As a Teaching Assistant you are not allowed to act as a paid tutor for a student in the course you are assigned to. Such behavior would constitute a conflict of interest because you are being paid by the Department to provide office hours and direct contact support (recitation, lab, etc.) to students for that course. You may act as a paid tutor for any chemistry course to which you are not assigned as a TA in any given semester.

7. Guidance Committee

a) Choice of Research Advisor and Guidance Committee

All first year graduate students will be assigned an initial advisor upon entering the Chemistry Graduate Program. New students will meet with this advisor during the Chemistry Orientation Program in order to determine course enrollment for their first semester in the graduate program. **All first year graduate students must choose a major area and a research advisor by the end of their first semester in residency. Each student should interview at least three regular faculty members concerning their research interests and projects**. After these interviews, the student will select a major professor, obtain the professor's agreement, and report the result to the Graduate Office by submission of a completed *Research Advisor Selection Form*. Some areas in the department may require that all faculty in that area be interviewed before a selection can be made.

Each student must select a Guidance Committee and return a completed *Guidance Committee Selection Form* to the Graduate Office by the end of the second semester of their first year (excluding summer).

The Guidance Committee, of which the research advisor is Chairperson, is composed of at least two faculty members from the major area and at least one faculty member from another area in the Department. Substitution of one or two faculty from other departments is permissible when the dissertation research is allied with other disciplines. The Chairperson of the Guidance Committee must be a member of the regular faculty of the Chemistry Department, or are recognized as jointly-appointed faculty who are allowed to be advisors for Chemistry graduate students. Additional faculty members beyond the minimum of four may be invited to join the Guidance Committee. One member of the Guidance Committee must agree to serve as the second critical reader of the dissertation. Committee selection is subject to final approval by the Graduate Office. Graduate students meet with their Guidance Committees at least three times - at their First Committee Meeting, their Second Year Oral Examination and their Final Dissertation Defense.

GUIDELINES FOR GRADUATE STUDENT ADVISING AND MENTORING RELATIONSHIPS

Graduate education, research, and creative activities take place within a community of scholars where constructive relationships between graduate students and their advisors and mentors are essential for the promotion of excellence in graduate education and for adherence to the highest standards of scholarship, ethics, and professional integrity. The effective advising and mentoring of graduate students is the joint responsibility of the graduate degree-granting and program units (henceforth referred to as academic units), the faculty advisors, and the students. The following guidelines are intended to foster faculty-graduate student relationships that are characterized by honesty, courtesy, and professionalism and that provide students with intellectual support and guidance. These guidelines recognize that good advising and mentoring of graduate students entail a considerable commitment of time and effort on the part of the faculty and the academic unit. The academic unit forms the community of scholars responsible for cultivating a stimulating intellectual environment and, through the joint efforts of all faculty members of the unit, for mentoring of graduate students.

The responsibilities of the academic unit include:

- Preparing and maintaining a graduate handbook that includes the information outlined in the Graduate Handbook Template (*http://grad.msu.edu/handbooktemplate/*), as well as academic unit and college requirements for degree completion
- Providing opportunities for graduate students to interact with a wide array of colleagues from within and outside the University through such activities as speaker series, colloquia, and other formal and informal events
- Creating opportunities for graduate students to become familiar with the various forms of scholarship in the field

- Sharing responsibility with guidance committees and faculty advisors in fostering the professional and career development of graduate students, for example, by providing venues for honing professional writing and presentation skills and organizing seminars on such issues as ethics, professional integrity and grantsmanship

The responsibilities of the chair or director of the academic unit and/or director of graduate studies include:

- Knowing University and academic unit rules, procedures and policies applicable to graduate study, research, and creative activities, including those in Academic Programs (***http://www.reg.msu.edu/AcademicPrograms/***), Graduate Student Rights and Responsibilities (***http://grad.msu.edu/gsrr/***), or Medical Student Rights and Responsibilities ***(http://splife.studentlife.msu.edu/medical-student-rights-and-responsibilites-mssr***), and Academic Freedom for Students at Michigan State University (***http://splife.studentlife.msu.edu/academic-freedom-for-students-at-michigan-state-university***) and ensuring that they are followed in the academic unit
- Distributing to incoming graduate students the academic unit's Graduate Handbook
- Organizing orientation sessions for incoming graduate students
- Ensuring that required courses and examinations are scheduled on a regular basis, thereby enabling graduate students to make timely progress in their degree programs
- Providing advice on matters such as course selection until a permanent faculty advisor and guidance committee are selected, or appointing a committee or temporary advisor to assume that role
- Facilitating selection of a faculty advisor and guidance committee and facilitating changes of faculty advisor and/or guida n c e committee should this become necessary
- Monitoring at least annually the progress of students in the graduate program and the quality of their research or creative activity, as well as the standards and fairness of examinations
- Monitoring the performance of faculty advisors and guidance committees to ensure that graduate students are receiving appropriate mentoring
- Working toward fair resolution of conflicts between graduate students and faculty

The responsibilities of the faculty advisor include:

- Ensuring that graduate students receive information about requirements and policies of the graduate program
- Advising graduate students on developing a program plan, including appropriate course work, research or creative activity, and on available resources
- Advising graduate students on the selection of a thesis or dissertation topic with realistic prospects for successful completion within an appropriate time frame and on the formation of a guidance committee
- Providing training and oversight in creative activities, research rigor, theoretical and technical aspects of the thesis or dissertation research, and in professional integrity
- Encouraging graduate students to stay abreast of the literature and cutting-edge ideas in the field
- Helping graduate students to develop professional skills in writing reports, papers, and grant proposals, making professional presentations, establishing professional networks, interviewing, and evaluating manuscripts and papers
- Providing regular feedback on the progress of graduate students toward degree completion, including feedback on research or creative activities, course work, and teaching, and constructive criticism if the progress does not meet expectations
- Helping graduate students develop into successful professionals and colleagues, including encouraging students to participate and disseminate results of research or creative activities in the appropriate scholarly or public forums
- Facilitating career development, including advising graduate students on appropriate job and career options, as well as on the preparation of application materials for appropriate fellowship, scholarship, and other relevant opportunities
- Writing letters of reference for appropriate fellowship, scholarship, award, and job opportunities
- Providing for supervision and advising of graduate students when the faculty advisor is on leave or extended absence

The responsibilities of the guidance committee include:

- Advising graduate students on course work, research, or creative activities
- Providing at least annually feedback and guidance concerning progress toward the degree
- Administering exams in a fair and professional manner

- Reviewing the thesis or dissertation in a timely, constructive and critical manner

The responsibilities of the graduate student include:

- Learning and adhering to University and academic unit rules, procedures,and policies applicable to graduate study and research or creative activities, including those outlined in Academic Programs (***http://www.reg.msu.edu/AcademicPrograms/***), Graduate Student Rights and Responsibilities (***http://grad.msu.edu/gsrr/***), or Medical Student Rights and Responsibilities (***http://splife.studentlife.msu.edu/medical-student-rights-and-responsibilites-mssr***), and Academic Freedom for Students at Michigan State University (***http://splife.studentlife.msu.edu/academic-freedom-for-students-at-michigan-state-university***)
- Meeting University and academic unit requirements for degree completion
- Forming a guidance committee that meets University requirements as well as requirements that are outlined in the Graduate Handbook of the academic unit
- Following disciplinary and scholarly codes of ethics in course work, thesis or dissertation research, and in creative activities
- Practicing uncompromising honesty and integrity according to University and federal guidelines in collecting and maintaining data
- Seeking regulatory approval for research in the early stages of thesis or dissertation work where applicable
- Keeping the faculty advisor and guidance committee apprised on a regular basis of the progress toward completion of the thesis or dissertation

RESOURCES

"*Adviser, Teacher, Role Model, Friend: On Being a Mentor to Students in Science and Engineering*", National Academy Press, Washington, D.C., 1997, 84 pp (***http://www.nap.edu/catalog.php?record_id=5789***).

"*Integrity in Scientific Research: Creating an Environment that Promotes Responsible Conduct*", National Academies Press, Washington, D.C., 2002, 216 pp (***http://www.nap.edu/books/0309084792/html/***).

"*On Becoming a Scientist: Responsible Conduct in Research*", Third Edition, National Academy Press, Washington, D.C.,

2009, 63 pp (***http://www.nap.edu/catalog.php?record_id=12192***).

"*On the Right Track: A Manual for Research Mentors*", M.F. King; D.D. Denecke (Ed.), Council of Graduate Schools, Washington, D.C., 2003, 26 pp.

b) First Committee Meeting

No later than the midpoint of the third semester (not including Summer semesters) each graduate student must meet with his/her Guidance Committee. The student will schedule the First Committee Meeting, with their research advisor presiding over this short meeting (please inform the Graduate Office when you have scheduled this meeting). The purpose of this meeting is to:

i. Discuss course requirements and the Guidance Committee Report. **A draft copy of the Guidance Committee Report will be completed at this meeting, however, the final version will be approved and signed at the Second Year Oral Examination.**

ii. Present the plan for the student's second year, focusing on the work to be completed to prepare for the Second Year Oral. The advisor will present his/her goals for the student for his/her second year and beyond. In some cases, the goals for the student may be to perform certain experiments, learn certain instrumental methods, build an instrument, make compounds, etc. In other cases, the goal may be to master certain concepts required for pursuing the research. In this way, the student and the committee members will clearly know what will be expected by the time of the Second Year Oral Examination.

iii. The first seminar (scheduling, content) should be discussed at this meeting.

iv. There should be some preliminary planning of the time of the Second Year Oral Exam.

8. Comprehensive Exams

a) Introduction

The Chemistry Department Comprehensive Examinations consist of a series of Cumulative Examinations and a Second Year Oral Examination.

b) Cumulative Examinations

The Chemistry Department Cumulative Examinations are given three times each semester during the academic year. The structure is flexible. An examination may consist of written questions or problems on either announced or unannounced topics, a take-home written examination, or a laboratory practical examination. Announced topics will be posted at least one week prior to the examination date.

Cumulative examinations in Analytical, Biological, Inorganic, Organic and Physical areas of Chemistry are given concurrently six times per year normally, and are given in Chemical Physics and Nuclear Chemistry several times per year. Candidates for the Ph.D. degree should begin these examinations immediately after they have enrolled in the graduate program. Students may write any of the examinations given in order to fulfill this requirement. Grading of the Cumulative Exams is on a 0,1,2,3 point basis. **Completion of the Comprehensive Examinations requires that a student accumulate a total of 6 Cumulative Exam Points and these points must be earned by the end of the second academic year (4th semester, excluding summer) in the program.** The Cumulative Examination Requirement must be completed before the Second Year Oral Examination can be *scheduled*. **Students who fail to meet this requirement will be transferred to the M.S. degree**

program. The student's Guidance Committee will meet soon after this action has occurred in order to evaluate the student's progress in the program. Possible outcomes of this meeting are (a) that the student will be moved to the Plan A or Plan B M.S. Degree program, and the M.S. Degree must be completed by the end of the fifth semester of study (excluding summer semesters), or (b) that the student will be dismissed from the graduate program. For students who are allowed by their Guidance Committee to proceed in the Plan A M.S. degree program, their M.S. defense will take place by the end of the fifth semester. If the Plan A M.S. is defended successfully and the student has six Cumulative Exam Points at the M.S. defense, they would be eligible to continue to the Ph.D. program at the discretion of the M.S. Guidance Committee. Requirements for this readmission are outlined in the M.S. Degree requirements.

c) Second Year Oral Exam

The Second Year Oral Examination can only be scheduled after the Cumulative Exams have been passed. The purpose of the Second Year Oral Examination is to allow the student to demonstrate ***preparedness*** for dissertation research and an ability to think critically and independently. It may or may not require preliminary results or data. The advisor determines what is satisfactory progress in the student's first two years. Thus, ***preparedness*** is defined at the First Committee meeting. The date, time and location is arranged by the student. This examination is administered by the student's Guidance Committee; the second reader chairs the examination. For the examination, the student is to prepare a 10-15 page research proposal. The proposal must be distributed to the Guidance Committee members no later than two weeks prior to the scheduled examination date. Any of the committee members not satisfied with the scientific merit of the proposal or the quality of the student's writing must inform the second reader no later than one week prior to the scheduled examination date. The second reader may direct the student to rewrite the proposal, and possibly to reschedule the examination. **The Graduate Office must be informed of the date, time, and location of the exam by submitting an electronic announcement, which is located on the Chemistry Department Web Site (*http://www.chemistry.msu.edu/graduate/oralExamReg.cfm*).**

Possible outcomes of the Second Year Oral Examination:

i. Student passes and a grade for CEM 890 is assigned.

ii. Re-examination is recommended, with no grade assigned at that time. If re-examination takes place before the term is over, a grade may be assigned. If the term ends before the re-examination takes place, a Deferred grade will be submitted. This deferred will be changed to an assigned grade after successful completion of the Second Year Oral Exam requirement.

iii. Dismissal from the Graduate Program.

d) Enrollment Requirement for Comprehensive Exams

Enrollment for the Second Year Oral is used for the Comprehensive Exam enrollment. For students who were enrolled in the Spring and are taking their comprehensive exams during the immediate Summer semester, the department can request a waiver of the requirement that the student be enrolled for at least one credit the last semester of the comprehensive exam. These requests are to be directed to the Graduate School and must be endorsed by the student's department and college. All students defending their thesis or dissertations in the Summer need to be registered for at least one credit during that Summer, regardless of their being enrolled in the previous Spring semester.

e) Full Time Status

Full time status for doctoral students is defined as a minimum of 1 credit for those students who:

1) Have successfully completed all comprehensive examinations and are actively engaged in dissertation research (Chemistry Graduate Students should continue to enroll for more than one credit until they attain the 24 credits of CEM 999 (Ph.D. Research Credits) required by MSU to graduate.
2) Are doing department-approved off-campus fieldwork related to preparation of their dissertation.

9. Research Integrity

The conduct of research and creative activities by faculty, staff, and students is central to the mission of Michigan State University (***http://president.msu.edu/mission/***) and is an institutional priority. Faculty, staff, and students work in a rich and competitive environment for the common purpose of learning, creating new knowledge, and disseminating information and ideas for the benefit of their peers and the general public. The stature and reputation of MSU as a research university are based on the commitment of its faculty, staff, and students to excellence in scholarly and creative activities and to the highest standards of professional integrity. As a partner in scholarly endeavors, MSU is committed to creating an environment that promotes ethical conduct and integrity in research and creative activities.

Innovative ideas and advances in research and creative activities have the potential to generate professional and public recognition and, in some instances, commercial interest and financial gain. In rare cases, such benefits may become motivating factors to violate professional ethics. Pressures to publish, to obtain research grants, or to complete academic requirements may also lead to an erosion of professional integrity.

Breaches in professional ethics range from questionable research practices to misconduct (***http://www.hr.msu.edu/documents/facacadhandbooks/facultyhandbook/misconductproc/index.htm***). The primary responsibility for adhering to professional standards lies with the individual scholar. It is, however, also the responsibility of advisors and of the disciplinary community at large. Passive acceptance of improper practices lowers inhibitions to violate professional ethics.

Integrity in research and creative activities is based not only on sound disciplinary practice but also on a commitment to basic personal values such as fairness, equity, honesty, and respect. These guidelines are intended to promote high professional standards by everyone—faculty, staff and students alike.

KEY PRINCIPLES

Integrity in research and creative activities embodies a range of practices that includes:

- Honesty in proposing, performing, and reporting research
- Recognition of prior work
- Confidentiality in peer review
- Disclosure of potential conflicts of interest
- Compliance with institutional and sponsor requirements
- Protection of human subjects and humane care of animals in the conduct of research
- Collegiality in scholarly interactions and sharing of resources
- Adherence to fair and open relationships between senior scholars and their coworkers

Honesty in proposing, performing, and reporting research. The foundation underlying all research is uncompromising honesty in presenting one's own ideas in research proposals, in performing one's research, and in reporting one's data. Detailed and accurate records of primary data must be kept as unalterable documentation of one's research and must be available for scrutiny and critique. It is expected that researchers will always be truthful and explicit in disclosing what was done, how it was done, and

what results were obtained. To this end, research aims, methods, and outcomes must be described in sufficient detail such that others can judge the quality of what is reported and can reproduce the data. Results from valid observations and tests that run counter to expectations must be reported along with supportive data.

Recognition of prior work. Research proposals, original research, and creative endeavors often build on one's own work and also on the work of others. Both published and unpublished work must always be properly credited. Reporting the work of others as if it were one's own is plagiarism. Graduate advisors and members of guidance committees have a unique role in guiding the independent research and creative activities of students. Information learned through private discussions or committee meetings should be respected as proprietary and accorded the same protection granted to information obtained in any peer-review process.

Confidentiality in peer review. Critical and impartial review by respected disciplinary peers is the foundation for important decisions in the evaluation of internal and external funding requests, allocation of resources, publication of research results, granting of awards, and in other scholarly decisions. The peer-review process involves the sharing of information for scholarly assessment on behalf of the larger disciplinary community. The integrity of this process depends on confidentiality until the information is released to the public. Therefore, the contents of research proposals, of manuscripts submitted for publication, and of other scholarly documents under review should be considered privileged information not to be shared with others, including students and staff, without explicit permission by the authority requesting the review. Ideas and results learned through the peer-review process should not be made use of prior to their presentation in a public forum or their release through publication.

Disclosure of potential conflicts of interest. There is real or perceived conflict of interest when a researcher has material or personal interest that could compromise the integrity of the scholarship. It is, therefore, imperative that potential conflicts of interest be considered and acted upon appropriately by the researcher. Some federal sponsors require the University to implement formal conflict of interest policies. It is the responsibility of all researchers to be aware of and comply with such requirements.

Compliance with institutional and sponsor requirements. Investigators are granted broad freedoms in making decisions concerning their research. These decisions are, however, still guided, and in some cases limited, by the laws, regulations, and procedures that have been established by the University and sponsors of research to protect the integrity of the research process and the uses of the information developed for the common good. Although the legal agreement underlying the funding of a sponsored project is a matter between the sponsor and the University, the primary responsibility for management of a sponsored project rests with the principal investigator and his or her academic unit.

Protection of human subjects and humane care of animals in the conduct of research. Research techniques should not violate established professional ethics or federal and state requirements pertaining to the health, safety, privacy, and protection of human beings,-or to the welfare of animal subjects. Whereas it is the responsibility of faculty to assist students and staff in complying with such requirements, it is the responsibility of all researchers to be aware of and to comply with such requirements.

Collegiality in scholarly interactions and sharing of resources. Collegiality in scholarly interactions, including open communications and sharing of resources, facilitates progress in research and creative activities for the good of the community. At the same time, it has to be understood that scholars who first report important findings are both recognized for their discovery and afforded intellectual property rights that permit discretion in the use and sharing of their discoveries and inventions. Balancing openness and protecting the intellectual property rights of individuals and the institution will always be a challenge for the community. Once the results of research or creative activities have been published or otherwise communicated to the public, scholars are expected to share materials and information on methodologies with their colleagues according to the tradition of their discipline.

Faculty advisors have a particular responsibility to respect and protect the intellectual property rights of their advisees. A clear understanding must be reached during the course of the project on who will be entitled to continue what part of the overall research program after the advisee leaves for an independent position. Advisors should also strive to protect junior scholars from abuses by others who have gained knowledge of the junior scholar's results during the mentoring process.

Adherence to fair and open relationships between senior scholars and their coworkers. The relationship between senior scholars and their coworkers should be based on mutual respect, trust, honesty, fairness in the assignment of effort and credit, open communications, and accountability. The principles that will be used to establish authorship and ordering of authors on presentations of results must be communicated early and clearly to all coworkers. These principles should be determined objectively according to the standards of the discipline, with the understanding that such standards may not be the same as those used to assign credit for contributions to intellectual property. It is the responsibility of the faculty to protect the freedom to publish results of research and creative activities. The University has affirmed the right of its scholars for first publication except for "exigencies of national defense" (***http://www.hr.msu.edu/documents/facacadhandbooks/facultyhandbook/sponsoredresearch.htm***). It is also the responsibility of the faculty to recognize and balance their dual roles as investigators and advisors in interacting with graduate students of their group, especially when a student's efforts do not contribute directly to the completion of his or her degree requirements.

Misconduct in Research and Creative Activities. Federal (Office of Science and Technology Policy, "Notice of Final Policy", 65 CFR 76260). and University (***http://www.hr.msu.edu/documents/facacadhandbooks/facultyhandbook/misconductproc/miscon-definitions.htm***) policies define misconduct to include *fabrication* (making up data and recording or reporting them), *falsification* (manipulating research materials, equipment or processes, or changing or omitting data such that the research is not accurately represented in the record), and *plagiarism* (appropriation of another person's ideas, processes, results, or words without giving appropriate credit). Serious or continuing non-compliance with government regulations pertaining to research may constitute misconduct as well. University policy also defines retaliation against whistle blowers as misconduct. Misconduct does not include honest errors or honest differences of opinion in the interpretation or judgment of data.

The University views misconduct to be the most egregious violation of standards of integrity and as grounds for disciplinary action, including the termination of employment of faculty and staff, dismissal of students, and revocation of degrees. It is the responsibility of faculty, staff, and students alike to understand the University's policy on misconduct in research and creative activities', to report perceived acts of misconduct of which they have direct knowledge to the University Intellectual Integrity Officer, and to protect the rights and privacy of individuals making such reports in good faith.

RESOURCES

"Guidelines on Authorship". Endorsed by the University Research Council, January 15, 1998 (***http://rio.msu.edu/authorshipguidelines.htm***)

"Integrity in Scientific Research: Creating an Environment that Promotes Responsible Conduct", National Academies Press, Washington, D.C., 2002, 216 pp (***http://www.nap.edu/books/0309084792/html***)

"Research Data: Management, Control, and Access Guidelines". Endorsed by the University Research Council, February 7, 2001 (***http://rio.msu.edu/research_data.htm***)

10. Conflict Resolution

While the graduate experience is typically a smooth one, there are certain circumstances where conflicts can arise between students and other students, students and advisors or course instructors. The Graduate Program in Chemistry at MSU has experience in achieving conflict resolution in a variety of

circumstances. In all cases the Graduate Program works at achieving conflict resolution in a manner that is fully consistent with the procedures articulated by the Graduate School (***http://grad.msu.edu/conflictresolution/***). The keys to success in conflict resolution are open communication between the parties involved and the graduate office, and a clear sense of what the appropriate expectations are for the specific situation.

Any student who believes that there has been an infringement upon his/her academic or professional rights should first seek redress from the individual(s) involved, and the Graduate Office should be made aware of the situation. If a satisfactory conclusion is not reached with the aid of the Graduate Office, the student should present the problem to the Department Chairperson. If the grievance involves the Department Chairperson, an alternate faculty member, not involved in the conflict, should be contacted. If the problem cannot be resolved at this stage, it may be referred to a departmental judiciary committee comprised of both faculty and student representatives (two faculty members and two graduate students, selected by the Department Chairperson or the alternate faculty member if the Chairperson is a party to the grievance). The functions of the judiciary committee are as specified in the relevant articles of the Graduate Student Rights and Responsibilities document. Subsequent appeal procedures are given in Article 5 of the Graduate Student Rights and Responsibilities document.

The Office of the University Ombudsperson provides assistance to students, faculty, and staff in resolving University-related concerns. Such concerns include: student-faculty conflicts; communication problems; concerns about the university climate; and questions about what options are available for handling a problem according to Michigan State University policy. The University Ombudsperson also provides information about available resources and student/faculty rights and responsibilities. The office operates as a confidential, independent, and neutral resource. It does not provide notice to the University - that is, it does not speak or hear for the University. Contact the Ombudsperson at any point during an issue when a confidential conversation or source of information may be needed. The Ombudsperson will listen to your concerns, give you information about university policies, help you evaluate the situation, and assist you in making plans to resolve the conflict.

As part of the professional development program, the MSU Graduate School regularly conducts workshops on conflict resolution. Further information on these workshops is available at the following website: ***http://grad.msu.edu/conflictresolution/workshop.aspx***

11. Research

All graduate students MUST have EHS (Environmental Health and Safety) training prior to working in a lab. This training is provided during the Department of Chemistry Graduate Orientation Program. Please contact EHS (Web: ***http://www.ehs.msu.edu***) to arrange training outside of the orientation program.

a) Dissertation and Final Oral Examination

The Ph.D. in Chemistry is primarily a research degree. The student is expected to perform significant, original research and to write a dissertation. The format of the dissertation is standardized found at the Graduate School website ***http://grad.msu.edu/etd/***. Follow the instructions there for the preparation and electronic submission of your Dissertation. Once the major professor and the student reach agreement on the Dissertation, it must be approved by the Second Reader before it is distributed to the Guidance Committee. The Dissertation must be defended before the Guidance Committee in an Oral Examination.

At least two weeks before a Final Oral Examination for the Ph.D. degree in Chemistry, the candidate must present an acceptable copy of the dissertation to each member of the Guidance Com-

mittee together with reprints of one or more refereed papers based on the dissertation research. If at least one reprint is not provided, a manuscript that has been submitted for publication to a refereed journal must be included. All changes in the dissertation suggested by the Guidance Committee after the Oral Examination must be made before the candidate is certified for the degree. In addition to the unbound copy of the dissertation that is required by the Graduate School for the University Library, one **HARDBOUND** copy of the dissertation should be given to the student's research advisor and one hardbound copy must be provided to the Chemistry Graduate Office, which will maintained with all of the Ph.D. dissertations. All hardbound copies must have a black cover with gold lettering.

b) Research Evaluation

After the student completes the Second Year Oral Examination, the only course enrolled in for research is CEM 999. No grade is received for these credits, unlike CEM 890 (Section 002), which is graded research. The Graduate Office will request an evaluation of each student's research progress at the end of each semester. A copy of the evaluation will be provided to the student. If successive semesters of "unsatisfactory" research evaluations are reported, the student will be required to call a meeting of the Guidance Committee to review her/his progress.

c) Research Involving Human and/or Animal Use

University and Federal policies and procedures require that all research involving human or animal subjects receive prior approval from the appropriate review board. At Michigan State University, that Board is the University Committee on Research Involving Human Subjects (UCRIHS). Specific information regarding procedures for obtaining appropriate review of proposed research projects involving human subjects is available from the Office of the Vice President for Research & Graduate Studies (232 Administration Building; Web: ***http://www.vprgs.msu.edu/***).

12. Financial Support and Time Limits

a) Limits for Financial Support

The Chemistry Department faculty have established that students should be able to complete the requirements for the Ph.D. degree within a 5-year period. This is meant to include time spent in the University/Department. Semesters during which a student is supported by funds from outside the University or is paid on student labor payroll are included in this time period if (s)he is working on his/her research program.

b) Graduate Assistantships

All Ph.D. students who receive a Graduate Assistantship must be enrolled for a minimum of three credits for the Fall and Spring Semesters (with a tuition waiver of nine credits available) and a minimum of three credits for Summer Term (with a tuition waiver of five credits available). Students may enroll for one credit during the semester in which they defend, however, this can only be done once, so it is important to enroll for one credit in the semester in which you are certain you will defend.

c) Continuing Support in the Graduate Program

Paragraph 4.2.3. of the *Graduate Students Rights and Responsibilities* document requires that each student be notified, by March 31, of the status of his/her graduate assistantship for the subsequent academic year. Ph.D. students in the second, third, and fourth years of their program will be notified that their assistantship support for the next academic year will be renewed provided:

i. the student remains in good standing (GPA of at least 3.0)

ii. the student continues to make satisfactory progress toward his/her degree; and

iii. the University provides funding for TA stipends that is at least equivalent to past years.

Students who are in the Plan A M.S. program, or who started in the graduate program in a Spring semester, may be notified that their support will be renewed for a portion of the upcoming academic year, consistent with the time limits established for support.

Students in their fifth year (i.e., entering their sixth year) will be notified that they are no longer eligible to receive a Teaching Assistantship for the following year, since they will have exceeded the time limit for support established by the faculty for their program.

d) Illness/Injury/Pregnancy Leave/Vacation Time/Leaves of Absence Policy

A graduate assistant unable to fulfill the duties of his/her appointment because of illness or injury shall notify the Associate Chair of the Graduate Program or the Graduate Program Administrator of his/her appointing unit as promptly as possible. Similarly, a graduate assistant unable to fulfill the duties of her appointment due to pregnancy shall notify the Associate Chair of the Graduate Program or the Graduate Program Administrator of her major unit as soon as circumstances permit.

During the illness, injury, or pregnancy, the appointing unit shall adjust (reduce, waive, or reschedule) the graduate assistant's duties as those duties and the assistant's physical circumstances reasonably dictate. If total absence from duties becomes necessary and the graduate assistant is still enrolled, the appointing unit shall maintain the stipend of the appointment, provided for a period of two months or to the end of the appointment period or the semester, whichever occurs first.

The graduate assistant shall have the right to return to the assistantship, with the original terms of the appointment, at such time as he or she is able to resume their duties.

Teaching Assistants should refer to Article 18 of the GEU Contract for information on Employee Leave Time (i.e., bereavement leave, adoption and parental leave, and jury duty).

During the course of the calendar year, graduate assistants are allowed a total of two weeks of paid vacation time. A period of absence beyond two weeks MUST have the approval of the student's research advisor; however, an absence of one month or more constitutes a leave of absence and requires the approval of the Chemistry Graduate Office. The specific period(s) of vacation are to be arranged by mutual consent with the research advisor and the instructor of the course for which the student is assigned as a TA, if applicable, and approved by him/her. Additional absences for vacation purposes may not be granted with pay. An absence beyond a period of three weeks will be treated as a Leave of Absence. Requests for a Leave of Absence must be made to the Chemistry Graduate Office prior to the absence. Such situations will be considered on a case-by-case basis, and final authority rests with the Associate Chair for the Graduate Program.

International students are cautioned about returning to their home country, which could result in visa related problems that could hamper a return to the U.S. Such an absence will have a negative impact on research productivity, create an inability to fulfill the responsibilities of a Teaching Assistantship and can result in a reduction in support for the semester of the absence.

ALL graduate assistants must be present during the period of their appointment. Absence without specific permission from the Graduate Office may result in loss of pay or, in some cases, termination of the Graduate Assistant Appointment. (Appointment Periods: FS = 08/16-12/31, SS = 01/01-05/15, US = 05/16-08/15.)

e) Continuation in the Graduate Program after Five Years

The Guidance Committee of every student beginning their sixth year of study and every year thereafter must meet during the first semester of the year. The purpose of the meeting will be

to assess the progress of the student and could be the Final Oral Examination. The meeting will normally be called by the Guidance Committee Chairperson with the student making the arrangements for time and room reservation. If the Committee does not meet during the first semester of the year, the Associate Chair for the Graduate Program will call a meeting of the Committee during the first month of the following semester.

University rules require that all requirements for the Ph.D. degree must be completed within eight years from the time of a student's first enrollment as a doctoral student. If the requirements are not completed within this eight-year period, all of the comprehensive examinations must be passed again.

13. Two Additional Considerations

a) Changing Research Groups

Students may decide to change their research advisor at some point in the graduate program. Such a decision must be approved by the Associate Chair for the Graduate Program. A decision to change research advisors does not change the student's overall eligibility for financial support in the Ph.D. program in the Department, which is a period of no more than 5 years. The decision to change a research group may require additional action, depending on when the decision is made. Some possibilities include:

i. Change <u>before</u> Second Year Oral Examination.
   Action required: None.

ii. Change of advisor at the time of M.S. thesis defense.
   Action required: The student should, within one semester, select a new Guidance Committee and hold a Second Year Oral Examination.

iii. A student in the Ph.D. program decides to change advisors after completing the Second Year Oral Examination.

   Action required: The student should select a new Guidance Committee, and schedule a meeting analogous to the First Committee Meeting, so there will be some discussion of the research plan with a Guidance Committee before the final defense.

b) Relationship Between the M.S. Program and the Ph.D. Program

A student may enter MSU as a Ph.D. candidate, may decide to move to the M.S. program, or may be moved, by the Faculty or the Guidance Committee, to the M.S. program.

The M.S. degree is normally considered to be a terminal degree. In unusual cases, a student may be admitted into the Ph.D. program at their Plan A M.S. Thesis Defense. This would require a strong record in terms of GPA, points in Cumulative Examinations, and commendable performance in research and at the defense.

A student who wishes to be considered for admission into the Ph.D. program at the M.S. defense, and to have the thesis defense also serve as a Second Year Oral Examination, must do the following:

i. Their Guidance Committee should consist of 4 members, not 3;

ii. They should enroll for one credit of CEM 890, if they did not already enroll for this credit during the second semester of their second year in the graduate program;

iii. They should plan not only to defend their thesis, but make a presentation on future plans.

If a student is admitted into the Ph.D. program at the M.S. thesis defense, that student will be eligible for an additional 8 semesters of support (including summer semesters) for completion of the requirements for the Ph.D. Degree. The additional 8 semesters of support will be available only after all requirements for the M.S. degree have been met (Thesis Defense, submission of unbound copy of the thesis to the Graduate School, and submission of hardbound copies of the thesis to the Chemistry Graduate Office and to the research advisor).

14. Student Records

Every graduate student has an academic student file, which is located in the Chemistry Graduate Office. This file contains all academic forms required by the Chemistry Graduate Program and the University (e.g., Research Advisor Selection, Selection of Guidance Committee, First Committee Meeting Report, Second Year Oral Report, Report of the Guidance Committee, etc.) plus copies of graduate appointments, fellowship forms, Chemistry Department Status Reports, grade reports, evaluations, and admissions material. Chemistry TA files are also maintained separately in the Chemistry Graduate Office.

At the end of the Fall and Spring Semesters, students will receive a Status Report which lists all of the academic information pertaining to a student's progress in meeting the Chemistry Ph.D. and/or M.S. degree requirements. Students are encouraged to review this information and any discrepancies in this information should be indicated on the report and returned to the Chemistry Graduate Office for review. A revised Status Report will be issued after the correction(s) has been confirmed and made.

Possession of an academic student file and/or TA file, by the graduate student is not allowed; however, a student may ask to review their file by making a request to the Graduate Office Administrator. The file cannot be removed from the Graduate Office; all reviews will take place in the Graduate Office under the supervision of Graduate Office Personnel. It is important to remember that students receive copies of all forms, graduate appointments, evaluations, most correspondence, and RA and TA evaluations. Students can review their admissions material with the exception of letters of reference, which are confidential.

ELECTRONIC SUBMISSIONS OF THESES & DISSERTATIONS:

Graduate handbooks must indicate that MSU only accepts electronic theses and dissertations submitted via ProQuest. The instructions for electronic submissions are available from *http://grad.msu.edu/etd/*.

The target date for the FINAL APPROVAL of an electronic Thesis or Dissertation to the Graduate School for graduating the semester of that submission is FIVE working days prior to the first day of classes for the next semester (see future target dates below). Be aware that a submission via ProQuest does not mean that the document has been ACCEPTED. The review process is interactive and final approval can take anywhere from a few hours to weeks, depending upon the extent of the necessary revisions and how diligent the author is when making the necessary revisions.

The Graduate School has hard due dates for submission of Thesis/Dissertation materials which need to be met for graduation in a specific Semester. Refer to the Graduate School website for the specific due dates.

Graduation on the semester of the electronic submission is only guaranteed if the document is APPROVED on or before the target date for that semester

NOTE: GradPlan was developed for Ph.D. students to lay out their Ph.D. program of study, record faculty approval, and make notes on all the requirements as they are completed. GradPlan is also the only way final degree certification/degree audit will be conducted beginning in Fall 2016. The Graduate School will certify the acceptance of each dissertation final format using GradPlan. The Office of the Registrar will access GradPlan to complete degree certification once a student completes an application for graduation. ***http://grad.msu.edu/gradplan/Default.aspx***

B. M.S. Degree

1. Two Plans

The Department of Chemistry offers a Master of Science Degree in Chemistry through two programs: Plan A, which is the normal program and requires a research thesis, and Plan B, a terminal graduate program composed of graduate course work.

2. Admission Requirements

Candidates for the M.S. program are expected to have completed the equivalent of a Bachelor's degree in Chemistry. Deficiencies in specific areas at the undergraduate level must be removed by passing undergraduate courses in those areas.

3. Foreign Language Requirement

The Chemistry Department has no formal foreign language requirement.

4. Credit Requirements

The University requires 30 semester hours of graduate work beyond the Bachelor's degree for the M.S. degree. Courses numbered 400 or higher are acceptable as graduate credit toward the degree, but at least 15 semester credits must be from courses at the 800 or 900 level. Plan A requires 8 credit hours and permits up to 15 credit hours of research, CEM 899, and enough course credits to equal 30 semester credit hours. A Plan B M.S. degree can be obtained with 30 semester credits of course work. Credits of CEM 999 cannot be counted in the 30 credit requirement for the M.S. degree. Students who enrolled for CEM 999 and then moved to the M.S. program should contact the Graduate Office to address the situation. Credits in CEM 999 and CEM 899 cannot be applied toward completion of a Plan B course work M.S. program. Graduate Students in a Plan B program can be involved in research; however, it must be done as CEM 890, Graduate Problems and Reports.

A candidate for a second master's degree, or for joint or dual master's degrees, from MSU may request the application of up to 9 credits, appropriate to both programs, from the first master's degree program to the second or from one master's program to another. These credits must have been earned within the time limitations of the college concerned. Graduate courses taken in related departments (Biochemistry, Physics, Chemical Engineering, Mathematics and others by specific approval in advance by the Associate Chair for the Graduate Program) can be applied to the M.S. degree, but at least 2/3 of the total credits must be in the Chemistry Department. Up to 8 credits of graduate work at other accredited institutions are transferable to the M.S. program if judged acceptable by the Department and the College of Natural Science.

5. Placement Exams

All incoming graduate students are required to take Placement Exams that are designed to test their background in the traditional areas of Chemistry. The information obtained from these exams will be used to design a coursework plan for each student, to make initial teaching assignments and to measure the student's preparedness for research. Placement exams will normally be administered at the start of orientation week in the Fall semester. For students entering our graduate program at off-times, the exams must be taken prior to their first enrollment as a chemistry graduate student at MSU. Two exams will be given. The first will cover undergraduate training in synthetic chemistry and cover material traditionally taught in Organic and Inorganic chemistry. The second, will test background knowledge in Analytical and Physical chemistry. In certain cases, non-traditional students with multiple deficiencies in their undergraduate training may be excused from one of these exams.

6. Minimum Grade Point Average

Candidates for the M.S. degree are expected to maintain a minimum grade point average of 3.0 for all course work. If a M.S. candidate accumulates grades below 3.0 in more than three courses, (s)he is

removed from candidacy for the degree by the College of Natural Science. A final GPA of at least 3.0 is required for the M.S. degree.

7. Seminar

Candidates for the M.S. degree are required to give at least one seminar in a seminar series in the department. All students in the M.S. degree program are required to give a literature seminar, and those students in the Plan A M.S. degree program shall present a formal research seminar immediately prior to their M.S. oral examination.

8. Oral Examination

The Oral Examination Committee for the Plan A M.S. degree will include the student's advisor (as Chairperson), at least one other faculty member from the same research area, and at least one faculty member from a different area. The Oral Examination Committee for the Plan B M.S. degree will include the student's advisor, as Chairperson, and at least two additional faculty. In either case, the composition of the committee requires the approval of the Associate Chair for the Graduate Program.

Students electing Plan A will defend their research thesis and may be questioned on course work. Those electing Plan B will be examined only on course work. For the Plan A student, the Oral Examination Committee determines whether the student must terminate at the M.S .level or is recommended to the faculty for admission to the Ph.D. program. If the student wishes to be recommended for admission to the Ph.D. program, they must have, as part of their oral presentation, a plan for future research work in the Ph.D. program. The decision will be based on performance in the Oral Examination, quality of the M.S. research, performance in graduate courses, and the student's Qualification and Cumulative Examination record. If a positive recommendation is made, the Committee may further recommend that the M.S. Plan A Oral Examination be accepted in lieu of the Ph.D. Second Year Oral Examination. The Plan A candidate must present an acceptable copy of the thesis to the Oral Examination Committee at last one week before the date scheduled for the Oral Examination.

The Plan B M.S. program is terminal.

Students preparing for the Final Oral Exam should address the following issues:

1. Apply for graduation through the Registrar's Office.
2. Navigate to the Graduate School website ***http://grad.msu.edu/etd/*** and follow the instructions there for electronic submission of your Thesis.
3. For the Chemistry Department you must complete an M.S. Oral Exam Announcement (located on the Chemistry Department web site, ***http://www.chemistry.msu.edu/graduate/oralExamReg.cfm***) and submit the form electronically to the Chemistry Graduate Office. This process informs the Graduate Office of your Final Oral Exam. The announcement should be submitted five working days prior to the exam.
4. A completed "Distribution of Unbound Copy of Thesis form, signed by the members of the Evaluation Committee, must also be submitted to the Graduate Office five days in advance of the Final Oral Exam.

In order for the Final Certification of a degree to be approved by the Chemistry Department and submitted to the Registrar's Office, students **MUST** submit a **HARDBOUND** (black cover with gold lettering) copy of their dissertation to the Chemistry Graduate Office, along with completed "Check Out Form" and "CNS Placement Form." Degree approval will not occur until these requirements are met.

Students must be registered for one credit in the semester in which they hold their Final Oral Exam. Exams can be held on the last day prior to the start of the next semester. For example, if a student is enrolled for one credit for Fall semester, they have until the start of Spring semester to defend and be

considered a Fall semester graduate and, hence, not have to enroll for Spring semester. Students must deliver the final, unbound copy of their thesis to The Graduate School by their deadline in order to be considered a graduate for that particular semester.

9. Limit for Financial Support

Plan A M.S. candidates are eligible for financial support from the department for up to 2 years plus one semester (7 semesters total, including summer semesters). Plan B M.S. candidates are not eligible for financial support from the department.

10. Financial Support Prioritization

The department prioritizes support in the following manner. PhD students in good standing receive top priority for support, and Plan A M.S. students in good standing receive second priority. In rare circumstances and solely at the discretion of the department, Ph.D. students beyond their fifth year in the program or Plan A M.S. students beyond their seventh semester may receive support from the department. In such instances, Ph.D. students in good standing who are beyond their fifth year in the program receive higher priority than Plan A M.S. students beyond their support. Plan B M.S. students are not eligible for support.

III. Descriptions of Chemistry Courses

CEM 141

CEM 141 General Chemistry

Credits: Total Credits: 4 Lecture/Recitation/Discussion Hours: 4 4(4-0)

Prerequisites: (MTH 103 or concurrently or MTH 110 or concurrently or MTH 116 or concurrently or MTH 124 or concurrently or MTH 132 or concurrently or MTH 152H or concurrently or LBS 117 or concurrently or LBS 118 or concurrently) or designated score on Mathematic placement test.

Not open to students with credit in: CEM 152 or CEM 182H or LBS 171

Reenrollment Information:

Description: Atoms, molecules, ions; chemical calculations; reactions, energy changes; gases; periodic properties of elements; chemical bonds; states of matter, solutions; acids and bases; aqueous reactions and ionic equations.

CEM 142

CEM 142 General and Inorganic Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 4 3(4-0)

Prerequisites: (CEM 141 or LBS 171)

Not open to students with credit in: CEM 151 or LBS 172

Reenrollment Information:

Description: Kinetics; gaseous equilibria; acids and bases; pH; aqueous equilibria involving buffers, hydrolysis, and titrations; heterogeneous equilibria of weakly soluble salts; electrochemistry; coordination chemistry, stereochemistry, and bonding within the transition elements.

CEM 143

CEM 143 Survey of Organic Chemistry

Credits: Total Credits: 4 Lecture/Recitation/Discussion Hours: 3 Lab Hours: 3 4(3-3)

Prerequisites: (CEM 141 or CEM 151)

Not open to students with credit in: CEM 251 or CEM 351

Reenrollment Information:

Description: Chemistry of carbon compounds. Chemistry of the main organic functional groups with applications to everyday life, industry, and biology.

CEM 151

CEM 151 General and Descriptive Chemistry

Credits: Total Credits: 4 Lecture/Recitation/Discussion Hours: 4 4(4-0)

Prerequisites: (MTH 116 or concurrently or MTH 124 or concurrently or MTH 132 or concurrently or MTH 152H or concurrently or LBS 117 or concurrently or LBS 118 or concurrently) or designated score on Mathematics placement test.

Not open to students with credit in: CEM 142 or CEM 181H or LBS 172

Reenrollment Information:

Description: Atomic and molecular structure; ionic and molecular bonding models; periodic trends; chemical reactivity by periodic group; nomenclature, structure, bonding and reactivity of coordination compounds; bioinorganic chemistry.

CEM 152

CEM 152 Principles of Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites: (CEM 151 or CEM 181H)

Not open to students with credit in: CEM 142 or CEM 182H or LBS 172

Reenrollment Information:

Description: The mole concept and stoichiometry; solution stoichiometry; thermochemistry; gases, liquids, and solids; kinetics; chemical equilibria; acid-based equilibria; aqueous equilibria; thermodynamics; redox and electrochemistry.

CEM 161

CEM 161 Chemistry Laboratory I

Credits: Total Credits: 1 Lab Hours: 3 1(0-3)

Prerequisites: (CEM 141 or concurrently or CEM 151 or concurrently)

Not open to students with credit in: LBS 171L or CEM 185H

Reenrollment Information:

Description: Experiments in general chemistry; stoichiometry, calorimetry, electrochemistry, molecular geometry, gas laws, kinetics, acids and bases, and inorganic chemistry.

CEM 162

CEM 162 Chemistry Laboratory II

Credits: Total Credits: 1 Lab Hours: 3 1(0-3)

Prerequisites: (CEM 161 or LBS 171L or CEM 185H) and (CEM 142 or concurrently and CEM 152 or concurrently)

Not open to students with credit in: LBS 172L or CEM 186H

Reenrollment Information:

Description: Analytical and inorganic chemistry; redox and acid base titrations; spectrophotometric and gravimetric analysis; preparation and analysis of coordination complexes of nickel, iron, and cobalt.

CEM 181H

CEM 181H Honors Chemistry I

Credits: Total Credits: 4 Lecture/Recitation/Discussion Hours: 4 4(4-0)

Prerequisites: (MTH 124 or concurrently or MTH 132 or concurrently or MTH 152H or concurrently or LBS 118 or concurrently)

Not open to students with credit in:

Reenrollment Information:

Description: States of matter. Descriptive inorganic chemistry by periodic groups of elements. Kinetic theory of gases. Thermodynamics, chemical equilibrium and electrochemistry. Properties of solutions. Macromolecular chemistry. Macroscopic kinetics.

CEM 182H

CEM 182H Honors Chemistry II (Interim)

Credits: Total Credits: 4 Lecture/Recitation/Discussion Hours: 4 4(4-0)

Prerequisites: (CEM 181H or CEM 151) and (MTH 126 or concurrently or MTH 133 or concurrently or MTH 153H or concurrently)

Not open to students with credit in:

Reenrollment Information:

Description: Thermodynamics and chemical equilibria; acids and bases; redox chemistry; main group elements; solid state; group theory and symmetry; molecular orbital theory; transition metal chemistry and spectroscopy.

CEM 185H

CEM 185H Honors Chemistry Laboratory I

Credits: Total Credits: 2 Lab Hours: 6 2(0-6)

Prerequisites: (CEM 181H or concurrently)

Not open to students with credit in:

Reenrollment Information:

Description: Spectroscopy and diffraction methods for the study of electronic structure and molecular geometry; synthesis and separation methods for the preparation and characterization of molecules; application to inorganic, organic, and biochemical molecules and materials.

CEM 186H

CEM 186H Honors Chemistry Laboratory II

Credits: Total Credits: 2 Lab Hours: 6 2(0-6)

Prerequisites: (CEM 182H or concurrently)

Not open to students with credit in:

Reenrollment Information:

Description: Laboratory research.

CEM 251

CEM 251 Organic Chemistry I

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 4 3(4-0)

Prerequisites: CEM 141 or CEM 151 or CEm 181H or LB 171

Not open to students with credit in: CEM 351

Reenrollment Information:

Description: Common classes of organic compounds including their nomenclature, structure, bonding, reactivity, and spectroscopic characterization.

CEM 252

CEM 252 Organic Chemistry II

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 4 3(4-0)

Prerequisites: (CEM 251)

Not open to students with credit in: CEM 352

Reenrollment Information:

Description: Continuation of CEM 251 with emphasis on polyfunctional compounds, particularly those of biological interest.

CEM 255

CEM 255 Organic Chemistry Laboratory

Credits: Total Credits: 2 Lecture/Recitation/Discussion Hours: 1 Lab Hours: 3 2(1-3)

Prerequisites: (CEM 252 or concurrently) and (CEM 161 or LBS 171L or CEM 185H)

Not open to students with credit in: CEM 355

Reenrollment Information:

Description: Preparation and qualitative analysis of organic compounds.

CEM 262

CEM 262 Quantitative Analysis

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 Lab Hours: 3 3(3-3)
Prerequisites: (CEM 162 or LBS 172L)
Not open to students with credit in: CEM 186H
Reenrollment Information:
Description: Preparation and quantitative analysis of chemical compounds.

CEM 311

CEM 311 Inorganic Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3
Prerequisites: CEM 142 or CEM 152 or CEM 182H or LB 172.
Not open to students with credit in:
Reenrollment Information:
Description: Basic symmetry, molecular orbital theory, and valence bond theory applications to inorganic systems. Physical properties and reactivity of transition metal systems.

CEM 333

CEM 333 Instrumental Methods

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 2 Lab Hours: 3 3(2-3)
Prerequisites: (CEM 143 or CEM 251 or CEM 351) and (CEM 262 or CEM 186H) and completion of Tier I writing requirement.
Not open to students with credit in:
Reenrollment Information:
Description: Principles of instrumental analysis. Application of separation techniques and instrumental analysis.

CEM 351

CEM 351 Organic Chemistry I

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 4 3(4-0)
Prerequisites: (CEM 152 or CEM 182H or CEM 142 or LBS 172)
Not open to students with credit in: CEM 143 or CEM 251
Reenrollment Information:
Description: Structure, bonding, and reactivity of organic molecules.

CEM 355

CEM 355 Organic Laboratory I

Credits: Total Credits: 2 Lab Hours: 6 2(0-6)
Prerequisites: (CEM 162 or CEM 186H or LBS 172L or CEM 352 or concurrently) and completion of Tier I writing requirement.
Not open to students with credit in: CEM 255
Reenrollment Information:
Description: Organic laboratory techniques. Distillation. Spectroscopy. Melting points. Recrystallization. Chromatography. Measuring physical properties.

CEM 356

CEM 356 Organic Laboratory II

Credits: Total Credits: 2 Lab Hours: 6 2(0-6)
Prerequisites: (CEM 355)
Not open to students with credit in:
Reenrollment Information:
Description: Multi-step organic synthesis. Qualitative organic analysis. Separation, identification, and characterization of unknowns.

CEM 383

CEM 383 Introductory Physical Chemistry I

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 4 3(4-0)
Prerequisites: (CEM 142 or CEM 152 or CEM 182H or LBS 172) and (MTH 133 or MTH 153H or MTH 126 or LBS 119)
Not open to students with credit in: CEM 391
Reenrollment Information:
Description: Physical chemistry of macroscopic systems: thermodynamics, kinetics, electrochemistry.

CEM 395

CEM 395 Analytical/Physical Laboratory

Credits: Total Credits: 2 Lecture/Recitation/Discussion Hours: 1 Lab Hours: 3 2(1-3)
Prerequisites: (CEM 391 or CEM 383) and (CEM 262) and completion of Tier I writing requirement.
Not open to students with credit in:
Reenrollment Information:
Description: Chemical kinetics, thermodynamics, and computer-based data analysis methods.

CEM 400H

CEM 400H Honors Work

Credits: Variable from 1 to 12
Prerequisites: Completion of Tier I writing requirement.
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 12 credits in all enrollments for this course.
Description: Readings and investigations in chemistry.

CEM 410

CEM 410 Literature and Writing in Chemistry

Credits: Total Credits: 3 3(0-0)
Prerequisites: (CEM 252) and (CEM 384) and (CEM 333 or concurrently) and completion of Tier I writing requirement.
Not open to students with credit in:
Reenrollment Information:
Description: Library research related to a topic in contemporary chemistry; thesis required.

CEM 415

CEM 415 Advanced Synthesis Laboratory

Credits: Total Credits: 3 Lab Hours: 8 3(0-8)
Prerequisites: (CEM 411) and completion of Tier I writing requirement.
Not open to students with credit in:
Reenrollment Information:
Description: Methods of synthesizing inorganic and organometallic compounds.

CEM 419

CEM 419 Independent Study

Credits: Variable from 1 to 12
Prerequisites:
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 12 credits in all enrollments for this course.
Description: Faculty supervised readings in chemistry.

CEM 420

CEM 420 Independent Research

Credits: Variable from 1 to 12
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Faculty supervised independent investigations in chemistry.

CEM 434

CEM 434 Advanced Analytical Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites: (CEM 392 and CEM 395 and CEM 352)
Not open to students with credit in:
Reenrollment Information:
Description: Instrumental methods of analysis, including spectroscopy, chromatography and electrochemistry.

CEM 435

CEM 435 Analytical Chemistry Laboratory

Credits: Total Credits: 2 Lecture/Recitation/Discussion Hours: 1 Lab Hours: 3 2(1-3)
Prerequisites: (CEM 434 or concurrently) and completion of Tier I writing requirement.
Not open to students with credit in:
Reenrollment Information:
Description: Electronic and optical components of chemical instrumentation. Spectroscopic and chromatographic methods.

CEM 444

CEM 444 Chemical Safety

Credits: Total Credits: 1 Lecture/Recitation/Discussion Hours: 1 1(1-0)
Prerequisites: CEM 142 and CEM 252
Not open to students with credit in:
Reenrollment Information:
Description: Prudent laboratory practices. Regulatory agencies' expectations of chemical industries and academia..

CEM 481

CEM 481 Seminar in Computational Chemistry

Credits: Variable from 1 to 6
Prerequisites: (MTH 133 and CSE 231) and (CEM 152 or concurrently or CEM 182H or concurrently)
Not open to students with credit in:
Reenrollment Information:
Description: Written and oral reports on selected journal articles in computational chemistry.

CEM 483

CEM 483 Quantum Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 4 3(4-0)
Prerequisites: (MTH 235 or MTH 255H) and (PHY 184 or PHY 294H) and (CEM 142 or CEM 152 or CEM 181H)
Not open to students with credit in: CEM 384
Reenrollment Information:
Description: Postulates of quantum mechanics and the application to model systems, atoms and molecules. Introduction to molecular spectroscopy.

CEM 484

CEM 483 Molecular Thermodynamics

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 4 3(4-0)
Prerequisites: (MTH 235 or MTH 255H) and (PHY 184 or PHY 294H or LB 272) and (CEM 142 or CEM 152 or CEM 182H or LB 172)
Not open to students with credit in: CEM 383
Reenrollment Information:
Description: Statistical mechanics and its use in classical chemical thermodynamics. Applications of thermodynamics to chemical systems at equilibrium.

CEM 485

CEM 485 Modern Nuclear Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites: (CEM 141 or CEM 152 or CEM 182H) and (PHY 232 or PHY 184) (CEM 392 or CEM 384 or PHY 471)
Not open to students with credit in:
Reenrollment Information:
Description: Elementary nuclear processes and properties; radioactivity, its measurement and its interaction with matter.

CEM 495

CEM 495 Molecular Spectroscopy

Credits: Total Credits: 2 Lecture/Recitation/Discussion Hours: 1 Lab Hours: 3 2(1-3)
Prerequisites: (CEM 392)
Not open to students with credit in:
Reenrollment Information:
Description: Experiments in magnetic resonance, optical, and vibrational spectroscopies.

CEM 499

CEM 499 Chemical Physics Seminar

Credits: Total Credits: 1 Lecture/Recitation/Discussion Hours: 1 1(1-0)
Prerequisites: (PHY 321) and (MTH 235 or LBS 220 or MTH 255H) and completion of Tier I writing requirement.
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 2 credits in all enrollments for this course.
Description: Written and oral reports on selected journal articles in chemical physics.

CEM 811

CEM 811 Advanced Inorganic Chemistry I

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Principles of chemical bonding, electronic structure, and reaction mechanisms of main group and transition metal compounds. Concepts of group theory.

CEM 812

CEM 812 Advanced Inorganic Chemistry II

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites: (CEM 811)
Not open to students with credit in:
Reenrollment Information:
Description: Descriptive chemistry of inorganic compounds. Emphasis on synthesis, structure, and reactivity patterns of coordination, organometallic, and solid state compounds of transition metals and main group elements.

CEM 820

CEM 820 Organometallic Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Organometallic functional groups. Principles of electronic structure, and bonding in organometallic species will be related to reactivity patterns in common systems. Preparation of complexes with applications to catalytic and stoichiometric organic syntheses.

CEM 832

CEM 832 Mass Spectrometry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites: CEM 835
Not open to students with credit in:
Reenrollment Information:
Description: Instrumentation of mass spectrometry. Interpreting mass spectra of organic and inorganic molecules. Applications to analysis of large molecules and chromatography.

CEM 834

CEM 834 Advanced Analytical Chemistry I

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Basic electronics and data acquisition/analysis, electrochemistry, and statistics for chemists.

CEM 835

CEM 835 Advanced Analytical Chemistry II

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 2 Lab Hours: 3 3(2-3)
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Separations, molecular spectroscopy, and mass spectrometry.

CEM 836

CEM 836 Separation Science

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information:

Description: Physical and chemical principles of separations, column technology, and instrumentation for gas, liquid, and supercritical fluid chromatography.

CEM 837

CEM 837 Electroanalytical Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information:

Description: Modern electroanalytical chemistry. Theory and applications to chemical and biological problems. Coulometry, voltammetry, ion-selective potentiometry, and other electrochemical techniques.

CEM 845

CEM 845 Structure and Spectroscopy of Organic Compounds

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information:

Description: Structural and stereochemical principles in organic chemistry. Applications of spectroscopic methods, especially nuclear magnetic resonance, static and dynamic aspects of stereochemistry. Spectroscopy in structure determination.

CEM 850

CEM 851 Intermediate Organic Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information:

Description: Traditional and modern basic reaction mechanisms and principles and their synthetic applications.

CEM 851

CEM 851 Advanced Organic Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information:

Description: Structure, reactivity, and methods. Acid-base reactions, substitution, addition, elimination, and pericyclic processes. Major organic intermediates related to simple bonding theory, kinetics, and thermodynamics.

CEM 852

CEM 852 Methods of Organic Synthesis

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information:

Description: Principal reactions leading to carbon-carbon bond formation and functional group transformations. Strategies and methods of organic synthesis.

CEM 881

CEM 881 Atomic and Molecular Structure

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information:

Description: Postulates of quantum mechanics, analytical solutions of the Schroedinger equation, theoretical descriptions of chemical bonding, spectroscopy, statistical mechanics, and statistical thermodynamics.

CEM 882

CEM 882 Kinetics and Spectroscopic Methods

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Rate equations and mechanisms of chemical reactions: reaction rate theory, kinetic theory of gases, photochemistry. Spectroscopic methods, and applications of spectroscopy in reaction kinetics.

CEM 883

CEM 883 Computational Quantum Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 2 Lab Hours: 3 3(2-3)
Prerequisites: (CEM 461 or CEM 881)
Not open to students with credit in:
Reenrollment Information:
Description: Computational methods in determining electronic energy levels, equilibrium nuclear configurations, and other molecular properties.

CEM 888

CEM 888 Computational Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 2 Lab Hours: 3 3(2-3)
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Computational approaches to molecular problems. Use of ab initio and semi-empirical electronic structure, molecular mechanics and molecular dynamics software.

CEM 890

CEM 890 Chemical Problems and Reports

Section 001: Faculty Seminar Series – for first year students (1 credit only)
Section 002: Second Year Oral Exam – for second year students (1 credit only)
Section 003: Graded Research – to be arranged through student's Advisor (usually 3 credits but 1-6 are possible for this section)
Section 004: Area Seminar –only if enrolled for in the summer (1 credit) Course to be arranged through student's Advisor

Credits: Variable from 1 to 6
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Investigation and report of a nonthesis problem in chemistry.

CEM 899

CEM 899 Master's Thesis Research

Credits: Variable from 1 to 20
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Master's thesis research.

CEM 913

CEM 913 Special Topics in Inorganic Chemistry

Credits: Variable from 1 to 3
Prerequisites:
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 9 credits in all enrollments for this course.
Description: Chemistry of metal-metal bonds and clusters, organometallic chemistry, layered oxides, and complex layered oxides. Photochemistry. Solid state chemistry and applications of quantum mechanics

CEM 918

CEM 918 Inorganic Chemistry Seminar

Credits: Total Credits: 1 Lecture/Recitation/Discussion Hours: 1 1(1-0)
Prerequisites:
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 3 credits in all enrollments for this course.
Description: Advances in inorganic chemistry reported by graduate students.

CEM 924

CEM 924 Selected Topics in Analytical Chemistry

Credits: Variable from 2 to 3
Prerequisites:
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 9 credits in all enrollments for this course.
Description: Advanced computer techniques, surface chemistry, analytical chemistry of polymers, or statistics for chemists.

CEM 938

CEM 938 Analytical Chemistry Seminar

Credits: Total Credits: 1 Lecture/Recitation/Discussion Hours: 1 1(1-0)
Prerequisites:
Not open to students with credit in:
Reenrollment Information: Open only to graduate students in College of Natural Science or College of Engineering.
Description: Advances in analytical chemistry reported by graduate students, faculty, and guest lecturers.

CEM 956

CEM 956 Selected Topics in Organic Chemistry

Credits: Variable from 1 to 3
Prerequisites:
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 12 credits in all enrollments for this course.
Description: Heterocyclic and organometallic chemistry, natural products, photochemistry, free radicals, or reaction mechanisms.

CEM 958

CEM 958 Organic Chemistry Seminar

Credits: Total Credits: 1 Lecture/Recitation/Discussion Hours: 1 1(1-0)
Prerequisites:
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 2 credits in all enrollments for this course.
Description: Advances in organic chemistry reported by graduate students.

CEM 987

CEM 987 Selected Topics in Physical Chemistry I

Credits: Variable from 1 to 3
Prerequisites:
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 9 credits in all enrollments for this course.
Description: Topics such as kinetics and photochemistry, macromolecular and surface chemistry, molecular spectroscopy, electric and magnetic properties of matter, or applications of statistical mechanics to chemical problems.

CEM 988

CEM 988 Selected Topics in Physical Chemistry II

Credits: Variable from 1 to 3
Prerequisites:
Not open to students with credit in:
Reenrollment Information: A student may earn a maximum of 9 credits in all enrollments for this course.
Description: Topics such as analysis and interpretation of molecular spectra, advanced molecular structure theory, magnetic resonance, X-rays and crystal structure, scientific analysis of vacuum systems, or problems in statistical mechanics.

CEM 991

CEM 991 Quantum Chemistry and Statistical Thermodynamics I

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites:
Not open to students with credit in:
Reenrollment Information:
Description: Principles and applications of quantum chemistry. Partition functions, spectroscopic measurements, and thermodynamic applications.

CEM 992

CEM 992 Quantum Chemistry and Statistical Thermodynamics II

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)
Prerequisites: (CEM 991)
Not open to students with credit in:
Reenrollment Information:
Description: Analytical and numerical methods for solving quantum chemical problems. Statistical mechanics of solids and liquids.

CEM 993

CEM 993 Advanced Topics in Quantum Chemistry

Credits: Total Credits: 3 Lecture/Recitation/Discussion Hours: 3 3(3-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information: A student may earn a maximum of 9 credits in all enrollments for this course.

Description: Spectroscopic theory, properties of atoms and molecules in electric and magnetic fields, intermolecular forces. Many-body theory, molecular electronic structure, solid state chemistry, or molecular reaction dynamics.

CEM 995

CEM 995 Nuclear Chemistry Seminar

Credits: Total Credits: 1 Lecture/Recitation/Discussion Hours: 1 1(1-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information: A student may earn a maximum of 3 credits in all enrollments for this course.

Description: Advances in physical chemistry reported by graduate students

CEM 998

CEM 998 Physical Chemistry Seminar

Credits: Total Credits: 1 Lecture/Recitation/Discussion Hours: 1 1(1-0)

Prerequisites:

Not open to students with credit in:

Reenrollment Information: A student may earn a maximum of 3 credits in all enrollments for this course.

Description: Advances in physical chemistry reported by graduate students.

CEM 999

CEM 999 Doctoral Dissertation Research

Credits: Variable from 1 to 20

Prerequisites:

Not open to students with credit in:

Reenrollment Information: A student may earn a maximum of 99 credits in all enrollments for this course.

Description: Doctoral dissertation research.

IV. Graduate Examinations

A. Placement Examinations

All incoming graduate students are required to take Placement Exams that are designed to evaluate their background in the traditional areas of Chemistry. The information obtained from these exams will be used to establish a coursework plan that will help prepare each student for research and to make initial teaching assignments. Placement exams will normally be administered at the start of orientation week in the Fall semester. Two exams will be given. The first will cover undergraduate training in synthetic chemistry and focus on material traditionally taught in Organic and Inorganic chemistry. The second will test background knowledge in Analytical and Physical chemistry.

Placement exams may consist of ACS standardized exams, exams written by faculty members in the areas being tested, or a combination of both.

Descriptions of these exams prepared by the faculty are given below.

1. Analytical Chemistry Placement Exam

Typical areas of emphasis include solution chemistry (acid-base, precipitation, complex formation, and redox equilibria); instrumentation and instrumental methods of analysis (chromatography, spectroscopy, mass spectrometry, and electrochemistry); kinetic methods; and simple electronics. Analytical chemistry placement examinations are written at the level found in textbooks such as:

Analytical Chemistry. An Introduction, 5th edition, by Skoog, Holler, and Nieman
Principles of Instrumental Analysis, Current edition, by Skoog and Leary.

2. Physical Chemistry Placement Exam

Placement Exam questions in Physical Chemistry consist of problems that generally fall into three subject areas: thermodynamics, chemical kinetics and elementary quantum mechanics. The student should be able to manipulate, solve and apply differential and algebraic equations, provide straightforward derivations, and occasionally explain significant physical techniques or theories. A list of equations and constants is provided and calculators are necessary. The level of coverage is no higher and often lower than that found in textbooks, such as the following:

Physical Chemistry, Current edition, by Atkins,
Physical Chemistry: A Molecular Approach, Current edition, by McQuarrie and Simon.

3. Inorganic Chemistry Placement Exam

The placement examination in synthetic chemistry will contain questions designed to test a student's knowledge of inorganic chemistry at the undergraduate level of an ACS accredited program. Such programs usually include courses in inorganic chemistry at the freshman/sophomore and junior/senior levels; the content of these courses normally span both descriptive chemistry and physical principles and methods. There are many appropriate texts that will prepare the student for this portion of the examination including the descriptive chemistry sections of most introductory chemistry texts, and more advanced texts such as:

Basic Inorganic Chemistry by Cotton, Wilkinson, and Gaus,
Inorganic Chemistry by Shriver and Atkins (3rd Edition).

4. Organic Chemistry Placement Exam

The organic chemistry portion of the synthetic chemistry placement examination is designed to verify that each student has retained a basic knowledge and understanding of the organic chemistry of functional groups, as well as synthetic methods, reaction mechanisms, and spectroscopic methods of

characterization. Questions are based on information contained in, and at the level found in, textbooks such as:

Organic Chemistry, Current edition, by McMurry,
Organic Chemistry, Current edition, by William Brown.

If incoming graduate students have any questions on whether the material covered in their undergraduate courses, or the textbook used in these courses, are representative of the material cited above, they are encouraged to contact either the Graduate Office (517) 355-9715, ext. 343, or a faculty member in a particular area.

B. Cumulative Examinations

The successful completion of Comprehensive Examinations is a requirement for all Ph.D. programs at MSU. In the Chemistry Department, this requirement is satisfied through Cumulative Examinations, which are given six times each academic year. Six Cumulative Exam points must be accrued by the end of the fourth semester (excluding summers) in the Ph.D. program. Examinations in Analytical, Biological, Inorganic, Organic, and Physical areas of Chemistry are given concurrently each time normally, and given in Chemical Physics and Nuclear Chemistry several times per year. Students may write examinations in any area to fulfill this requirement. More than one exam may be written in a single examination period. The structure is flexible: an examination may consist of questions or problems, may be on an announced topic, may be a take-home written examination, or may be a laboratory practical examination. Details of the Cumulative Examination requirements may be found in the Ph.D. Program description.

Cumulative examinations are designed to test graduate-level knowledge and skills related to Chemistry. They may involve critiquing a paper or proposal, writing a brief proposal, answering questions derived from the current literature, describing how a specific problem might be solved, solving numerical problems, or discussing advanced concepts. Problems and questions may involve the application of basic knowledge to real problems that include current topics in the literature, graduate courses, departmental colloquia, lectureships, and area seminars. Cumulative examinations not only test knowledge and the ability to apply knowledge, but writing skills as well (i.e., the ability to organize and convey information).

Students are encouraged to read the scientific literature to enhance the quality of their research and to broaden their scientific perspective. Both journals and graduate courses serve an important role of helping the student to master the ever-changing vocabulary and applications of the Chemical Sciences. To this end, the faculty suggest regular reading of general chemistry journals such as the *Journal of the American Chemical Society*, *Angewandte Chemie*, *Chemical Communications*, and *Accounts of Chemical Research.*

Information specific to the Cumulative Examinations in each area is as follows:

Analytical Chemistry. Cumulative examinations in Analytical Chemistry are primarily designed to test the student's knowledge of, and ability to apply the principles of, analysis and instrumentation. Examinations are usually written by one or two faculty. The format of the examinations may vary from reviews of major areas of Analytical Chemistry to detailed examinations of emerging analytical techniques. Examinations intended to cover the basic principles are typically written at the level of graduate courses such as CEM 834 (Advanced Analytical Chemistry), CEM 837 (Electroanalytical Chemistry), CEM 835 (Spectrochemical Methods of Analysis), CEM 832 (Mass Spectrometry) and CEM 836 (Separation Science). These examinations often focus on the application of fundamental concepts to new ideas in Analytical Chemistry. Emerging areas, as encountered in the seminar/colloquium program, recent articles in journals such as *Analytical Chemistry*, and in CEM 924 (Special Topics in Analytical Chemistry) also serve as exam topics. These examinations frequently require the use of fun-

damental knowledge and problem solving abilities. The topics of some of the examinations each year will be announced in advance.

Chemical Physics. See Appendix B, paragraph B.5.

Inorganic Chemistry. Cumulative examinations in Inorganic Chemistry are written with a prime objective of encouraging students to follow emerging areas of Inorganic Chemistry. These emerging areas are most easily identified by actively participating in departmental seminars and colloquia and by reading the current literature. Literature-related questions frequently involve articles published in the last six months in the four general journals cited above, and additional journals such as *Inorganic Chemistry*, *Chemistry of Materials*, and *Organometallics*, Certainly, reading beyond these few journals is encouraged and required, however they will provide a primary focus.

Nuclear Chemistry. Students should focus on exams in the nuclear chemistry and chemical physics areas. These exams will be offered on an alternating basis, and three of each will be given for the academic year. The nuclear chemistry cumulative exams will test fundamental principles in nuclear structure and nuclear reactions, as well as experimental techniques, statistical principles, and applications of nuclear methods in science and technology. Students taking the exam should have excellent working knowledge of material contained in textbooks such as "Nuclear Chemistry" by Freidlander, et al., "Nuclear Reactions," by Marmier and Sheldon, "Radiation Detection and Measurement," by Knoll, and "Experimental Nuclear Science," by Leo, and "Statistical XXX," by Bevington. Details regarding the Chemical Physics cumulative exams are provided in Appendix B.

Organic Chemistry. The cumulative examinations in organic chemistry have two purposes, First, they demonstrate a student's ability to solve advanced problems. Second, they instill and foster the tenet that learning does not cease with formal course work; and they emphasize the importance of expanding ones knowledge and understanding of Organic Chemistry by reading extensively in the current and older literature, by attending seminars and colloquial and through daily discussions with colleagues. Cumulative exam questions will generally provide sufficient data to permit a rational answer to be formulated, whether or not the original source of the topic (such as a particular journal article) was familiar to the student. In some cases, topics and/or specific sources may be announced in advance.

Physical Chemistry. Cumulative examinations in Physical Chemistry test a graduate student's in-depth knowledge of specific topics and techniques. The examinations often consist of two parts, and each exam is written by two faculty. The material in the two sections can be very different, but the grade reflects the combined performance. The mode of the exam also ranges quite broadly. Students are often required to solve detailed mathematical problems in *e.g.*, thermodynamics, statistical mechanics, advanced kinetics and quantum mechanics; to provide an in-depth discussion of the basis, application and limitations of experimental techniques; and occasionally, to discuss and analyze material provided from the current literature or covered in a recent colloquium or special topics course.

Important topics that students can expect to be covered over the course of many examinations include:

Advanced quantum chemistry, including detailed definitions and calculations for specific well-known systems; chemical thermodynamics, particularly derivations and applications; chemical kinetics, including experimental techniques; spectroscopy, basis and applications (e.g., FTIR, Raman, EPR, NMR, multiple photon, etc.); statistical mechanics, including detailed definitions and calculations for specific well-known systems; crystallography, fundamental concepts and structure determination; symmetry and group theory; nuclear chemistry and structure; general estimates of physical quantities and ef-

fects; discussion and explanation of fundamental physical concepts; data analysis techniques; recent (Physical Chemistry) seminars and colloquia.

C. Second Year Oral Examination

1. Philosophy and Student Preparation

The purposes of this examination are to allow the student to demonstrate his or her preparedness for thesis research and ability to think critically and independently, and to review research progress. The examination should test general knowledge as well as specific research results and goals. Some suggestions are given below.

a. General knowledge:
   1) General awareness of literature in the field.
   2) Place of proposed research in the overall scheme of science.
   3) Adequacy of theoretical background.
   4) Knowledge of common instrumental techniques.
   5) Familiarity with available aids at MSU; library, computer, instruments, research help from others, etc.
   6) Information from seminars and colloquia.

b. Specific preparedness:
   1) Information on research progress to date.
   2) Specific goals and plan of attack for continued research.
   3) Details of previously published work on the subject.
   4) Demonstration of sufficient background in the research area with suitable plans to strengthen this background where needed.
   5) Knowledge of experimental and/or theoretical techniques which have been or will be used in the research.
   6) Demonstration of readiness to deal with unexpected results; alternate plans or follow-up.

2. Timing of the Examination

The examination is to be taken by the end of the fourth semester (excluding summer). The student must complete the requirement of six Cumulative Exam Points prior to scheduling the Second Year Oral Exam. In order to avoid schedule conflicts during spring semester, students are encouraged to take the examination as early in their second year as possible. Since the student begins research during the first year, he or she will normally have some research experience prior to the examination.

Postponement of the examination beyond the end of the fourth semester (excluding summer) may be granted if written reasons are presented to the Associate Chairperson by the student and the major professor along with a specified deadline for the examination. The following guidelines should be observed in recommending a postponement:

a. "Poor background" is not an acceptable reason for delay.

b. The student's inability to complete the requirement of six Cumulative Exam Points in the allotted time is not a valid reason for postponement of the exam. Such students are moved to the M.S. program and their Guidance Committee is required to meet soon afterward to determine the student's status.

c. It is desirable but not necessary for the student to have produced results in research prior to the examination. The examination may be used to test research preparedness as well as research progress.

d. Failure does not mean automatic termination of the student's graduate program. Therefore the penalty for being "too early" is not severe.

e. If the examination has not been taken by the end of the fourth semester or by the specified deadline, the Guidance Committee shall be requested to initiate a review of the student's program. If no Guidance Committee has been formed, the Departmental Graduate Advising Committee shall conduct the review.

f. In the case of failure, the examination committee will specify the deadline for reexamination on the report of the examination. Re-examination should be as early as is practical. If the performance is so poor that excessive time would be required, then it would be better to request faculty review of the student's graduate program than to delay the re-examination. Normally, not more than one semester should elapse between the first examination and the re-examination.

3. Administration of the Examination

The examination will be administered by the student's Guidance Committee; the second reader will serve as chairperson of the examination committee. The following procedures should be followed:

a. Since this examination is one of the most important functions of the Guidance Committee, any substitutions made (except in the case of the major professor) should be permanent.
b. Any interested faculty member may be present at the examination, whether or not he or she is a member of the Guidance Committee. However, only members of the Guidance Committee will vote on the results of the examination.
c. It is the responsibility of the student, in consultation with the second reader, to schedule the examination and to provide required information to the committee, as well as informing the Graduate Office of the date, time and location of the examination.

d. The graduate student is to prepare and defend before the Oral Committee a research proposal which describes his or her research. The proposal, 10-15 pages in length, should:

    1) Present the problem and explain its significance.

    2) Provide background information, including contributions of other members of the student's research group to the project if any, and primary literature citations.

    3) State the objectives of the student's program of research.

    4) Outline the student's contribution to the project in terms of research already accomplished.

    5) Describe how the proposed research plan will be accomplished.

    The proposal must be presented to the members of the committee no later than two weeks prior to the scheduled date of the examination. Any of the committee members not satisfied with the scientific merit of the proposal or the quality of the student's writing must inform the second reader no later than one week prior to the scheduled examination date. The second reader may direct the student to rewrite the proposal and in cases of questionable scientific merit to reschedule the oral examination.

e. The examination format should be determined by the examining committee. Since the student will normally have started research, the examination might begin with a report of research progress to date. Faculty members should use the guidelines given above in preparing questions.

4. Grading Philosophy and Practice

The committee may give a passing grade, require re-examination, or recommend a faculty review of the student's progress. This should be viewed as an important step in the student's graduate program, both for the assessment of the strengths and weaknesses and to provide advice relative to the proposed research. While it is expected that the average student who has prepared for the examination will pass the first time, failure is not uncommon. The following guidelines are recommended:

a. The results of the examination will be determined by majority vote.

b. The chairperson of the examination committee will complete the Second Year Oral Examination form and submit it to the Associate Chairperson along with the recommendation of the committee. In the case of failure, reasons for the failure should be specified and areas which need to be strengthened prior to re-examination should be described. A copy will be given to the student.

c. The chairperson of the examination committee will also submit a form signed by the members of the committee indicating acceptance of the written proposal. This form must be received by the Associate Chairperson for completion of the Second Year Research Oral Examination requirement.

d. If the committee recommends a faculty review of the student's program, the chairperson should present the recommendations of the committee to the faculty in writing. A copy will be given to the student.

e. Failure to pass the re-examination should result in a recommendation for faculty review of the student's program. Possible outcomes of the review are either placement of the student in the Plan A or Plan B M.S. Degree program, or termination of the student from the graduate program.

Important: Upon successful completion of the oral examination, a signed Guidance Committee Report must be delivered to the Graduate Office. No grade will be reported for the Second Year Oral Exam until the completed Guidance Committee Report has been submitted.

D. Research Proposal

The Research Proposal is a new requirement for students entering in the Fall semester of 2012 and beyond. The details of the Research Proposal requirement have not been established at the time this document was prepared; the Faculty will provide full details of the requirement as soon as they become available.

E. Final Oral Examination

1. Preparing For Defense and Graduation

The Final Oral Examination is the final formal step in the progress toward the Ph.D. degree. This examination is administered by the Guidance Committee with the Guidance Committee Chairperson presiding. After the Final Oral Examination, the only requirement remaining is to edit the dissertation according to the Guidance Committee recommendations and have the dissertation printed.

The Final Oral Examination is based on the research described in the dissertation and in any published or submitted manuscripts. The dissertation and at least one published or submitted manuscript must be given to Guidance Committee members at least one week before the examination. The dissertation must be approved by the Guidance Committee Chairperson and by the Second Reader before submission to the Committee.

The format of the Final Oral Examination is determined by the Guidance Committee, but it must consist of two parts. The first is a presentation that must be open to faculty members and members of the public without a vote. Only dissertation committee members may attend the second part, which is the examination portion of the defense.. Normally, the student presents the results of the research to the Committee and audience as an informal seminar. The Committee members may interrupt with questions at any time. The presentation is followed by a closed oral question period with the Guidance Committee members asking the questions.

For a thesis or dissertation that consists of one or more chapters that are already published papers: (a) These chapters must be introduced with the list of all authors, citation for the publication, and include a copy or notation of the written permission from the publisher (who generally holds the copyright) to reprint the article. (b) If multiple articles make up the document, these must be "tied together" with a required general introduction and summary/discussion. The dissertation/guidance committee chair will decide any further requirements.

The Guidance Committee may accept the dissertation and recommend that the student pass; they may recommend that the student be passed after an acceptable rewrite of portions of the dissertation; they may recommend that the student be re-examined after additional research and rewriting of the dissertation; or they may fail the student and recommend a review of the student's progress.

Students preparing for the Final Oral Exam should address the following issues:

1. Apply for graduation through the Registrar's Office.
2. Navigate to the Graduate School website ***http://grad.msu.edu/etd/*** and follow the instructions there for electronic submission of your Dissertation.
3. For the Chemistry Department you must complete an Ph.D. Oral Exam Announcement (located on the Chemistry Department web site, ***http://www.chemistry.msu.edu/graduate/oralExamReg.cfm***) and submit the form electronically to the Chemistry Graduate Office. This process informs the Graduate Office of your Final Oral Exam. The announcement should be submitted five working days prior to the exam.
4. A completed "Distribution of Unbound Copy of Dissertation" form, signed by the members of the Guidance Committee, must also be submitted to the Graduate Office five days in advance of the Final Oral Exam.

In order for the Final Certification of a degree to be approved and submitted to the Registrar's Office, students **MUST** submit a hardbound copy of their dissertation to the Chemistry Graduate Office and one hardbound copy to their research advisor, along with a completed "***Check Out Form***." Degree approval will not occur until these two requirements are met.

Students must be registered for one credit in the semester in which they hold their Final Oral Exam. Exams can be held on the last day prior to the start of the next semester. For example, if a student is enrolled for one credit for Fall semester, they have until the first day of classes for Spring semester to defend and be considered enrolled for the semester in which they defend. Submission of the final unbound dissertation to The Graduate School will determine a student's semester of graduation.

2. Publishing Agreement for Theses/Dissertations

The new publishing agreement for theses/dissertations with ProQuest now provides an "Open Access Publishing Option" as alternative to the traditional publishing option available to students. The Open Access option gives ProQuest the authorization to make the electronic version of the document accessible to all via the internet, including the selling of the document by commercial retailers and the accessibility to the work via search engines. A student selecting the Open Access option will not be

eligible to receive royalties. For more information visit: ***http://www.proquest.com/assets/downloads/products/open_access_overview.pdf***

Exit Survey

Completion of a short online exit survey for all students graduating with a Plan A or Plan B M.S. or with a Ph.D. is required. Only students who have applied for graduation will have access to the survey. The survey asks questions about educational experiences in MSU graduate programs, as well as about immediate professional plans. The Graduate School uses data from this survey when reviewing graduate programs and to guide decisions about services and initiatives for graduate students.

The identity of all respondents will be kept confidential and only aggregate (group) information will be made available to faculty and administrators. The students will receive an e-mail message from the dean of the graduate school with a link to the survey. However, students do not need to wait for that e-mail message to complete the survey after applying for graduation. It takes about 5-10 minutes to complete the online survey. Below are the instructions for completing the survey and they are also available from ***http://grad.msu.edu/etd/***

Instructions:

- Access the following website:
- Doctoral Students: ***https://www.egr.msu.edu/doctoral/survey/***
- Master's Students: ***https://www.egr.msu.edu/masters/survey/***
- Enter your MSU NetID (Login Name) and Password
- Complete all the items on the survey. When finished, click Submit.

If you cannot open this survey, please contact Katey Smagur by email at smagurka@msu.edu, and include your name, student ID #, degree level (PhD, MA/MS) and semester of graduation. You will then be notified when you are able to complete the survey.

V. Graduate Seminar

A. Analytical Chemistry Seminar Guidelines

1. Goals

For the speakers, the analytical chemistry seminar program is designed to provide experience in presenting scientific talks of the type and quality given at national scientific meetings, job interviews and university and industrial symposia. The experience includes a thorough survey of the scientific literature, organization of pertinent information, preparation of visual aids, presentation of the talk itself, response to audience questions and a critical evaluation by the audience.

For the audience, the seminars provide information on various topics in analytical chemistry and an opportunity for critical evaluation of each seminar. A successful seminar should educate the audience in the subject presented.

2. Attendance and Participation

All graduate students in the analytical chemistry program except for first year students in their first semester are required to attend and participate in the analytical chemistry seminar program. First semester students are encouraged to begin attending seminars regularly as soon as they arrive.

The analytical chemistry seminar program, as indicated above, has a formal course number; Chemistry 938. This course meets once a week and consists of 50-minute talks presented by graduate students, or, occasionally, by faculty or guest speakers. Each Ph.D. candidate is required to present two seminars while in residence, and candidates for the M.S. degree present one seminar. Student speakers should enroll for one credit of Chemistry 938 only during the semester in which they are presenting a seminar.

Graduate students should be aware of their seminar responsibilities. The faculty member responsible for the analytical seminar program will schedule seminars in the late summer/early fall for the entire academic year. Preference in scheduling will be given to those students who make their choice known. If no preference is indicated by a student, then the seminar date will be assigned.

3. Seminar Topics

a) Introduction

The seminar topic is determined by consultation between the speaker, the research preceptor and the professor in charge of the seminar program. Students should be constantly in search of potential seminar topics so that a preliminary review of the literature may be undertaken well in advance of the topic selection. Selection of a topic and faculty approval should be completed as determined by the professor in charge, or at least before the first week of the semester in which the seminar will be given. To avoid duplication, students should consult the subjects covered in analytical seminars during the past three years. Abstracts of previous seminars are available in the Chemistry Library.

b) First (literature) seminar

The first seminar for Ph.D. candidates is to be a literature seminar. It is to be given in the second year of the student's program, usually in the Fall semester. The subject of the seminar can be quite diverse, depending on the speaker's interests. The topic is unrestricted, however, it must be approved by the research preceptor and the professor in charge of the seminar program. Seminars on broad subjects, such as those described in textbooks, are not appropriate for presentation because it is difficult to assemble the large amount of material available and to avoid a "book chapter" presentation. Organization of the seminar is a more tractable task if the topic is defined carefully in advance, and a clear, single train of thought is chosen for the presentation.

One type of seminar that is appropriate can be the presentation of a recent, forefront research topic, placed in the context of its importance to the field of chemistry. Another type of seminar

is an in-depth critical examination of a relatively narrow topic or a key publication. In all cases the source materials should be drawn from the scientific literature (i.e. journals, monographs and recent review articles). Other types of seminars, not mentioned above, can be discussed with the professor in charge of the program. For example, it is possible, and even desirable, for several students to collaborate on developing a "short course" on a significant topic, with each student concentrating on one aspect of the topic.

c) Second (research) seminar

The second seminar given by Ph.D. students will be a report on research progress and accomplishments. This seminar is to be given immediately prior to their PhD oral examination. The purpose of this seminar is very different from that of the literature seminar. In the research seminar the speaker should provide background on the research project. Goals should be presented. The area of research should be defined in the context of the current scientific literature. The speaker should not only discuss how the project fits into the particular field of research, but its impact on the broadest area of science. Results should be presented and critiqued, and future directions outlined. The progress on the project should be presented, including discussions of problems encountered and solved, as appropriate.

Students may choose to develop this seminar as a "chalk talk". Obviously, there will be occasions when a figure of data such as a chromatogram or a spectrum should be shown, and slides or viewgraphs are appropriate for this purpose.

4. Abstract

a) Introduction

All seminar speakers are requires to provide an abstract summarizing the material to be covered in the seminar. The abstract should be reviewed first and approved by the student's advisor. It should then be presented to the professor in charge of the seminar program **at least ten days in advance of the presentation**, for final approval. Secretarial services will be provided for the final typing of the abstract, given sufficient advance notice. However, **it is the responsibility of the speaker to reproduce and distribute copies to analytical students, faculty, postdoctoral associates, library, business office and others expected to be interested in the seminar topic**. Abstracts must be distributed no later than the Monday of the week for which the seminar is scheduled. Extra copies should also be placed in the seminar room before the talk. Failure to meet any of these deadlines will likely result in a reduction in the final grade.

b) Abstract for first (literature) seminar

Attention to the following points in the preparation of the abstracts will minimize rewriting and revision. The scope of the seminar should be stated clearly near the beginning of the abstract, if not in the title. It should be made clear whether the coverage of the defined topic is comprehensive, or if not, how the material was selected.

The abstract should be a critical, readable and brief review of the literature of the topic. The text should be concise in presenting only the important material in detail. It should avoid detailed exposition of repetitive examples. A literature reference should be given for every fact cited, so that the abstract will be useful as a reference source. It should not be a list of the topics to be discussed but rather should include statements of the most significant points of the presentation.

The abstract should be of sufficient length and detail to make it be of lasting value to the reader. However, the maximum length of the abstract should be two typewritten pages (1.5 line spacing) plus the bibliography. The main value of the length limitation is that it gives the student practice in summarizing facts from different sources in a concise manner, and in using his or her critical sense to discard or minimize any unimportant, irrelevant or incorrect literature. A topic that cannot be covered well in two pages is too broad for a 50-minute seminar and should be reduced in scope.

The list of references should be as complete as possible. It should include both the original literature references and review articles, if available. For the sake of uniformity, the references in the bibliography should be written in the form commonly used in research journals (ACS and APS). Particular attention should be given to the initials of the authors, order cited, abbreviations of journal names and punctuation.

c) Abstract for second (research) seminar

Since the second seminar is a research seminar, the abstract to be written and distributed will use a research format, such as that typically required for a scientific meeting. The Analytical Faculty have chosen the abstract format used for the FACSS (Federation of Analytical Chemistry and Spectroscopy Societies) Meetings.

How to prepare your abstract

1) Prepare abstract with a header that indicates the seminar time and date, as given on the example at the end of this document.
2) Type the abstract title only in capital letters.
3) Follow the title with the author's name, business address and zip code.
4) Leave one line blank between the heading and the abstract.
5) Print the entire abstract in one paragraph.
6) Keep the entire abstract within a 6.5 inch wide by 4.5 inch high area. This size limitation will be enforced.
7) Figures or tables are not allowed.
8) The maximum length of the abstract is 250 words. A shorter abstract is fine if the pertinent information can be conveyed in less than 250 words.

5. Seminar length and level

The seminar should be 45 to 50 minutes long, followed by a short "question and answer" period. Seminars that exceed or fall short of this time limit significantly will run the risk of receiving a lower grade.

A major purpose of the seminar is to convey information to the audience in a clear and concise manner. The level of the talk should be such that the majority of the audience can understand it and also learn something. The audience consists of graduate students, postdoctoral associates and the faculty. The talk should contain only as much background material as is necessary to bring the audience to the level required by the subject and then should develop the subject with emphasis on the important fundamental aspects and evaluation of the state of the art techniques and applications. If the introduction and background material are well prepared and presented, the audience of scientists can learn what is necessary in a short time (no more than 10 - 15 minutes), and the bulk of the seminar can contain material that is new to the majority of the audience.

6. Presentation

The effectiveness of an oral presentation is inversely proportional to the frequency with which the speaker refers to notes or cards. Most of us cannot recall extensive numerical data, and an outline of topics to be covered helps one to avoid leaving out something important. However, it makes a poor impression if the speaker must frequently look at notes to recall the interpretation of some particular point or to derive a simple equation. It is not acceptable, however, to recite a talk from memory. A memorized talk is not only uninspiring but also indicates to the audience a lack of fundamental familiarity with the principles under discussion. It is best to have the facts and ideas pertinent to the talk clearly in mind before the presentation, and to use wording that is appropriate for logical presentation as the talk progresses.

Early in your presentation, you should make the audience aware of your approach. Make sure that the audience is carefully guided from point to point as you develop the theme of your talk. It is important to avoid discussing minor aspects of the topic in such detail that the essential objectives of the talk become obscured. For example, presentation of algebraic details of a mathematical derivation is guaranteed to lose audience interest and should be attempted only if the point of the derivation is central to the topic at hand. If a long and detailed mathematical derivation is an essential feature of the seminar, then only the important aspects of the derivation should be described, with the algebra included in an appendix to the abstract.

Extensive tables of data are not usually of interest. They can be presented on slides, but the data should be pre-digested by the speaker and pertinent examples or a summary should be presented as needed to illustrate the important points.

The interpretation of the data presented in the talk should be that of the speaker, which may or may not be the same as that of the experimenter. In the latter case, the reasons for disagreement should be made clear. It should be self-evident that the speaker cannot form valid opinions nor defend the opinions expressed unless the data presented are thoroughly familiar to him or her. A statement such as "the author didn't say anything about that" is usually not an adequate answer to a question from the audience. The listeners are interested in learning the facts and also the speaker's opinion of the facts, and not simply what any given author stated.

An excellent article, entitled "The Graduate Student Seminar," by Keith J. Laidler was published in *J. Chem. Ed.* **1971**, *48*, 671. Several important items not included in the above discussion are discussed, such as appropriate language, how to conclude a seminar, etc. It is recommended reading for all students. Likewise, "A Handbook of Public Speaking for Scientists and Engineers", by Peter Kenney is a useful guide for seminar preparation.

7. Visual Aids

When chalk is used, writing should be large and clear. The effectiveness of a scientific talk can be improved with the use of visual aids. In fact, for most experienced speakers, their set of slides serves as a carefully organized, running outline of the talk. Overhead and computer projectors are available for presentations. It is generally not advisable not to use both transparencies and projected slides, although some seminar speakers make effective use of the combination. The number of visual aids should not be excessive. For a 50 minute talk, 20-25 transparencies will usually be sufficient, depending on the style and content of the presentation. It is not advisable to exceed 45 slides in a talk under any circumstances. The visual aids should be easily readable from the back of the room. Care should be taken not to include so much information that the reader cannot digest it and see the important points. Diagrams of apparatus, equipment, or other supporting material can be placed on the chalk board or on slides before the seminar for ready reference during the presentation.

It is the responsibility of the speaker to arrange for the projector to be delivered to the designated place, on time. Further detailed information can be obtained from the professor in charge of the seminar.

8. Seminar Grade

The grade for the seminar will be determined at the end of the semester in which it was presented. The seminar grade will be based on the following criteria:

- Critical Insight
- Choice and preparation of the topic
- Level of the seminar
- Oral presentation (clarity, diction, grammar, word choice, mannerisms, length)
- Responses to questions
- Suitability of the abstract

- Organization
- Quality and effective use of visual aids
- Timeliness in meeting deadlines

For second (research) seminars, there are, in addition, two questions that must be considered in the evaluation of the presentation:

1. Would this talk be a successful job interview presentation?
2. What is the most appropriate publication venue for this research?

Evaluation forms are distributed to the analytical faculty and the graduate students, who provide written comments and criticisms of each criterion. The combined comments of the analytical faculty will be made available to the speaker by the professor in charge within approximately a week after the presentation of the seminar. Graduate student evaluations (anonymous) are given to each speaker for his or her own information. The evaluations are intended to help the student clearly recognize the strong points in the seminar as well as any aspects which can be improved. The final grade will be assigned by the professor in charge of the seminar program following consultation with the other analytical faculty members. The basis on which the final grades are assigned must be flexible in order to reflect the inevitable element of subjectivity in such matters. However, a grade of 4.0 will generally be given only when the above criteria are all met in an exemplary way. A grade below 3.0 will be assigned if the standard of the seminar is judged to be inadequate or when a student does not follow the seminar deadlines. In such cases, the student will be required to present another seminar within the next semester, excluding summer, in order to remove the deficiency from their record. A failing grade will be assigned to a student who cancels their scheduled seminar without a compelling justification. Insufficient consideration of date conflicts or lack of preparation are not compelling justifications.

9. Summary of Deadlines

Choice of Date (Fall and Spring Semesters)	August 4 - August 15, 2014
Submission and Approval of Fall Semester Topics	August 18 - August 22, 2014
Submission and Approval of Outline for First (Literature) Seminars	One month prior to presentation
Abstract	1. Ten days prior to the seminar, a polished draft of the abstract, approved (by signature of the advisor), must be presented to the professor in charge of the program. 2. Seven days prior to the seminar, the revised (if necessary) abstract, again signed by the advisor, must be presented to the professor in charge. 3. Four days prior to the seminar, the abstract must be distributed as described above.

10. Conclusion

Seminars are among our most important endeavors. A high quality program is of great benefit to everyone involved. Let us strive collectively to make our program excellent in all respects. It is particularly important that you attend regularly and contribute to the audience feedback. Above all, the preparation and presentation of a research-level seminar on a topic of genuine interest to the speaker can be a rewarding experience. Such enthusiasm is easily communicated and will help to make our seminar program a positive educational experience for all concerned.

Analytical Chemistry Seminar Program
Research Seminar
Friday, DD October, 20YY
12:40 P.M. Room 136 Chemistry

ADSORPTION KINETICS STUDY OF SELF-ASSEMBLED MONOLAYERS USING A QUARTZ CRYSTAL MICROBALANCE, D. S. Karpovich and G. J. Blanchard, Department of Chemistry, Michigan State University, East Lansing, MI 48824-1322.

Alkanethiols self assemble spontaneously on crystalline gold surfaces to form highly ordered monolayers. These monolayers, in addition to being intriguing from a fundamental perspective, are potentially useful for surface-modification and sensor applications. Though much work has been done to understand the steady-state structure of these monolayers, there is only a very limited understanding of the details of how these monolayers form. We have examined the growth kinetics of alkyl thiol self-assembled monolayers on a quartz microbalance with vapor deposited gold electrodes. Our data show that the formation kinetics for these monolayers depend sensitively on the concentration and chain length of the alkanethiol and the solvent medium. At high thiol concentration, pseudo zero order adsorption kinetics are observed, while at low concentration, higher order processes contribute. We also find that the adsorption of thiols to gold is reversible. We report equilibrium constants for the adsorption of C_8 and C_{18} thiols on gold. Our data show that the self assembly process is largely completed within minutes for these systems, while structural equilibration of the monolayer requires several hours.

ANALYTICAL SEMINAR

Faculty Evaluation Sheet

Speaker: Advisor:

Topic:

Date:

Please comment on each of the following aspects of the presentation and assign a grade (0-100) based on:

90-100	Outstanding
80-90	very good
70-80	passable
60-70	marginal
< 60	failure

Abstract

Organization, thoroughness

Critical insight

Visual aids

Presentation (delivery)

Level and length

Response to questions

Other comments

Evaluator: *Grade* (0-100):

B. Biological Chemistry Seminar Guidelines

In the Biological Chemistry Area, a student will give two seminars. The first seminar is given in the student's second year on a topic which is different than the student's Ph.D. research project. The second seminar is given in the fourth year in the Chemistry Graduate Program and will be a progress report of the student's research. The guidelines for the seminar are similar to those of the Physical Chemistry Area.

C. Inorganic Chemistry Seminar Guidelines

1. Who Attends Seminars and Why?

Each graduate student in inorganic chemistry is expected to attend every inorganic chemistry seminar. The reasons for this should be apparent: the seminar speaker is entitled to an audience, the material presented should be of interest and importance, and knowing how to learn from a seminar is an important skill. The seminar is one of the most common means of transmitting information from one person to a group, and knowing how to listen is as important as being able to speak.

2. Who Gives Seminars and When?

According to the current rules, each Ph.D. candidate in chemistry must give two seminars; each M.S. candidate must give one. Normally Ph.D. candidates give their first seminar during the second year of graduate study and the second in the fourth or fifth year. The first seminar should be based on research in the literature, with the exclusion of the candidate's thesis research; the second is usually a report of completed original research with supporting references to published work. A student should register for one credit of CEM 918 during the semesters and a seminar scheduled for presentation.

Faculty members, research associates, and guests from other universities may give seminars in addition to those given by graduate students.

3. What is Expected of a Seminar Speaker?

a) Format

The seminar should consist of a 45-50 minute talk, during which members of the audience can occasionally ask questions, and a question period at the end. The seminar topic should be selected by the speaker in consultation with his/her major professor. The title of the seminar must be advertised one week prior to the date of the talk.

b) Abstract

A seminar abstract must be prepared by the speaker. The abstract should contain the title of the talk; the speaker's name; the time, room and date of the seminar; a summary of the material to be covered during the talk; and a carefully selected bibliography. The summary should cover all significant aspects of the seminar, without exhaustively detailing its contents. References should include key papers or books to simplify literature searches by those with further interest in the subject. The abstract should be checked and approved by the major professor and submitted to the secretary of the professor in charge of CEM 918 at least ***one week prior to the seminar***. The abstract will be typed and duplicated (services provided by the department). Distribution to all faculty, inorganic chemistry research associates and graduate students is the responsibility of the seminar speaker; this should be done no later than the Friday of the week preceding the talk.

4. Topic

The first seminar topic chosen by the student must not be related to work going on in his/her group or the subject of his/her dissertation. If unsure, proper consultation with the faculty member in charge of the seminar series and with own thesis advisor is recommended.

5. Presentation

To give an effective seminar, the speaker must aim for the clear communication of ideas and results to the audience.

The introduction should specify the objectives of the research under discussion and explain its significance. Whenever possible, the work should be placed in a broad chemical context; in every case, it should be related to the research of other groups, including groups outside the immediate area of investigation. It is helpful for the audience if an outline of the reset of the talk is included in the introduction.

Ordinarily the presentation should be pitched at the level of a graduate student who has no special background in the area. Terms not widely used should be defined when introduced—this is often vital when important terms are from biology, other physical sciences, or mathematics, or are acronyms.

It is important to avoid treating minor aspects of the topic in such detail that essential features are obscured. The ***meaning*** of results should always be made clear.

All work (published or unpublished) done by others should receive appropriate attribution. In scientific seminars, work not attributed is presumed to be the speaker's own, unless the results are commonly known by those outside the field.

Speakers are encouraged to use the overhead projector and/or slide projector. Facilities for making transparencies are available. Slides and transparencies should be checked for legibility from any seat in Room 136 and altered if necessary.

Finally, talks that are memorized or read usually do not come off well. For a well-prepared speaker who is familiar with the subject matter, a set of slides or overheads often suffices as a running outline for the presentation.

6. Grade

Each seminar will be evaluated by all faculty members present, each of whom will submit a grade. However, the grade reported to the speaker and to the registrar will be determined by the professor in charge of the seminar. The evaluation form that the faculty uses is reproduced on the next page. After the seminar, the speaker will be informed of the grade and any pertinent comments from the faculty. If desired, the speaker can discuss their seminar with any of the faculty that were present.

INORGANIC SEMINAR EVALUATION

CHEMISTRY 918

(Literature Topics)

Speaker: _____ Date: _____

Topic: _____

Comments: (Specific)

Choice of Topic: _____

_____

Definition of Problem: _____

_____

Abstract: _____

_____

Preparation: _____

_____

Organization of Talk: _____

_____

Delivery: _____

_____

Discussion: _____

_____

GRADE SUMMARY

	4.0	3.5	3.0	2.5	2.0
Abstract	_____	_____	_____	_____	_____
Preparation	_____	_____	_____	_____	_____
Organization of Talk	_____	_____	_____	_____	_____
Delivery	_____	_____	_____	_____	_____
Discussion	_____	_____	_____	_____	_____
TOTALS (T)	_____	_____	_____	_____	_____

Grade in Course (T/5) = _____

Professor _____ (Optional)

INORGANIC SEMINAR EVALUATION

CHEMISTRY 918

(Research Topics)

Speaker: _____ Date: _____

Topic: _____

Comments: (Specific)

Abstract: _____

_____

Definition of Problem: _____

_____

Organization of Talk: _____

_____

Delivery: _____

_____

Discussion: _____

_____

GRADE SUMMARY

	4.0	3.5	3.0	2.5	2.0
Abstract	_____	_____	_____	_____	_____
Preparation	_____	_____	_____	_____	_____
Organization of Talk	_____	_____	_____	_____	_____
Delivery	_____	_____	_____	_____	_____
Discussion	_____	_____	_____	_____	_____
TOTALS (T)	_____	_____	_____	_____	_____

Grade in Course (T/5) = _____

Professor _____ (Optional)

D. Nuclear Chemistry Seminar Guidelines

Nuclear Chemistry Ph.D. students are required to present two seminars during their graduate career. The first seminar is of the literature type, and is given in the student's second year. The second seminar should be a presentation of the student's Ph.D. research. The timing of the second seminar is determined by the student and research preceptor. It is expected that at the time of the second seminar the student is well advanced in their analysis and interpretation of their research project, and that sufficient time is available for the student to thoughtfully consider the comments and questions that may arise during the seminar when completing their dissertation.

1. Seminar setting and audience

The Nuclear Chemistry Seminars will be part of the regular Research Discussion seminar series held weekly at NSCL. The audience typically consists of graduate students, post-doctoral researchers, research scientists, visitors, as well as faculty and staff. The audience will be informed in advance that the seminar is part of the requirements of the chemistry graduate program, and audience members will be asked to hold all questions until the end of the seminar.

2. First seminar procedures

The purpose of the first seminar is to demonstrate the student's ability to read, reference, and critically evaluate a topic in nuclear science of timely importance.

a) Topic selection.
The student should review the recent literature in the top tiered peer-reviewed journals that feature nuclear science (Science, Physical Review Letters, Physics Letters B, Physical Review C, etc.) to identify potential topics. The student will select an appropriate topic, in consultation with their research preceptor, in advance of the first committee meeting.

b) Scheduling the seminar.
Once the topic is selected, the student will consult with the chair of the NSCL seminar committee or his/her representative to schedule the seminar.

c) Seminar abstract.
One week in advance of the seminar, the student will submit to their second reader a one page abstract detailing their planned presentation. The format of the abstract is provided below, and should include title, speaker, presentation time and location, abstract body, and references to cited literature. The second reader will evaluate the appropriateness of the abstract, and if found to be satisfactory will publicly post the abstract in advance of the seminar.

d) Seminar presentation.
The student presentation should be a minimum of 45 minutes in length. The content should include an introduction of the topic (at the level of understanding for a first-year graduate student in nuclear science), placement of the topic in the context of our current understanding of nuclear science, discussion of outcomes and results, presentation of additional supporting or conflicting views, scientific impact, and future prospects. The presentation should show evidence of critical insight by the student. All materials contained the presentation should be properly credited to original sources.

e) Seminar grading.
The audience will be asked to provide a grade for the presentation. Audience members will be asked to evaluate the presentation based on organization, factual content, level and clarity of presentation, context, and critical insight. An audience feedback forms (given below) will be

collected by the second reader. Input from attending faculty will be used to determine the assigned grade.

3. Second seminar procedures

The second seminar serves as a summary of the student's Ph.D. research work. The timing of the seminar is at the discretion of the student and research preceptor. The student should be prepared to fully discuss their research results and implications. There should be sufficient time between the second seminar and final Ph.D. thesis defense so that comments and critiques received during the seminar can be thoughtfully considered before the written dissertation is submitted to the student's committee.

a) Topic selection.
The focus will be on the student's independent thesis work.

b) Scheduling the seminar.
The student will determine the timing of the second seminar in consultation with his/her research advisor. Final scheduling is done in a coordinated effort with the chair of the NSCL seminar committee or his/her designee.

c) Seminar abstract.
One week in advance of the seminar, the student will submit to their research advisor a one page abstract detailing their planned presentation. The format of the abstract is provided below, and should include title, speaker, presentation time and location, abstract body, and references to cited literature. The research advisor will post the abstract in advance of the seminar.

d) Seminar presentation.
The student presentation should be a minimum of 45 minutes in length. The content should include an introduction of the topic (at the level of understanding for a first-year graduate student in nuclear science), placement of the topic in the context of our current understanding of nuclear science, discussion of outcomes and results, presentation of additional supporting or conflicting views, scientific impact, and future prospects.

e) Seminar grading.
The audience will be asked to provide a grade for the presentation. Audience members will be asked to evaluate the presentation based on organization, factual content, level and clarity of presentation, context, and critical insight. An audience feedback forms (given below) will be collected by the research advisor. Input from attending faculty will be used to determine the assigned grade.

Abstract Example:

Nuclear Chemistry Seminar

Instructions for Preparing an Abstract for Nuclear Chemistry Seminar

Jane Q. Student

January 1, 2100

4:10 PM

Seminar Room, Cyclotron Building, MSU Campus

The abstract should start with the title "Nuclear Chemistry Seminar" centered in 12 pt. font at the top of the page. The next line should be the title, in 14 pt. Bold font, again centered. The student's name comes next, with identical font and centering as title. The date, time, and location all follow, on separate lines, below the student's name. Each should be in 12 pt. font and centered. The body of the abstract should be 12 pt. font, single spaced. The abstract body should be a single paragraph. References should be included as [1]. If a figure is included, it should have a descriptive caption, and be properly referenced in the abstract. For example, an image of this abstract is presented in Fig. 1. The completed abstract should fit on a single 8.5″ x 11″ page with 1″ margins on all edges.

Figure 1: Example of a figure inclusion for a nuclear chemistry seminar abstract. Font for figure caption is 12 pt.

References:

1. Please use standards established for Physical Review. See the reference document ***http://authors.aps.org/STYLE/ms.html#footnotes***. Font size 12 pt.

Evaluation Sheet **CEM 995** **Nuclear Chemistry Seminar**

Student Name:_____

Abstract Title: _____

Please score the following on a scale of 0 (lowest) to 4 (highest)

Organization

Abstract Format	_____	References	_____
Quality of Slides	_____	Transitions Easy to Follow	_____

Content

Choice of Topic	_____	Presentation Level	_____
Difficulty of Topic	_____	Thoroughness of Research	_____

Presentation

Clarity of Speech	_____	Expression	_____
Presentation Length	_____	Audience Engagement	_____

Context

Introductory Material	_____	Previous Work	_____
Scientific Impact	_____	Alternative Views	_____

Critical Insight

Response to Questions	_____	Conclusions	_____
Mastery of Topic	_____	Future Perspectives	_____

How much did you learn? Score 0 (nothing) to 4 (a lot). _____

General Comments:

Recommended Grade _____

Below Required for Faculty Only:

Name _____ Signature:_____

E. Organic Chemistry Seminar Guidelines

1. Course Description/Purpose

During the course of your graduate studies, there are a number of requirements that you must fulfill in order to successfully obtain a Ph.D. degree. Each of these requirements plays an important role in your scientific training. As part of this education, you must present two literature seminars to the faculty and students of this department. This requirement allows you to practice and develop a variety of important skills which are crucial to a successful career as a scientist.

Among these skills is the ability to thoroughly explore the chemical literature in a subject area that is not directly related to your current area of research. This exercise allows you to become familiar with methods of searching the chemical literature, to broaden your knowledge to include a previously unfamiliar area of chemistry, and to understand, compile, and relate the work of a number of individual investigators. All of this work must then be organized into a compact packet of information and prepared for presentation. Your organizational skills are demonstrated in both an oral and a written manner, which provides an opportunity for public speaking experience as well as composing concise written expression. Overall, this effort requires a great deal of discipline in the coordination of several different projects and the meeting of required deadlines.

2. Requirements/Deadlines

a) Six weeks prior to seminar

Cancellation of a scheduled seminar after this date (barring severe extenuating circumstances) will automatically result in a 0.5 grade point penalty when that student's seminar is finally delivered.

Get a seminar topic approved by the faculty member in charge of CEM 958 for the scheduled term.

In order to get a topic approved, each student should bring to the faculty member a one page outline of the topic and the papers that will be cited. Because of the nature and purpose of this learning experience, the topic should contain work that requires a reasonable amount of coordination and interpretation by the student and should not be covered by a recent review.

b) One week prior to seminar

Each student must supply a one paragraph abstract, including title and a short list of key references, to the course secretary no later than one week before the seminar. This abstract must be of a suitable quality for departmental distribution and posting. References should be cited in the standard journal style (S. T. Graul and R. R. Squires, *J. Am. Chem. Soc.*, **112**, 2517-2519 (1990) or Schore, N. E.; Croudace, M. C. *J. Org. Chem.* **1981**, *46*, 5436-5440).

c) Seminar day

Give a 45-50 minute presentation on a topic of current interest in organic chemistry. The subject should not involve the research being conducted by anyone in your research group.

d) One week after seminar

The final draft of the report is due to the faculty member in charge of CEM 958. The report is graded on accuracy, clarity, and writing skills (grammar, spelling, complete sentences, etc.). The report should be a 1500 word summary (not to exceed five typed pages, double-spaced, including figures, excluding references) of the talk. As a result of the limited space, this report should have only enough text to identify in which papers the various results and conclusions appear; it should have a comprehensive bibliography. The report is not meant to be an in depth review on a topic.

3. Grading Criteria

a) Choice of Topic

Because the selection of the topic is often accomplished with the help and advice of the faculty, the choice of topic receives a lower weighting factor in the overall grading. However, the topic

is critical to the success of the presentation. The subject should be of current interest and importance in organic chemistry. If these criteria are met, chances are that you and your audience will be very interested in and enthusiastic about learning the science. Some of the most successful presentations have had a mix of structure, synthesis, stereochemistry, and mechanism (think about the talks that have been some of your favorites). In many cases, current subjects which are associated with controversy or contradicting views also stimulate a significant amount of interest. In selection of a topic, establishing and defining boundaries for your talk are important. Proper boundaries should allow for the proper mix of scientific breadth and depth.

b) Difficulty of Topic

The amount of effort required to compile and understand the breadth of literature reports in the chosen area is taken into account. In addition, the conceptual difficulty in understanding the material in depth is considered.

c) Clarity of Presentation

For practical purposes, this category can be divided into two main factors, Organization and Presentation skills.

1) Organization

Introduction: The Introduction section should be used to convince your audience that the topic is important. Get them excited and interested in your subject at the beginning, or it will be very difficult to gain their attention during the course of your talk. Give the audience a verbal abstract of the talk outlining what they will learn from the presentation and so that they will know what to look for. Start by providing the big picture of the chemistry involved and then more narrowly define your subject. Establish the necessary vocabulary needed for the language of the talk.

Body: This section should be used to communicate your findings and to relate the many different results and reports you have uncovered.

Conclusion: Summarize what you have just taught the audience by briefly repeating the important concepts and achievements of the work discussed. Briefly mention current areas under study and directions that this work can be taken in the future. Finally, bring your audience out into the big picture again and reestablish the importance of this subject. Thank your audience.

2) Presentation

Transparencies: Your transparencies (slides) or visual presentation (models, chalkboard work) should be carefully planned out and neatly prepared. Don't use the slide as a crutch upon which you put all information. Instead, use the slide as an outline and guide to facilitate a talk during which you present the information to the audience instead of reading the information from the slide. Clarity in the slide is important. Information should be visible and legible from the back of the room and should summarize concepts. In some cases, it may seem optimal to put several ideas on a single slide for comparison, but if the slide becomes too complex and crowded, it may in fact be better to separate the examples and relate the two different slides verbally. When appropriate, the important features of these two examples can be compared on a third slide to provide the full impact of the similarities/contrasts. Often it is best to use the chalkboard for work or structures that will be commonly referred to throughout the talk. In addition, the chalkboard is the perfect instructional medium for a well thought out mechanism.

Delivery: Perhaps the most important nonintellectual aspect of your presentation is your ability to speak. This quality leaves a lasting impression with your audience. Think, for example, how you judge other speakers in seminar, colloquia, and everyday conversation. The way in which you express yourself, and the enthusiasm and interest with which you present the material, can be as important as what you are discussing. In fact, the smoothness and continuity of

your words and thoughts reflect upon your thoughtfulness, knowledge, and confidence in the subject area. Use complete sentences and avoid the common aaahhh's and uuummm's used to bridge thoughts; silence is far less distracting to the listener. Talk clearly and audibly while facing your audience, not the screen or the chalkboard. Be descriptive in your discussion of the slides and the chemistry that they contain. Do not remove your transparency until after you are done talking.

d) Thoroughness

Present and teach a complete package of work to your audience; do not leave out important pieces of related information. In cases where there are deficiencies in areas of research, clearly state that this area has not been explored and needs further work or cannot be studied. This aspect of your talk is important to show an in depth knowledge of your subject. The nature of the questions asked and your ability to answer those questions also provides a means to judge the thoroughness with which you know the subject matter and organic chemistry in general.

e) Critical Insight

Although preparing for your seminar entails collecting and reading many published articles, the purpose of your presentation is not to present a "book report". Instead, you are required to relate the papers, discuss the evolution of the work, and critically evaluate the work. Tell what may be missing from each research finding and how the overall thinking or models have changed with time and experiments. Give the important contributions of each group of results, and discuss what improvements could be made in the studies. Point out differences of opinion between authors; don't hesitate to express your own opinions on the subject, but be prepared to explain how you came to these views. Discuss the directions that can be taken for future research in this area. You are teaching your audience a subject of current interest in organic chemistry. Take intellectual control of the subject material.

f) Attitude toward audience

Treat the audience with respect by coming prepared and being enthusiastic about your subject. Teach your audience the material and answer their questions in a way that is neither trivial nor condescending. Face your audience when you speak. Observe the 45-50 minute time limit for the presentation so that you can allow 10 minutes for questions. Dress as you would if you were going to a job interview because, in each case, you are showcasing your abilities. When a question is asked, either by students or faculty, you should approach it not as a test but as an opportunity to share your knowledge and enthusiasm for your topic. We all learn something new from each seminar, and when you are talking, you are the teacher, the expert on the chosen topic. **Teach your audience - professors and students.**

4. Common Problems

The most common problem in any type of presentation is the lack of practice. In most cases, simply practicing the talk in front of others, well in advance of the presentation so that changes and alterations can be made, can reduce or eliminate the problems that occur so often. How many of these problems sound familiar: seminar too long, seminar too short, speaker doesn't know published mechanisms and experimental details, errors in slides, can't read slides, too many aaahhh's and uuummm's, problems with communicating specific concepts, poor presentation of work on a slide, poor boardwork, uneasiness in front of audience, or lack of a conclusion to the talk? Practicing in front of others will help you to correct problems and weaknesses while building confidence.

Organic Seminar

Asymmetric Alkylation by Diorganozinc Reagents: A Classic Reaction with Nonclassic Aspects

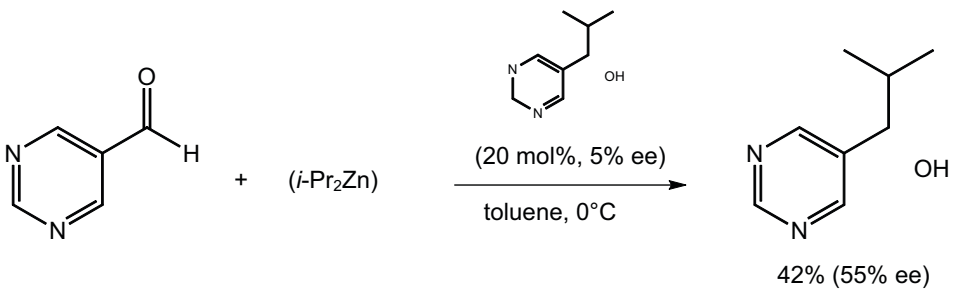
3:00-3:50 p.m., March 12, 1997

Room 136, Chem. Bldg.

Feng Geng

The asymmetric alkylation of aldehydes simultaneously achieves the construction of a carbon-carbon bond and the formation of a chiral secondary alcohol. Very high yields and high %ee can be obtained when such alkylations are carried out with organozinc reagents in the presence of chiral aminoalcohols. In recent years, such alkylation reactions have been the subject of intense study.[1] During the course of these studies, examples of nonclassic characteristics such as chirality amplification and asymmetric autocatalysis have been discovered.[1b, 2]

Scheme I



Asymmetric autocatalysis has attracted great interest for many years. In addition to its great potential for organic synthesis, the study and development of asymmetric autocatalytic systems may provide insight into the origin of molecular chirality and even the origins of life.[3] Early in 1953, Frank noted the significance of such study and called for a "laboratory demonstration" of asymmetric autocatalysis.[4] However, in spite of great efforts the first discovery of asymmetric autocatalysis with high enantioselectivity was achieved only very recently (Scheme I).[5] The main progress leading to this discovery was made only after a full and deep understanding of "general" organozinc chemistry had been realized.

This seminar will cover the background of the general alkylation reactions by organozinc reagents and will introduce the search and the discovery of asymmetric autocatalytic systems.

References:

1. (a) Noyori, R.; Suga, S.; Okata, S.; Kitamura, M.; Oguni, N.; Hayashi, N.; Kaneko, T.; Matsuda,Y. J., *Organomet. Chem.* **1990**, *382*, 19. (b) Kitamura, M.; Okada, S.; Suga, S.; Noyori, R. *J. Am. Chem. Soc.* **1989**, *111*, 4028. (c) Itsuno, S.; Frechet, J.M.J.; *J. Org. Chem*. **1987**, *52*, 4140. (d) Li, S.J.; Jiang, Y.Z.; Mi, A.Q.; Yang, G.S. *J. Chem. Soc. Perkin Trans. I* **1993**, *885*. (e) Dosa, J.P.; Ruble, C.; Fu, G.C. *J. Org. Chem.* **1997**, *62*, 444.
2. (a) Shibata, T.; Morioka, H.; Hayase, T.; Choji, K.; Soai, K. *J. Am. Chem. Soc*. **1996**, *118*, 471. (b) Soai, K.; Niwa, S.; Hori, H. *J. Chem. Soc. Chem. Commun.* **1990**, *982*. (c) Oguni, N.; Matasuda, Y.; Kaneko, T. *J. Am. Chem. Soc.* **1988**, *110*, 7877. (d) Albert, A.H.; Wynberg, H. *J. Am.Chem. Soc.* **1989**, *111*, 7265.
3. (a) Japp, F.R. *Nature* **1898**, *58*, 452. (b) Bonner, W.A. In "Origins of Molecular Chirality" Ponnamperuma, C. (Ed.) Exobiology, North Holland, Amsterdam, 1972, Chapter 6. (c) Wynberg, H. *Chimia* **1989**, *43*, 150. (d) Wynberg, H. *J. Macromol. Sci. Chem.* **1989**, *8*, 1033.
4. Frank, F.C. *Biochim. Biophys. Acta* **1953**, *11*, 459.
5. Soai, K.; Shibata, T.; Morioka, H.; Choji, K. *Nature* **1995**, *378*, 767.

ORGANIC CHEMISTRY SEMINAR EVALUATION SHEET

Wednesday, April 9, 1997

Please evaluate Spiros Kambourakis' seminar entitled, "Polyhydroxyalkanoates: Physiological Role and and Biocatalytic Synthesis of New Biodegradable Polymers", according to the following criteria. Please score on a scale ranging from 1-4.

CONTENT		PRESENTATION	
Choice of Topic	_____	Clarity of Drawings	_____
Difficulty of Topic	_____	Clarity of Expression	_____
Thoroughness	_____	Clarity of Organization	_____
Critical Insight	_____	Enthusiasm	_____
Overall	_____	Response to Questions	_____
		Overall	_____

How much did you learn? [nothing (1-2), a little (3), a lot (4)]

Comments:

Signed: _____

(not required)

Please give comments to Dr. Borhan.

F. Physical Chemistry Seminar Guidelines

1. Who Attends Seminars and Why?

Each graduate student in physical chemistry is expected to attend *every* physical chemistry seminar. The reasons for this should be apparent: the seminar speaker is entitled to an audience, the material presented should be of interest and importance, and knowing how to learn from a seminar is an important skill. The seminar is one of the most common means of transmitting information from one person to a group, and knowing how to listen is as important as being able to speak.

2. Who Gives Seminars and When ?

According to the current rules, each Ph.D. candidate in chemistry must give two seminars; each M.S. candidate must give one. Normally Ph.D. candidates give their first seminar during the second year of graduate study and the second in the fourth or fifth year. The first seminar is usuallly based on research in the literature; the second is usually a report of completed original research with supporting references to published work. A student should register for one credit of CEM 998 during the semesters a seminar is scheduled for presentation.

Faculty members, research associates, and guests from other universities may give seminars in addition to those given by graduate students.

3. What is Expected of a Seminar Speaker?

a) Format

The seminar should consist of a 45-50-minute talk, during which members of the audience can occasionally ask questions, and a question period at the end. The seminar topic should be selected by the speaker in consultation with his/her major professor. The title of the seminar must be advertised one week prior to the date of the talk.

b) Abstract

A seminar abstract must be prepared by the speaker. The abstract should contain the title of the talk; the speaker's name; the time, room and date of the seminar; a summary of the material to be covered during the talk; and a carefully selected bibliography. The summary should cover all significant aspects of the seminar, without exhaustively detailing its contents. References should include key papers or books to simplify literature searches by those with further interest in the subject. The abstract should be checked and approved by the major professor and submitted to the secretary of the professor in charge of CEM 998 at least ***one week prior to the seminar***. The abstract will be posted on the bulletin boards at the elevators and distributed electronically to all faculty as well as research associates and graduate students in physical chemistry.

4. Presentation

To give an effective seminar, the speaker must aim for the clear communication of ideas and results to the audience.

The introduction should specify the objectives of the research under discussion and explain its significance. Whenever possible, the work should be placed in a broad chemical context; in every case, it should be related to the research of other groups, including groups outside the immediate area of investigation. It is helpful for the audience if an overview of the rest of the talk is included in the introduction.

Ordinarily, the presentation should be pitched at the level of a graduate student who has no special background in the area. Terms not widely used should be defined when introduced—this is often vital when important terms are from biology, other physical sciences, or mathematics, or are acronyms.

It is important to avoid treating minor aspects of the topic in such detail that essential features are obscured. When the derivation of an equation is an integral part of the seminar, the physical content of the assumptions or relations used should be explained, and limits of validity of the result should be indicated; however, ***all*** algebraic manipulations need not be given. The ***meaning*** of results and equations should always be made clear.

All work (published or unpublished) done by others should receive appropriate attribution. In scientific seminars, work not attributed is presumed to be the speaker's own, unless the results are commonly known by those outside the field.

Speakers are encouraged to use the overhead projector, slide projector and/or computer projector. Facilities for making transparencies are available. Slides and transparencies should be checked for legibility from any seat in Room 136 and altered if necessary.

Finally, talks that are memorized or read usually do not come off well. For a well-prepared speaker who is familiar with the subject matter, a set of slides or overheads often suffices as a running outline for the presentation.

5. Grade

Each seminar will be evaluated by all faculty members present, each of whom will submit a grade. However, the grade reported to the speaker and to the registrar will be determined by the professor in charge of the seminar. The evaluation form that the faculty use is reproduced on the next page. After the seminar, the speaker will be informed of the grade and any pertinent comments from the faculty. If desired, speakers can discuss their seminars with any of the faculty that were present.

Chemistry 998

Faculty-Feedback Sheet

Speaker: _____

Topic: _____

I. Evaluate the seminar based upon the following criteria:

A. Topic (for Literature Seminars) and Abstract

B. Preparation and Critical Insight (including knowledge of subject and related literature)

C. Organization and Effectiveness of Presentation (including placement of material in a broader context, level of presentation, quality of and use of visual aids)

D. Delivery (including pacing, volume, clarity, demeanor)

E. Response to Questions

II. Please comment on aspects of the seminar that were especially strong, and suggest ways in which the seminar could be improved.

Material written above this line will be shared with the speaker. _____

Seminar grade given to _____

Grade: _____ Signature: _____ Date _____

Chemistry 998

Audience-Feedback Sheet

Speaker: _____

Topic: _____

I. Evaluate the seminar based upon the following criteria:

A. Topic (for Literature Seminars) and Abstract

B. Preparation and Critical Insight (including knowledge of subject and related literature)

C. Organization and Effectiveness of Presentation (including placement of material in a broader context, level of presentation, quality of and use of visual aids)

D. Delivery (including pacing, volume, clarity, demeanor)

E. Response to Questions

II. Please comment on aspects of the seminar that were especially strong, and suggest ways in which the seminar could be improved.

Suggested Grade: _____

VI. Operational Procedures and Regulations

A. Introduction

The primary activities in the Chemistry building are learning, teaching and research. For these activities a fine building and extensive equipment have been provided and the satisfaction of further needs is anticipated. How effectively, efficiently and safely these facilities serve for their designed purposes depends entirely on their care and the commendable conduct of each occupant in this building.

B. Building Security

Entrances to the building are unlocked Monday-Thursday from 7:45 a.m. to 10:30 p.m., Friday, 7:45 a.m. to 5:30 p.m. Saturday from 10:00 a.m. to 5:30 p.m. and Sunday from 12:30 p.m. to 5:30 p.m. Reduced hours will be in effect during holidays and vacation times. Only persons possessing issued keys may enter the building at other times and the holder of keys **must not admit anyone NOT possessing a key**.

Every individual working in the building must assume responsibility for locking doors to unoccupied areas, including teaching laboratories, to prevent tampering with or loss of personal or University property.

C. Building Keys

1. Statement of Policy

The entering graduate students and postdoctoral associates are given a submaster key to the floor that includes the room that they are initially assigned to. This key opens the outer doors and library. After assignment to a specific research area, this key may be traded for a different submaster key.

If a graduate student is teaching in the undergraduate laboratories, all keys necessary to perform that function are also made available for the term.

Keys to areas which are usually not accessible to students or postdocs must be negotiated with the Chair or a representative designated by him/her.

2. Requirements

a. A fee of $25.00 is assessed for each building key which is lost and not recovered.

b. The holder of a key may not admit anyone else to the Building or any area within.

c. Normal good conduct and safety practices are expected to all who have access to the Building.

d. The key must never be loaned to another individual.

3. Remarks

Anyone issued a key to a laboratory assumes the responsibility of becoming familiar with safety equipment and procedures. Anyone involved in a research effort in the laboratories should have a copy of the Department's Safety Manual, which outlines minimum safety standards.

Of greatest importance is that any student working in the laboratory should remain within voice range of another student in the same room in case assistance is required.

4. Maintenance and Repairs

Malfunctioning electrical, plumbing and ventilating equipment should be reported in writing to the Building Manager's Office. Location and nature of needed repair should be stated.

Thermostat adjustment should be requested through the Building Manager, in Room 141 (ext. 359).

5. Further Considerations
Keys to the building, departmental library, offices, and laboratories for teaching are issued from and returned to the sub-basement stockroom, B-1. Keys to desks are also issued from this office when a desk is assigned to an individual. Unneeded keys (such as "teaching" keys after the term ends) should be returned promptly to B-1.

Recipients of keys assume responsibility for proper care and handling of keys. They are not to be loaned or duplicated. Violation will result in forfeiture of keys. The fine levied for each lost building key is $25.00.

Students leaving campus for the summer must turn in all keys.

All keys must be turned in when those in possession are no longer employed in the building. This includes staff, graduate and undergraduate students, and other Departmental personnel with temporary access to the building.

The loss of a key must be reported immediately to the Business Office.

Master keys are issued only to the faculty, secretaries and certain staff members.

No keys are issued to undergraduates without specific authorization from the Chair. Since undergraduates are supposed to be supervised at all times they are in the laboratory, normally only a front door - library key is issued with the Chair's authorization. See key policy statements below.

D. Smoking
According to University Regulations, smoking is prohibited in all University buildings. Everyone must abide by these regulations, and furthermore, must enforce these regulations in areas under his/her supervision. There is no excuse for thoughtless stamping out of cigarettes on the floor. State law prohibits smoking in the elevators.

E. Shops
Supplies, assistance and instruction for machine shop work are available in Room 44. Tools may be signed out from the main stockroom (B-1).

Glass work is performed by the University Glass Shop located in Room 39.

F. Stockroom and Lecture Preparation Room
Laboratory instructors may check out chemicals and supplies for teaching from the appropriate teaching stockrooms.

Chemicals, supplies and equipment for research are checked out by graduate students from appropriate stockrooms. The student must record the items checked out, returnable and non-returnable, on sheets kept in the stockrooms.

Items not available at the stockrooms or shops are ordered by faculty members through the Business Manager's Office. No student is to order or purchase items without authorization from a faculty member and then only through the Business Manager's Office. If items must be picked up at a local or campus source, a purchase request form must first be completed by the Business Manager's Office.

Stockrooms serving teaching areas will only be open when laboratory sections are scheduled. Hours when the stockrooms will be open will be posted.

Everyone in the laboratory is urged to return all returnable supplies and equipment when no longer being used. These items will then be available to others who have need for them. Credit will be issued to the professor's research allotment upon return of goods (excluding chemicals) to the stockroom.

G. Telephones
Telephones have been installed in laboratories and offices for use by graduate students for local calls only. Personal long distance calls must be made from the graduate student's own cellphone or elsewhere. The "Red" phones located in the corridors are for emergency use only. These phones go

directly to the Department of Public Safety. In case of serious injury or emergency, simply pick up the phone—no dialing is required. Be sure to relate to the safety officer who answers the phone the following information:

1. Your name.
2. The nature of the accident or emergency.
3. The location of the accident or emergency.

H. Chemical Waste Disposal

Normal liquid wastes will be picked up in your laboratory. To schedule a pick-up, call Environmental Health & Safety (EHS) at 3-6675. They will need the following information: name, room number, building, phone number, the amount and type of waste. EHS will then come by sometime on Friday to pick up the material and leave new containers. Be sure the tag is properly completed prior to pick up. Containers that are leaking, too full, or have a spill on the top around the opening will not be taken nor the contents transferred to another can. **Please do not bring chemical wastes to the loading zone area.**

Wastes that cannot be combined into a five gallon container may also be scheduled for pick up so long as they are not classified as explosive by the DOT (e.g., organic peroxides and nitramines, azides, fulminates, etc.) and are properly labeled. Try, however, to minimize the number of containers. Reactive material, such as Na, K, P, CaH_2, etc., can also be picked up by EHS if packed under an appropriate solvent and properly labeled.

Used pump oil, including flushing oil, is to be poured into the 55-gallon drum located outside room 138A.

For material classified as explosive, or for other reasons rejected by EHS, contact Dave Voss, who will make arrangements for its disposal.

The responsibility for protecting staff, students and the community from hazardous substances employed in teaching and research is shared by instructors, principal investigators and the departmental and University administrations. **Fundamentally, however, all personnel must accept the responsibility for their own safety and for not imposing unwarranted risks on others**.

I. MSU Tornado and Disaster Warning System

Tornado Watch means conditions are favorable for tornadoes to develop.

Tornado Warning means a tornado has been seen - TAKE SHELTER NOW!

A tornado WATCH is announced over radio and television stations and by telephone to key locations on campus. Do not call the Weather Bureau EXCEPT to report the actual sighting of a tornado. Be prepared to move to shelter.

A tornado WARNING-TAKE SHELTER NOW condition is announced over local radio and television stations and by the sounding of a steady tone on campus and police vehicle sirens. (The campus siren on the top of the building is tested at 12:30 pm on the first workday of each month.)

Seek shelter in the basement. Do not use the end stairways. Windows in the stairways have broken in previous windstorms. STAY AWAY FROM ALL WINDOWS. All areas above ground must be evacuated when the siren on the roof sounds. You MUST leave any above ground portion of the building. You MAY, at your peril, leave the building and go outside, although this is not recommended.

Do not seek shelter in large rooms with wide, free-span roofs, such as gymnasiums or auditoriums. (Basement areas of the M.S.U. Auditorium and Jenison Gymnasium are approved shelters.)

In homes, seek shelter in the basement or in closets or rooms in the center part of the house. AGAIN, STAY AWAY FROM WINDOWS.

In open country, move away from the tornado at a right angle to its path. If this is not possible, lie flat, face down, in the nearest depression or ditch. DON'T STAY IN VEHICLES.

Married Housing units have been issued instruction sheets which give the building to seek shelter in and directions for proceeding to the shelter.

Plan now the action you will take during severe weather. Monitor local radio and television stations during unsettled weather. At home, keep your family together, ready to move to the shelter. Prepare blankets, a flashlight, necessary medicines, a battery operated radio and a first aid kit to take to the shelter.

The ALL CLEAR signal is given over radio and television stations. There is NO siren signal for "all clear."

Testing Program

The monthly tests of the MSU warning siren are held the first working day of each month at 12:30 p.m.

The siren is located on top of the Chemistry Building and is controlled from the headquarters of the Department of Public Safety.

The tests are intended to familiarize the University community with the signals so they may be recognized under different weather conditions.

J. University-Related Travel Information

A Michigan State University Travel Authorization/Voucher Form must be completed whenever a University related trip will be taken (i.e., attendance at a conference, seminar, etc., which is located off-campus). The Travel Authorization/Voucher Form must be completed even if the travel does not involve reimbursement (this is for insurance purposes only). Described below is the procedure for completing an MSU Travel Authorization/Voucher Form.

1. A Michigan State University Travel Authorization/Voucher Form can be accessed on-line at the following URL: ***http://ctlr.msu.edu/download/forms/TVLAuthorEmerg.xls***
2. **Prior to the trip, the "Travel Authorization" portion of the form must be completed (an account number must be provided)**; initialed by the student's research advisor and submitted to the Chemistry Business Office (Room 324 Chemistry) for approval.
3. After returning from the trip, submit your receipts and Travel Voucher to the area secretary for completion of the "Reimbursement" portion of the Travel Voucher. University Guidelines for reimbursement must be followed, and any arrangements that the student and research advisor have agreed upon must be taken into account. **Special note should be taken of requirements for receipts. In most cases an original receipt is required — under certain circumstances, a charge card receipt is acceptable**. The student's research advisor needs to approve the expenses being claimed before the completed Travel Voucher is submitted to the Business Office (Room 324 Chemistry Building) for processing through the University.
4. Graduate Students are eligible to receive a travel fellowship through The Graduate School. Applications can be acquired in Room 118 Linton Hall**.**
5. Graduate Students traveling abroad should:

   a) Check with the MSU Travel Clinic! They will let you know of any health risks or immunizations: ***http://www.travelclinic.msu.edu***. When students appointed as TAs or RAs travel outside the U.S. to conduct required thesis or dissertation research or to collaborate with investigators conducting research abroad, the department or research grant supporting

the work will be required to pay for all needed vaccinations and or medications (e.g., anti-malarials) as determined by the MSU Travel Clinic. Students may include those costs in applications for funds from the Research Enhancement or Travel Grant programs administered by the Graduate School.

b) Check the "Travel Smart" website (***http://grad.msu.edu/travel/***) before their trip.

c) Check the International Studies Programs website for issues related to safety around the world. ***http://keywords.msu.edu/viewpathfinder.asp?id=31***

d) Apply for assistance with travel funding via the Graduate School. If the Graduate School provides funding, they will also provide a MEDEX emergency card.

For additional information regarding University travel, please refer to the following web site: *http://www.ctlr.msu.edu/COTravel/*.

VII. Safety Practice in the Laboratory

A. Introduction

Safety manuals are issued to each incoming graduate student. Each student is urged to read the manual to familiarize himself/herself with its content. The manual contains detailed advice and information but the following brief statements should serve as the beginning guide to safe work in the laboratories.

B. Elementary Safety Rules

1. Laboratory safety is the personal responsibility of each individual.
2. Be a good housekeeper. Establish safe working habits. Be aware of possible hazards and ways to eliminate them. Order and neatness will minimize accidents.
3. Wear eye protection ***at all times*** in the laboratory. All laboratory work involves some eye hazards. Safety goggles must be worn by everyone in the teaching labs.
4. Supplement safety glasses with a ***face shield*** when experimenting with hazardous chemicals. Work in the hood behind a safety shield or barricade.
5. Wear safety goggles and/or a face shield when working with equipment that is either evacuated or under greater than atmospheric pressure.
6. Familiarize yourself with the location and use of fire alarms, fire-fighting equipment, safety showers, gas masks, fire blankets, and emergency exits in your work area.
7. Do not work in a laboratory alone. Be sure help is within voice range. There must be no exception to this rule.
8. Keep approaches to ***all*** doors free. You may need to use one in a great hurry someday.
9. Reactions should not be left unless you know them to be safe.
10. Securely fasten all cylinders of compressed gases.
11. Keep storage of reactive materials in the laboratory to a minimum - if economically feasible, order the smallest package available from the manufacturer.
12. Treat all chemicals as corrosive and toxic and all chemical reactions as hazardous unless you know them to be otherwise.

13. All spills of hazardous chemicals of 500 ml or more should be reported immediately to the Safety officer, Dr. Ardeshir Azadnia (Ext. 114) and the Building Manager, Mr. Robert Rasico (Ext. 360), and/or to the Environmental Health & Safety (EHS) (Tel: 5-0153). Contact the Main Office (Ext. 339) if you are unable to reach Dr. Azadnia or Mr. Rasico. Should a release of hazardous chemicals occur after hours, call MSU Police at 5-2221 or 911 or by simply picking up the red telephone in the corridor. They will take it from there.

14. Use nichrome wire to secure all cooling water tubing connections. Wire is available from the stockrooms. Anchor tubing in drains.

15. Consult the Safety Committee, your major professor, the instructor in charge of the laboratory, or safety literature if in doubt about chemicals or reactions.

16. Know what to do in case of an accident, who to call, where to get help, when to run, how to contain the damage and what forms to fill out.

17. Label prolifically. Remove all expired labels before re-using a bottle. State and federal Right-to-Know labels mandate that all chemical containers are clearly labeled.

18. Promptly neutralize or destroy any hazardous by-products such as excess sodium metal or cyanide solutions. Arrange for frequent pickup of wastes by calling EHS (5-0153).

19. Prior to starting a chemical reaction, obtain the Material Safety Data Sheets (MSDS) from the Chemistry Library or by calling EHS (5-0153).

20. Study the MSU-Chemical Hygiene Plan Manual before starting any laboratory work. Every research group has a copy of this plan and a copy is available in the Chemistry Library, which is located in the atrium of the BPS building. For your convenience, the main body of the MSU-Chemical Hygiene Plan Manual with regards to prudent laboratory practices and operating procedures is included here.

C. Safety Equipment Availability

1. Safety equipment is provided for your protection and use.

2. It is your responsibility to know the location of the nearest shower, sink, fire alarm, fire extinguisher, fire blanket, and emergency telephone. NOTE: These pieces of equipment have been located so that they are accessible to each laboratory.

3. Notify the Safety Officer, Dr. Ardeshir Azadnia (Ext. 114), of any deficiency of safety equipment.

4. Special safety equipment may be obtained as follows:

    a. Safety glasses. ***All occupants*** must wear splash proof safety goggles while wet chemistry is being done by anyone in the laboratory. Graduate students may obtain a pair of prescription safety glasses at the Department's expense. See the secretary in the Business Manager's office.

    b. Goggles, face shields and ultraviolet-absorbing glasses may be checked out from the main stockroom (B-1).

D. Contact Lenses in the Chemistry Laboratory

Contact lenses are not protective devices, and indeed, present an increased hazard to the wearer in a chemical laboratory. Hard lenses are constructed of polymethylmethacrylate, cellulose acetate-butyrate, and methyl methacrylate-silicone copolymers; all are soluble in or swollen by many organic solvents. Soft lenses are constructed of various water-swollen cross-linked polymers containing about 80-85% water, so in addition to absorption of organics, aqueous chemical solutions are readily soluble in the water phase of the soft lenses. Both types can trap vapors, but the probability of hazard is greater and more damaging with soft lenses.

Hard lenses are generally 7 to l0 mm in diameter covering only a part of the cornea. Foreign bodies such as small metal fragments, rust or powders can become entrapped beneath the lens. Since the lens floats on the cornea rather than being in a fixed position, there may be abrasion between the lens, foreign body and cornea. Likewise, recirculation of hazardous liquids, once trapped and solubilized in the tear fluid, is likely. Soft contact lenses are generally larger, between l2 and l5mm in diameter, and cover a larger area of the cornea and part of the sclera as well. They adhere more tightly to the cornea so do not have as much fluid motion as the hard lens, and therefore offer some protection against corneal foreign bodies. The major risk, however, is from chemicals. Because of the high water content of the soft lens, caustics or materials toxic to the cornea are quickly conducted through the lens and thus are held in place against the cornea by the proximity of the lens itself.

If a chemical spill into the eyes occurs, neither the normal tearing mechanisms nor external irrigation is effective in removing chemicals under the contact lens. If the spill is acute, the contact lens may be difficult, if not impossible to remove without anesthesia because of the reflexive squeezing together of the eyes. Alkaline materials in the eye are more dangerous than strong acids; acids tend to coagulate protein and form a barrier to further penetration; alkaline materials continue to soak into the tissue.

The use of contact lenses while the wearer is working in a laminar flow air environment (i.e., fume hood) can be considered a hazard potential as it aggravates the dehydration of the tear layer upon which the lens rides, giving rise to subsequent corneal abrasions and other related phenomena.

Wearing contact lenses does not obviate the need of protection from ultraviolet and infrared radiation. Most contact lens materials transmit wavelengths greater than 245nm, offering no protection from “Welder’s flash” or “arc-eye” (UV-induced conjunctivitis). Both lens types absorb IR radiation, thus generating heat. This effect is potentially more harmful to the soft lens wearer as it could upset the aqueous balance, as well as causing cutaneous burns in extreme cases.

The Chemistry Department does not allow the wearing of soft contact lenses in the undergraduate laboratories and strongly discourages the use of hard lenses. You are strongly encouraged to adhere to the same standards in the research laboratory. Check with your research preceptor for details. Consider the possibilities and consequences ***before*** you put your lenses in. The Department provides free prescription safety glasses (see the secretary in the Business Office). These are not a substitute for safety goggles. They provide only minimal protection from chemical spills

E. Emergency Action Plan

There are situations which require that all or parts of the building be evacuated. Examples are major fires, power outages, and major chemical spills. All possible attempts shall be made to circulate information as to the type of emergency and the proper evacuation routes. During normal working hours (8:00 AM - 5:00 PM), there will be staff members assigned to each floor (wearing yellow hats) to assist and direct building occupants in the case of an emergency evacuation. After hours (5:00 PM - 8:00 AM), the researchers in the chemistry building must rely upon one another for safety. Should you hear the alarm sound, leave the building immediately because someone is warning you of a severe hazard. Go to the main rally site located near the Shaw Lane parking ramp. You will receive further instruction from police/fire personnel.

In any evacuation, steps should be taken, if possible, to secure equipment so damage will be minimized. All equipment such as fans, heaters, and computers should be turned off. All doors should be closed and locked. This is advised both from a security aspect as well as for the need to contain the spread of any hazard. All occupants should carry any personal items (e.g. coats, purses, paperwork) that might be required if the building were to be closed overnight. Once the building has been evacuated, you are not allowed to return to your office or workstation until notified by the appropriate officials.

Severe Weather (i.e., tornado warnings) is announced by DPS with a siren located on the Chemistry Building roof which can be heard throughout most of the building. (An actual severe weather alarm should not be confused with the testing of the severe weather alarm that takes place at 12:30 p.m. on the first working day of each month.) All areas above ground are to be evacuated immediately via the center stairwells to basement or subbasement. Occupants of lower level floors could move to rooms with no windows such as bathrooms. Extra care should be exercised while moving down through the unavoidable areas of the first floor front entrance, due to the large area of exposed glass. **Elevators should not be and cannot be depended on for use during any evacuation procedure**. The end stairwells are especially hazardous during weather alerts due to the large exposed glass area and therefore **should not** be used. In the past, windows located in the end stairwells have blown in and would likely be blown in during severe weather. All persons are to remain below ground level until "the all clear" is announced by the officials from the MSU Department of Police and Public Safety. The building occupants will not be allowed to congregate in the lobbies or stairwells due to the potential hazard of flying glass. It is extremely important that everyone moves well into the basement and/or sub-basement rapidly so as to allow shelter to those still arriving via the stairwells.

Major fires require rapid evacuation. If the fire alarms are sounded (loud buzzer noise in the hallways) evacuate immediately. Use the nearest stairwell not blocked by smoke or flames. **Do not use the elevators**. Close all doors—especially any fire doors. If you are the person discovering a fire, call 911 (or use the red phone) and then sound the alarm. The fire alarm boxes are located near the stairwells.

If you are trapped in a smoky corridor, remember that smoke tends to rise, leaving the cleanest air near the floor. Crawl on the floor to the nearest exit. Get outside as rapidly as possible. The firemen will probably be using the main entrance and center stairwell first. Try to avoid congestion in these areas.

Major chemical spills and gas leaks are similar with two likely exceptions: the fumes are usually invisible and heavier than air. They may accumulate in low points. If you are below ground level, leave the building as soon as possible. Many fumes are flammable or even explosive. Put out all potential sources of ignition immediately. Do not turn lights or any other electrical equipment on or off. Avoid any action that may create sparks.

Power failures or loss of ventilation also requires the evacuation of the building, although in this case it can be more orderly. Experience has shown that the air within the building becomes unhealthy surprisingly fast once the ventilation system stops. Though you have sufficient time to leave the building in an orderly fashion, you could easily become trapped by toxic gases if you delay your evacuation too long.

All employees not assisting in the evacuation of the building shall proceed to the front of Shaw Hall and wait there for instruction. Obviously all personnel should avoid obstructing emergency traffic areas. It is important that employees do not leave without their supervisor's permission, or in the case of post working hours, their knowledge. All personnel need to be accounted for or be present to help account for others.

As many of you are aware, a command post for fire and hazardous material incidents is established at the Fire Department Command Vehicle. This is usually a Fire Department red "Suburban". For police incidents such as bomb threats, man-with-a gun calls, etc., the command post will be a police vehicle. People with important/first hand information pertaining to the incident, should go to the command post and inform the officials.

1. After Hours Emergency Evacuation Procedures

Due to the nature of the research performed in a chemistry building, one should expect the unexpected. Should you be faced with a life-threatening incident such as fire, react as follows:

1. Use the red phone in the corridor to inform the emergency response team.

2. Pull the "fire alarm". It is best to call for help first and then pull the alarm, since the sound may interfere with your conversation on the phone.

3. Take the nearest exit away from the incident and leave the building.

4. Wait for the fire department outside of the building and look for the red "Suburban" where the Command Post is located.

Upon hearing the sound of the alarm system and/or when notified by others of an emergency situation, regardless of whether or not you can physically see evidence of a disaster, you must evacuate the building immediately. **There are no exceptions to this rule.** However, you should take precautions and stop any reaction or turn off any equipment that cannot be left unattended for a long period of time since you may not be allowed to return to your lab overnight. Also, make sure you take your personal belongings with you for the same reason. The following is an excerpt from the Department of Police and Public Safety in regard to the concept of "Command Post".

Incident Command System: To insure the control of emergencies, the university utilizes the Unified Incident Command System for coordination of response agencies appropriate to the incident. Unified incident command takes place at, and through, a field command post. The command post staff consists of one key official from each functional unit or department (police, fire, safety, emergency coordination, physical plant, grounds, *etc*.) appropriate to the incident. The staff may also include key officials from neighboring jurisdictions affected by the incident (hazardous materials, border road, etc.). Other staff may be assigned to the command post as determined by the Incidental Commander. All officials contribute to the command process by:

1. Determining overall goals and objectives.

2. Jointly planning for tactical activities.

3. Conducting integrated tactical operations, and

4. Maximizing the use of the assigned resources.

The command post for fire and hazardous material incidents is established at the Fire Department vehicle. This is usually the Fire Department red "Suburban". For police incidents such as bomb threats, barricaded gunmen, man-with-a-gun calls, *etc*., the command post will be a police vehicle. In any event, any police officer or other emergency responder will be able to direct you to the command post when you have vital information pertaining to a particular incident."

F. Safety Publications Available in the BPS Library

The Library has available a number of books dealing with chemical hazards and toxicology. You may find it advisable at times to consult them.

All titles are on the Toxicology Shelf unless otherwise noted.

Allergy to Chemicals and Organic Substances in the Workplace; G.W. Cambridge and B.F.J. Goodwin; RC 963.5 .A4 1984

Analytical Techniques in Occupational Health Chemistry. (ACS Symposium Series; 120) D.D. Dollberg; RA 1229 .A5 1980

Analytical Toxicology of Industrial Inorganic Poisons. (Chemical Analysis; 22) M.B. Jacobs; QD 131 . J3 1967

Assessment and Management of Chemical Risks. (ACS Symposium Series; 239) J .V. Rodricks, R.G. Tardiff; RA 1199 .A77 1984 (This title circulates)

Cancer Causing Chemicals. N.I. Sax; RC 268.6 f.S29 1981

Care, Handling and Disposal of Dangerous Chemicals. c. 1964, P.J. Gaston; TP 149 .G3

Chemistry Hazard Communication Document. Michigan State University, Department of Chemistry; Not Cataloged - Located in Journals Room B.

Chemical Hazards in the Workplace; Measurement and Control. (ACS Symposium Series; 149) G. Choudhary; RA 1229 .C46 1981

Chemical Safety Supervision c. 1956, J. Guelich; TP 149 .G8

Chemistry of Industrial Toxicology. H.B. Elkins; RA 1221 .E4 1959

Chemistry of Organophosphorus Pesticides. 2nd ed., C. Fest and K.J. Schmidt; SB 952 .P5 F47 1982

CRC Handbook of Analytical Toxicology. c. 1969, I. Sunshine; RA 1215 .H3

CRC Handbook of Laboratory Safety. 2nd ed., N.V. Steere; QD 51 .S88 1971

Dangerous Properties of Industrial Materials. 6th ed., N.I. Sax; T 55.3 .H3 S3 1984

Detection and Measurement of Hazardous Gases. c. 1981, C.F. Cullis and J.G. Firth; TD 890 .D48

The Dose Makes the Poison. M Alice Ottoboni; RA 1213 .O88 1984

Environmental Sampling for Hazardous Wastes. Glenn E. Schweitzer ed. (ACS Symposium Series; 267); TD 193 .E58 1984 (This title circulates)

Guide for Handling Hazardous Materials. United Parcel Service; T 55.3 .H3 U48 1975

Guide for Safety in the Chemical Laboratory. 2nd ed. Manufacturing Chemists Association; QD 51 . M349 1972

Handbook of Reactive Chemical Hazards. 3rd ed. L. Bretherick; T 55.3 .H3 B73 1985

Handbook of Toxic and Hazardous Chemicals c. 1981, M. Sittig; RA 1193 .S58

Hazard Assessment of Chemicals. vols. 1-6, J. Saxena; QH 545 .A1 H38

Hazardous Chemicals Desk Reference. N.I. Sax and R.J. Lewis; T 55.3 .533 1987

Hazardous Chemicals; Information and Disposal Guide. M.A. Armour; T 55.3 .H3 A7

Hazards in the Chemical Laboratory. 4th ed., L. Bretherick; QD 51 .H35 1986

Material Safety Data Sheets. c. 1985, Not Cataloged - Located in Journals Room B.

Organic Chemicals Manufacturing Hazards. c. 1981, A.S. Goldfarb; TP 247 .O74

Patty's Industrial Hygiene and Toxicology. 3rd ed., F.A. Patty; RC 967 .P37 1978

Prudent Practices for Handling Hazardous Chemicals in Laboratories. Natl. Res. Council Comm. on Hazardous Substances in the Laboratory; QD 51 .N32 1981

Registry of Toxic Effects of Chemical Substances. c. 1980, Natl. Inst. for Occupational Safety and Health; RA 1215 .T6

Risk Assessment at Hazardous Waste Sites. Glenn E. Schweitzer, ed.

(ACS Symposium Series; 204); TD 811.5 .R57 1982 (This title circulates)

Safety and Accident Prevention in Chemical Operations. H.H. Fawcett and W.S. Wood; TP 149 . S197 1982

Toxicants and Drugs; Kinetics and Dynamics. E.J. O'Flaherty; RA 1216 .O35 1981

Toxicology of Drugs and Chemicals. 4th ed. W.B. Deichmann and H.W. Gerarde; RA 1211 .D42 1969

TSCA's Impact on Society and Chemical Industry. George W. Ingle ed., (ACS Symposium Series; 213); HD 9651.5 .T8 1983 (This title circulates)

G. What to do in Case of an Accident

1. Major Accident - involving serious damage to property or personnel

Immediate Action - as quickly as possible and in approximate order:

a. Yell, "Help – Fire" or whatever fits the emergency.

b. Take action to minimize or eliminate the spread of damage or hazardous conditions.

c. Administer any necessary emergency first aid.

d. Notify a senior staff member if one is readily available. Let the senior staff member take responsibility for further action.

e. Call Emergency. Press "OUT3" and then "911" on ***laboratory phones*** or use a"Red" direct-line phone found in corridors. Tell them you have an ***Emergency***. (Let senior staff member do this unless none is available.) Be sure to tell the police the **exact location** of the accident, the nature of the accident, and the type of assistance required.

f. Post someone at a pre-designated point to direct the police when they arrive. Police will make necessary arrangements for ambulance, doctor, hospital service, etc.

g. Notify Departmental Office. After all immediate emergency actions have been carried out, inform the Departmental Office, Department Administrator, Operations Manager, Building Engineer, Building Manager, and Safety Officer. Call them at home if needed.

NOTE: THE DEPARTMENTAL CHAIRPERSON IS ADMINISTRATIVELY RESPONSIBLE FOR MAKING THE NECESSARY REPORTS ON ACCIDENTS. **DO NOT ANSWER QUESTIONS FROM ANY NEWS MEDIA.**

2. Minor Accidents

Immediate Action – As quickly as possible and in this approximate order:

a. Take action to minimize or eliminate the spread of damage or hazardous conditions.
b. Administer any necessary emergency first aid.
c. Notify a senior staff member if one is readily available. Let the senior staff member take responsibility for further action.

As a TA, you must report any accidental injury incurred by your students, no matter how minor it seems.

3. Accident Reports

In filling out a Student Accident Report (Form 140-2583, available from the 1st floor stockroom):

a. No cut or burn should be considered minor. All accidents must be reported.
b. Use ball point pen or sharp pencil and bear down hard.
c. Advise the student to seek professional treatment at Olin or elsewhere. Transportation can be arranged by the stockroom attendant.
d. Indicate

1) That you recommended treatment at Olin.

2) If the injured declines medical treatment.

e. Include course and section number.

4. A point of information
Olin may charge for its services; MSU minor Emergency will charge for its services. The Chemistry Department does not pay or otherwise "take care of" medical bills resulting from an accident to a student in the laboratory.

5. Employees
Any employee (i.e. any person who receives a pay check from MSU on a regular basis) should follow the procedures found at ***http://olin.msu.edu/clinics.html#work***. In addition, Chemistry Personnel should report all occupational injuries to your supervisor and to the Business Office (Room 324). Within 24 hours after a reported illness/injury, the injured worker is to complete the Report of Claimed Occupational Injury or Illness (***http://www.hr.msu.edu/NR/rdonlyres/15530025-13F0-49E9-91BE-173E14BE3B6B/0/accidentreport.pdf***). Copies must be distributed to the parties listed at the bottom of the form. Do not wait for medical reports before filling out this form.

Failure to follow the correct procedure may jeopardize insurance coverage, both for treatment and lost wages. It is to your advantage to complete them as promptly as possible.

6. Transportation
Even if only a minor accident has occurred, the injured student should be advised to go to the Olin Health Center for professional treatment when it occurs during business hours. The Olin Courtesy Van may be called between 8:00 a.m. and 5:00 p.m. at 517-353-4700. Spartan-Yellow Cab may be called anytime after 5:00 p.m. at 517-482-1444, as well as Big Daddy Taxi at 517-367-7474.

7. Follow-up Action
On any accident involving personal injury or any use of gas masks, fire extinguishers, fire blankets, or extensive use of first aid materials:

l. Report accident as soon as possible on the appropriate forms to the Business Office (Room 324).

2. Refer requests for information, except by police or firefighters, to the Chairman of the Department.

8. Incidents
An incident is basically an accident without personal injury. Incidents that cause property damage or that could have caused an accident should be reported by means of an Incident Report available from the Business Office, Room 324. The purpose for collecting this information is not castigation, but to determine possible action to prevent a reoccurrence.

9. Informed Consent Statement
State law mandates that all employees working in research and teaching laboratories or other facilities in which they may be exposed to chemical or other hazards be informed of the extent of risk (where known). To assure that this has been done and that each individual agrees to follow established safety procedures, an informed consent statement must be signed by the individual and his supervisor (usually the Principal investigator).

There are two different forms: one for a ***teaching assistant***, (yellow color) one for a ***research assistant or fellow*** (white). New graduate students should sign the Informed Consent Statement for Teaching Assistants that will be made available to you at orientation. When you pick a research preceptor, the Graduate Secretary will ensure completion of the Informed Consent Statement for Research Staff.

Students enrolled in laboratory courses where they are exposed to chemical hazards shall be informed of these hazards and instructed in proper safety procedures. An informed consent statement is signed as part of their check-in procedure.

H. Right-to-Know Law

The State of Michigan's Right-to-Know Law became effective February 25, 1987. The intent of this law is to provide information to employees exposed to hazardous chemicals in the workplace. There are five major components of the law:

- Evaluation of Hazardous Chemicals
- Labeling of these Chemicals
- Maintaining Material Safety Data Sheets (MSDS)
- Training of Employees
- Written Hazard Communication Program developed by employer

The Chemistry Department is required to ensure that each employee is aware of the Right-To-Know Law and has received appropriate training. This will be accomplished at new graduate student orientation in the Fall or at other times during the year as appropriate.

Materials Safety Data Sheets (MSDS) are available in binders in the Journal Room of the Library, or can be generated from a data base through the University computer.

Perhaps a better name for this law is "Responsibility to Inform." You do have a basic "right to know" about the hazards of the workplace. However, it is your legal responsibility to inform others of the hazards of the workplace, your research laboratory. The law states that all containers must be explicitly labeled unless the material is used by the same person who filled the container – and it is used entirely the same day. All containers of chemicals (even just water) and wastes must be clearly labeled and dated at all times. This is the most commonly violated component of the Right-To-Know law. Laboratories can be closed by the EPA/DNR for violations of this law. **LABEL EVERYTHING**.

I. Safety Inspections

Laboratory safety inspections are conducted monthly during the academic year. Each month one quadrant of the building is inspected, along with any areas that had special problems the previous inspection. The inspections, usually held on the first Tuesday of the month, will be announced in the *Courier*. The date is announced in advance with the expectation that the laboratory personnel will survey the area in advance and remedy any problems before the inspection team arrives.

We prefer that at least one member of a research group be present when the inspections are made. This way, we are able to discuss any reservations we may have and make a more accurate assessment. The primary purpose of these inspections is to make your work area as safe as possible for you. Your input is actively encouraged.

Following the inspections, reports are sent to the principal investigator (faculty member responsible for the lab). This report will list the problems, if any, and the suggested changes.

MICHIGAN STATE UNIVERSITY **Informed Consent Statement**

Department of Chemistry **Teaching Assistants**

Regulations and guidelines, however well conceived are not sufficient to achieve safe laboratory practice. It is the skill, knowledge and basic common sense of the individual laboratory worker that is crucial to a safety program. To this end each person working in a laboratory assumes the following responsibilities:

I. To attend safety seminars when asked, and to read all safety materials issued him/her (such as manuals, hazard alerts, etc.). If new hazards come to his/her attention, these should be communicated to the course instructor and the unit safety committee.

2. To comply fully with all established safety regulations and practices, and to consult the instructor and/or safety committee for advice in circumstances where safe practice is in doubt.

3. To be cognizant of the Michigan Right-To-Know Law through reading, training and experience.

4. To limit laboratory work to experiments authorized by the instructor.

5. To warn visitors to the laboratory of existing hazards, and when necessary (*e.g.*, equipment use by visiting researchers) to inform them of Department and University safety regulations. Warning signs provided by the safety committee shall be properly displayed and maintained. Unoccupied laboratories must be locked.

I have read and understand the above responsibilities and agree to observe them. I recognize that I may be working with hazardous materials, and I consent to work with these materials.

Signing of this Informed Consent Statement is not a waiver of individual rights of redress in case of injury.

Signature_____ Date_____

Permission is hereby granted to the above student to be a teaching assistant. The identified hazards of the proposed work, as well as a teaching assistant's responsibilities toward safety, have been discussed.

Graduate Coordinator/Supervisor_____ Date_____

MICHIGAN STATE UNIVERSITY **Informed Consent Statement**

Department of Chemistry **Research Staff**

Regulations and guidelines, however well conceived are not sufficient to achieve safe laboratory practice. It is the skill, knowledge and basic common sense of the individual laboratory worker that is crucial to a safety program. To this end each person working in a laboratory assumes the following responsibilities.

I. To attend safety seminars when asked, and to read all safety materials issued him/her (such as manuals, hazard alerts, etc.). If new hazards come to his/her attention, these should be communicated to the course instructor and the unit safety committee.

2. To comply fully with all established safety regulations and practices, and to consult the instructor and/or safety committee for advice in circumstances where safe practice is in doubt.

3. To be cognizant of the Michigan Right-To-Know Law through reading, training and experience.

4. To limit laboratory work to experiments authorized by the principal investigator.

5. To warn visitors to the laboratory of existing hazards, and when necessary (*e.g.*, equipment use by visiting researchers) to inform them of Department and University safety regulations. Warning signs provided by the safety committee shall be properly displayed and maintained. Unoccupied laboratories must be locked.

I have read and understand the above responsibilities and agree to observe them. I recognize that I may be working with hazardous materials, and I consent to work with these materials.

Signing of this Informed Consent Statement is not a waiver of individual rights of redress in case of injury.

Signature_____ Date_____

Permission is hereby granted to the above research staff member to conduct experimental work under my supervision. I have discussed the identified hazards of the proposed work.

Principal Investigator/Supervisor_____ Date_____

J. Michigan State University Chemical Hygiene Plan

(The most up-to-date information can be found at ***http://www.ehs.msu.edu/chemical/programs_guidelines/programs_guidelines.htm***)

1. SCOPE

1.1 MICHIGAN STATE UNIVERSITY STATEMENT OF RESPONSIBILITY

It is the responsibility of Michigan State University, as an employer, to take every reasonable precaution to provide a work environment that is free from recognizable hazards for its employees in accordance with the "general duty" clause of the Michigan Occupational, Safety and Health Act, Section 11(a).

Furthermore, MSU is required by the Michigan Occupational Safety and Health Administration (MIOSHA) Hazardous Work in Laboratories standard (the Laboratory Standard - §408.1024 of the Michigan Compiled Laws) to ensure that the necessary work practices, procedures and policies are implemented to protect all employees working in University owned and operated laboratories from hazardous chemicals in the work area.

Michigan State University and its employees have the responsibility to be well informed regarding hazardous chemicals and risks associated with using hazardous chemicals in the laboratory environment. This document is intended for University-wide compliance with the MIOSHA Laboratory Standard and will serve as a broad-based Chemical Hygiene Plan for all University owned and operated laboratories.

1.2 THE MIOSHA LABORATORY STANDARD (adopted by MIOSHA January 1, 1992)

The Michigan Occupational Safety and Health Administration (MIOSHA) has determined that laboratories typically differ from industrial operations in the use and handling of hazardous chemicals. A different approach than that found in MIOSHA's substance specific health standards is warranted to protect workers. The Laboratory Standard applies to all laboratories that use hazardous chemicals in accordance with the definitions of laboratory use and laboratory scale provided in this document. Generally, where this standard applies it supersedes the provisions of all other standards in the MIOSHA Right-to-Know Law and the federal Occupational Safety and Health Administration (OSHA) Hazard Communication Standard 29 CFR, part 1910.1200, except the obligation to maintain employee exposures at or below the permissible exposure limits (subpart Z of 1910.1200), prohibition of skin and eye contact where specified by any OSHA/MIOSHA standard and in other instances where the scope of hazards are not adequately addressed by this standard.

Effective Date: January 24, 1992

Compliance Date: Effective Immediately

Revision: July 28. 2003

Compliance Date: Effective Immediately

1.3 SCOPE AND APPLICATION

This document serves as the written guide for MSU compliance to the Laboratory Standard and the Chemical Hygiene Plan (CHP) requirements contained therein. All units at Michigan State University engaged in the laboratory use (as defined by this document) of hazardous chemicals are required to comply with this document.

The primary objective of this document is to provide a general guide for handling hazardous chemicals in laboratories. The Chemical Hygiene Plan establishes the basic safety principles for laboratory procedures, equipment and work practices that are capable of protecting employees from physical and health hazards of hazardous chemicals in laboratories.

This document is intended only to highlight those safety measures necessary for achieving a safe and healthy work environment. Where the scope of hazards are not adequately addressed by this general document, specific Standard Operating Procedures must be developed by the project director. This CHP does not, however, apply to:

1. Work involving chemicals that do not meet the conditions of the definition of laboratory use of hazardous chemicals. In such cases, the employer shall comply with all relevant specific substance standards even if such use occurs in a laboratory type setting.

2. Work involving the laboratory use of hazardous chemicals that does not have the potential for employee exposure.

This document will hereafter be known as the Michigan State University Chemical Hygiene Plan (MSU CHP).

1.4 HAZARDOUS CHEMICAL DEFINITIONS

A hazardous chemical is defined by MIOSHA as any chemical, chemical compound, or mixture of compounds which is a physical and/or health hazard.

A chemical is a **physical hazard** by MIOSHA definition if there is scientifically valid evidence that it is:

- a flammable or combustible liquid
- a compressed gas
- an organic peroxide
- an explosive
- an oxidizer
- a pyrophoric
- an unstable material (reactive)
- a water reactive material

A chemical is a **health hazard** by MIOSHA definition if there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Included are:

- allergens
- embryotoxicants
- carcinogens
- toxic or highly toxic agents
- reproductive toxicants
- irritants
- agents which damage the lungs, skin, eyes or mucous membranes
- corrosives
- sensitizers
- hepatoxins (liver)
- nephrotoxins (kidneys)
- neurotoxins (nervous system)
- hematopoietic systems agents (blood)

Particularly hazardous substances, by MIOSHA definition, are select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity.

Select carcinogens are chemicals listed by MIOSHA as carcinogens by the National Toxicology Program (NTP) as "known to be carcinogens" or "reasonably anticipated to be carcinogens" and by the International Agency for Research on Cancer (IARC) as Group 1, Group 2A or Group 2B carcinogens. Select carcinogens are listed in Appendix J.

Reproductive toxicants are defined by MIOSHA as any chemical which affects the reproductive capabilities of males or females, including chromosomal damage (mutagenesis) and effects on fetuses (teratogenesis). Information on reproductive effects will be listed on the Material Safety Data Sheet.

Chemicals with a high degree of acute and chronic toxicity are not defined in the Laboratory Standard. Therefore, the MIOSHA Hazard Communication definition of a highly toxic chemical will be used. Chemicals with a high degree of acute toxicity are chemicals that have a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each. The LD_{50} is that dose at which a lethal response is observed in 50% of the test animals.

The following two sources have established lists of hazardous chemicals based on substantiated tests:

1. OSHA, 29 CFR 1910.1200 Subpart Z, Toxic and Hazardous Substances and Appendices A and B of OSHA 29 CFR 1910.1200 which are referenced in MIOSHA R325.70101(2)
2. American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment," (latest edition)

The hazard(s) of a chemical may also be listed on its container label. Additionally, if the hazard of a chemical is not evident from the container label, the **Material Safety Data Sheet (MSDS)** will list the specific hazards. Use the MSDS to address chronic toxicity. For further help in determining the hazard of a chemical, contact your supervisor, instructor or the EHS.

1.5 RESPONSIBILITY

The **Office of Environmental Health and Safety** (**EHS**) shall be responsible for assuring University compliance with State and Federal standards and for preparing any reports, as established in the "Policies, Procedures and Guidelines for Radiation, Chemical and Biological Safety" document. In this vein, the EHS is responsible for oversight of University compliance with the MIOSHA Laboratory Standard and the Chemical Hygiene Plan required therein and will develop the provisions of the Michigan State University Chemical Hygiene Plan.

The Chemical Safety Officer of the EHS will serve as the Chemical Hygiene Officer (CHO). The CHO, along with the EHS, can assign areas of responsibility to units, project directors, laboratory supervisors and other individuals as necessary, to implement and carry out the provisions of the CHP. The CHO will serve on the Chemical Hygiene Subcommittee (CHS). The CHS will share in responsibility for oversight of the MSU CHP.

The EHS, the CHO and the CHS will serve as the on-campus authorities and sources of information for the MIOSHA Laboratory Standard and the MSU CHP.

Unit (departments, institutes, schools, outlying field stations, service groups, facilities, etc.): Unit chief administrative officers are responsible for maintaining a unit safety system, including identification of a safety officer. They have the responsibility to support and ensure the enforcement of the MSU CHP and to support the CHO and the CHS in implementing the provisions of this plan within their respective units.

Project Directors: The legal responsibility for safety and well-being of all personnel in contact with any university-related activity utilizing radiation, chemical or biological hazards lies with the project director (P.D.) and the administrative officers responsible at the various university levels. Specifically, the P.D. is responsible for:

1. Ensuring all employees under his/her supervision have received general chemical training from the EHS.
2. Providing all employees under his/her supervision with site-specific training and documenting such training.
3. Following appropriate guidelines proscribed in this document.

Employee: Individual laboratory employees are responsible for their own safety. All individuals performing work with hazardous substances must accept a shared responsibility for operating in a safe manner once they have been informed about the extent of risk and safe procedures for their activities. They also have the responsibility to inform their supervisors of accidents and work practices or working conditions they believe hazardous to their health or to the health of others.

Student: While students are not covered under the provisions of the MIOSHA Laboratory Standard, students should be made aware of chemical health and safety hazards in classroom situations and should be provided with information and equipment to protect themselves from those hazards. Units should provide student training at the beginning of each course in which hazardous chemicals are used. Specific safety instructions should be provided at the beginning of each class period.

1.6 EMPLOYEE RIGHTS

It is the employee's right to receive information about the known physical and health hazards of the hazardous chemicals in their work areas and to receive adequate training to work safely with these substances.

Employees have the right to work in a safe environment and inform the P.D. or laboratory supervisor about potential risks in the laboratory.

1.7 AVAILABILITY

The MSU Chemical Hygiene Plan must be readily available to employees and employee representatives through their P.D., supervisor or departmental office.

Additional copies of this document are available from the EHS office and the EHS web site: ***http://www.ehs.msu.edu/***.

1.8 ANNUAL REVIEW

The MSU Chemical Hygiene Plan will be reviewed annually from its effective date by the Chemical Hygiene Officer and the Chemical Hygiene Subcommittee.

1.9 EMPLOYEE INFORMATION AND TRAINING

Employees must have access to information and training to ensure that they are apprised of the hazards of chemicals present in the work area. Such information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignment involving new exposure situations. Employees should receive periodic refresher information and training to ensure that they are aware of the risks of exposure to hazardous chemicals.

Information. Information provided by the EHS/Units/P.D.s/Supervisors to employees must include:

1. The contents of the MIOSHA Hazardous Work in Laboratories standard.
2. The location and availability of the MSU CHP.
3. The permissible exposure limits for OSHA/MIOSHA regulated substances or published exposure limits for other hazardous chemicals where there is no applicable OSHA/MIOSHA standard.
4. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory (available on Material Safety Data Sheets).
5. The location and availability of known reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory, including, but not limited to, Material Safety Data Sheets received from the supplier.

All of the above information is available from the EHS web site: ***http://www.ehs.msu.edu/***.

Method of Training. General training will be provided by the EHS and may take the form of individual instruction, group seminars, audiovisual presentations, handout material, or any combination of the above. Site-specific training will be provided by P.D.s or an appropriate designee. Please call the EHS at 355-0153 for information about the general chemical safety course or sign up for a safety course on our web site: ***http://www.ehs.msu.edu/***.

Training.

General awareness training provided by the EHS to employees will include:

1. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.).
2. General physical and health hazards of chemicals in the work area. This must include an awareness that many factors influence whether a given chemical might constitute a hazard (e.g. dose, exposure time, genetic background, developmental state, mixtures of interactions of chemicals, etc.).
3. The measures employees can take to protect themselves from these hazards, including specific procedures the University or department has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
4. The applicable details of the MSU CHP.

Site-specific training provided by Units/P.D.s/Supervisors to employees will include:

1. Site-specific standard operating procedures.
2. Specific physical and health hazards of chemicals in the work area (available on Material Safety Data Sheets).

Documentation. General awareness training required by the CHP will be documented by the EHS. The training certification form in Appendix A will be filled out by employees at the time of training. The EHS will maintain these training forms. Site-specific training must be documented and maintained by the unit/P.D./supervisor and be available to representatives of the EHS, the CHO, members of the CHS or other regulatory officials upon request.

1.10 RECORD KEEPING

The EHS will retain records of all employees who attend the general chemical safety seminar and the Laboratory Standard/Chemical Hygiene Plan seminar given by the EHS.

It is required that records of specific laboratory training for individual laboratories be retained by the P.D. in the laboratory or the department.

Accident records for employees should be written and retained within the laboratory or unit.

The amount of time a unit chooses to retain training records is not specified in the Laboratory Standard. It is recommended by this document that such records be retained for at least one year after an employee leaves a position. Ideally, training records should be retained indefinitely.

1. STANDARD OPERATING PROCEDURES

The EHS has developed generic standard operating procedures relevant to safety and health considerations when laboratory work involves the use of hazardous chemicals. Where the scope of hazards are not adequately addressed by this general document, units and/or P.D.s must develop written standard operating procedures for work area specific operations. Standard operating procedures must be provided to all affected laboratory employees. **The Standard Operating Procedures in this document specify minimum regulations and recommendations.**

Note: "Prudent Practices for Handling Hazardous Chemicals in Laboratories" (National Research Council, 1981) was used as the basis for the standard operating procedure guidelines.

2.1 GENERAL SAFETY PRINCIPLES

The following guidelines have been established to minimize hazards and to maintain basic safety in the laboratory.

A. Examine the known hazards associated with the materials being used. Never assume all hazards have been identified. Carefully read the label before using an unfamiliar chemical. When appropriate, review the Material Safety Data Sheet (MSDS) for special handling information. Determine the potential hazards and use appropriate safety precautions before beginning any new operation.
B. Be familiar with the location of emergency equipment - fire alarms, fire extinguishers, emergency eyewash and shower stations and know the appropriate emergency response procedures.
C. Avoid distracting or startling other workers when they are handling hazardous chemicals.
D. Use equipment and hazardous chemicals only for their intended purposes.
E. Always be alert to unsafe conditions and actions and call attention to them so that corrective action can be taken as quickly as possible.
F. Wear eye and face protection when appropriate.
G. Always inspect equipment for leaks, tears and other damage before handling a hazardous chemical. This includes fume hoods, gloves, goggles, etc.
H. Avoid tasting or smelling hazardous chemicals.

2.2 HEALTH AND HYGIENE

The following practices have been established to protect laboratory employees from health risks associated with the use of hazardous chemicals:

A. Avoid direct contact with any hazardous chemical. Know the types of protective equipment available and use the proper type for each job.
B. Confine long hair and loose clothing and always wear footwear which fully covers the feet.

C. Do not mouth pipette.
D. Use appropriate safety equipment whenever exposure to gases, vapors or aerosols is suspected and ensure exhaust facilities are working properly.
E. Wash thoroughly with soap and water after handling chemicals, before leaving the laboratory and before eating or drinking.
F. Contact lenses are prohibited when using hazardous chemicals.
G. Replace personal protective equipment as appropriate.
H. Laboratory employees shall be familiar with the symptoms of exposure for the chemicals with which they work and the precautions necessary to prevent exposure.

2.3 FOOD AND DRINK IN THE LABORATORY

The following statement is the accepted practice on food and drink in laboratories and should be followed at all times:

> "There shall be no food, drink, smoking or applying cosmetics in laboratories which have radioactive materials, biohazardous materials or hazardous chemicals present. There shall be no storage, use or disposal of these 'consumable' items in laboratories (including refrigerators within laboratories). Rooms which are adjacent, but separated by floor to ceiling walls, and do not have any chemical, radioactive or biohazardous agents, present, may be used for food consumption, preparation, or applying cosmetics at the discretion of the project director responsible for the areas."

2.4 HOUSEKEEPING

Safety follows from good housekeeping practices. Use the following guidelines to maintain an orderly laboratory:

A. Keep work areas clean and uncluttered with chemicals and equipment. Clean up work areas upon completion of an operation or at the end of each work day, including floors.
B. Dispose of waste as per the **Michigan State University Hazardous Waste Disposal Guide** (***http://www.ehs.msu.edu/waste/programs_guidelines/programs_guidelines.htm***).
C. A separate waste receptacle must be designated for non-contaminated glass. Follow guidelines established in the MSU Hazardous Waste Disposal Guide for disposal of contaminated glass.
D. Clean spills immediately and thoroughly, as per the guidelines established in section 4.0 of this document. Ensure a chemical spill kit is available and that employees know how to use it.
E. Do not block exits, emergency equipment or controls or use hallways and stairways as storage areas.
F. Assure hazardous chemicals are properly segregated into compatible categories (see section 5.1.4 and Appendix C of this document).

2.5 CHEMICAL HANDLING AND STORAGE

The decision to use a hazardous chemical should be a commitment to handle and use the chemical properly from initial receipt to disposal.

A. Information on proper handling, storage and disposal of hazardous chemicals and access to related Material Safety Data Sheets should be made available to all laboratory employees prior to the use of the chemical.
B. Always purchase the minimum amount necessary to maintain operations.
C. Chemical containers with missing or defaced labels or that violate appropriate packaging regulations should not be accepted.
D. Chemicals utilized in the laboratory must be appropriate for the laboratory's ventilation system.

E. Chemicals should not be stored on high shelves and large bottles should be stored no more than two feet from floor level.
F. Chemicals shall be segregated by compatibility.
G. Chemical storage areas must be labeled as to their contents (see section 5.1.4)
H. Storage of chemicals at the lab bench or other work areas shall be kept to a minimum.
I. Any chemical mixture shall be assumed to be as toxic as its most toxic component.
J. Substances of unknown toxicity shall be assumed to be toxic.

2.6 TRANSFERRING OF CHEMICALS

When transporting chemicals outside the laboratory, precautions should be taken to avoid dropping or spilling chemicals.

A. Carry glass containers in specially designed bottle carriers or a leak resistant, unbreakable secondary container.
B. When transporting chemicals on a cart, use a cart that is suitable for the load and one that has high edges to contain leaks or spills.
C. When possible, transport chemicals in freight elevators to avoid the possibility of exposing people on passenger elevators.

2.7 COMPRESSED GASSES Special systems are needed for handling materials under pressure. Cylinders pose mechanical, physical and/or health hazards, depending on the compressed gas in the cylinder.

A. **Cylinders with regulators must be individually secured**. Only cylinders with valve protection caps securely in place may be safely gang-chained (chained in groups).
B. When storing or moving a cylinder, have the valve protection cap securely in place to protect the stem.
C. Cylinders must be secured in an upright position at all times. Use suitable racks, straps, chains, or stands to support cylinders against an immovable object, such as a bench or a wall, during use and storage. Do not allow cylinders to fall or lean against one another.
D. Use an appropriate cart to move cylinders.
E. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
F. Oil or grease on the high pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Use an oxygen approved regulator.
G. Always wear goggles or safety glasses with side shields when handling compressed gases.
H. Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled.
I. When working with a toxic, corrosive, or reactive gas is planned, the EHS should be contacted for information concerning specific handling requirements. Generally, these gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.

2.8 UNATTENDED OPERATIONS

At times, it may be necessary to leave a laboratory operation unattended. Follow these basic guidelines in the design of an experiment to be left unattended:

A. Always check with your laboratory supervisor to determine if it is necessary to leave a laboratory operation unattended. If necessary, develop a protocol with your laboratory supervisor for the unattended operation of potentially dangerous equipment or methods. Develop a protocol for potential interruptions in electric, water, inert gas and other services and provide containment for toxic substances as part of the protocol.

B. A warning notice must be posted in the vicinity of the experiment if hazardous conditions are present.

2.9 WORKING ALONE

Avoid working alone whenever possible.

2.10 STORAGE AND DISPOSAL OF HAZARDOUS WASTE

For guidelines on the storage and disposal of hazardous wastes from laboratory operations at Michigan State University, refer to the **Michigan State University Hazardous Waste Disposal Guide.** Copies of this document are available from the EHS.

2. STANDARD LABORATORY SAFE HANDLING / STORAGE REQUIREMENTS

3.1 HAZARD IDENTIFICATION

Identifying the specific hazard associated with a chemical greatly reduces chances of misuse by regular laboratory employees, new users, or visitors to the laboratory. At the very minimum, hazardous chemical containers must have the chemical name(s) and hazard identification(s). With respect to identifying containers, storage areas and laboratory entranceways, the following conditions entail hazard identification:

1. P.D.s/supervisors must ensure that labels on incoming containers of hazardous chemicals for laboratory use are not removed or defaced. Labels contain information on the identity of the chemical(s) in the container and the hazard identification of the chemical(s). It is recommended that incoming containers be labeled with the P.D.'s name and date of receipt.

2. P.D.s/supervisors must ensure that laboratory containers (those containers filled from the original shipping container) of chemicals are labeled (see section 3.4.1).

3. P.D.s/supervisors must ensure that hazardous chemical storage areas are labeled per the guidelines established in section 5.1.4.

4. P.D.s/supervisors must ensure that entranceways to laboratory facilities are labeled with the appropriate warning signs per the guidelines established in section 5.1.2.

5. P.D.s/supervisors must ensure that employees have access to MSDS's (see section 5.1.1).

3.2 HAZARDS SUBJECT TO REVIEW OR PRIOR APPROVAL

The Laboratory Standard requires that project directors identify those activities that the project director believes to be of a sufficiently hazardous nature to warrant prior approval before implementation by an employee. Prior approval for using Class A Carcinogens is required by the EHS (Appendix L). Appendix L also contains the list of chemicals for which MIOSHA has specific regulations for use.

3.3 CHEMICALS DEVELOPED IN THE LABORATORY

The following requirements apply to chemical substances developed in the laboratory:

1. If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the P.D. must determine if it is a hazardous chemical. This can be done by a literature search for similar substances. If the chemical is determined to be hazardous, the P.D. must provide appropriate training to protect employees.

2. If the chemical produced is a product or a by-product whose composition is not known, the P.D. must assume that the substance is hazardous and must comply with the requirements of the CHP.

3. If the chemical is produced for sale or use outside of the laboratory, the P.D. must prepare an appropriate MSDS in accordance to the Michigan Right-to-Know Law.

3.4 LABELING

3.4.1 Container Labels. All containers of hazardous chemicals must be labeled with the name of the chemical and the hazard(s), if not provided by the manufacturer. If a chemical has more than one hazard, it must be labeled with both hazards. For example, acetaldehyde is both a flammable and a carcinogen, and must be labeled appropriately. Additionally, the subsequent guidelines shall be followed:

1. All peroxide forming chemicals must be labeled with the date the container was opened. After the recommended disposal date, test the chemical for peroxides or dispose of properly (see Appendix H for a list of peroxide forming chemicals and peroxide testing protocols).

2. As per the MSU Hazard Communication Document,

   A. Anything available over the counter to the general public is exempt from labeling requirements if it has already been labeled by the manufacturer. This includes consumer products such as cans of spray paint or turpentine.

   B. Stationary process containers such as tanks may be identified with signs, placards, process sheets, batch tickets or other written materials instead of actually affixing labels to process containers. The sign or placard must convey the same information that a label would and be visible to employees throughout the work shift.

   C. Portable containers into which hazardous chemicals are transferred from labeled containers and which are intended to be under the use and control of the person who transferred it, within the work shift in which it was transferred, are exempt from labels. However, it is recommended that a temporary label identifying the chemical and its primary hazard be affixed to the container.

   D. All sample containers or prepared solutions must be labeled. If there is a large quantity of containers with the same chemical, labeling of the container, tray, cupboard or refrigerator will suffice.

3.4.2 Waste Containers. All hazardous chemical waste should be segregated and labeled according to the MSU Hazardous Waste Disposal Guide. Special attention should be given to the following areas:

1. Waste containers for non-contaminated glass **must be labeled** (label as “Broken Glass”) and kept separate from other non-contaminated waste.

2. Upon initial waste collection, attach a dated MSU Materials Pick Up tag and label containers with the words “Hazardous Waste.”

3. Once a chemical has been dated and labeled as a hazardous waste, it may not be accumulated for more than 90 days. Please request a hazardous waste pick-up from the EHS once the 90-day storage limit is approached.

For more specific information regarding hazardous wastes, reference the ***MSU Hazardous Waste Disposal Guide***.

3.5 PROVISIONS FOR PARTICULARLY HAZARDOUS SUBSTANCES

3.5.1 Permissible Exposure Limits. The Laboratory Standard requires that employers, for laboratory uses of substances regulated by OSHA/MIOSHA occupational health standards, assure that employees' exposures do not exceed the Permissible Exposure Limits (PELs). The PELs represent Time Weighted Averages (TWA's) in parts per million (ppm) or milligrams of substance per cubic meter of air (mg/m^3). The TWA represents the ratio between exposure and work shift. Appendix K lists the PELs established by OSHA, referenced by MIOSHA.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLV's), which are TWA values similar to PEL's. The TLV's are in some cases lower than the PELs. To keep employee exposures as low as reasonably achievable, employers will be expected to uphold the lowest exposure limit, be it a PEL or a TLV.

3.5.2 Employee Exposure Determination. Employers must contact the EHS to perform employee exposure monitoring under the following circumstances:

1. Initial monitoring must be performed if there is reason to believe employee exposure levels routinely exceed the action level, or Permissible Exposure Limit (PEL).

2. Periodic monitoring must be performed when initial monitoring reveals an exposure. The employer must comply with exposure monitoring provisions of the relevant standard.

Monitoring can be terminated in accordance with the relevant standard. Employers must notify the employee of the monitoring results within 15 working days after receipt of monitoring results. The results must be either individually distributed in writing or posted in a location accessible to all affected employees.

3.5.3 Special Considerations. The MIOSHA Laboratory Standard requires that special precautions for additional employee protection be followed for the laboratory use of **select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity (defined in section 1.4)**.

Protection from these hazards is provided by assuring exposure to such hazards is minimized, i.e. kept under the PEL, TLV, or STEL, or eliminated. To minimize exposure, it is necessary to determine the route by which exposure may occur, whether by inhalation, absorption, injection, ingestion or a combination of exposure routes. To ensure employees do not receive exposures in excess of the PEL or TLV, hygienic standards have been established for many toxic materials. The following general hygiene standards should be observed when using select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity.

Establish a designated area.

A. Use and store materials only in **designated areas**: a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances. Assure that all personnel with access are aware of necessary safety precautions.

B. Label all containers, storage and use areas appropriately. Follow the guidelines established in sections 3.4.1, 5.1.3 and 5.1.4 of this document.

Use proper containment devices for the protocol and chemical(s) being used.

A. Use a hood or other containment device for procedures which may result in the generation of aerosols or vapors; trap released vapors to prevent their discharge with fume hood exhaust.
B. It is recommended that breakable containers be stored in chemical-resistant trays. Work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.

Removal of contaminated waste.

A. Follow the guidelines established in the MSU Hazardous Waste Disposal Guide.

Follow decontamination procedures prior to leaving the designated area.

A. On leaving the designated area, remove protective apparel (place it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.
B. Thoroughly decontaminate or dispose of contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion to a less toxic product.
C. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed.
D. Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces. DO NOT DRY SWEEP SPILLED POWDERS.
E. Protect vacuum pumps against contamination with scrubbers or HEPA filters and vent effluent into the hood.

Always take extra precautions when working with particularly hazardous chemicals.

A. Consult the MSDS for toxic properties and follow the specific precautions and procedures.
B. Guard against spills and splashes. Appropriate safety apparel, especially gloves, should be worn. All hoods, glove boxes, or other essential engineering controls should be operating properly before work is started.
C. Notify the P.D. of all incidents of exposure or spills.

3.6 PHYSICAL HAZARDS

Materials which present a physical hazard (see section 1.4) can be safely used if the specific hazard(s) are understood. If appropriate precautions are not taken, personal injury or property damage may occur. Additionally, certain chemicals cannot be safely mixed or stored with other chemicals because of the danger of a severe or extremely toxic reaction. See Appendix C in ***http://www.ehs.msu.edu/chemical/programs_guidelines/chem_hygiene/chem_hygiene_plan/chp_full.pdf*** for a table of incompatible chemicals.

Hazardous chemicals require that employees follow special procedures for handling and storage. The P.D. or laboratory supervisor must create specific SOP's for unit safety.

3.6.1 Flammable/Combustible Material: The National Fire Protection Agency (NFPA) places flammable and combustible liquids in the following classes:

	Flash Point	Boiling Point
Flammable		
Class IA	< 73 °F (22.8 °C)	< 100 °F (37.8 °C)
Class IB	< 73 °F (22.8 °C)	≥ 100 °F (37.8 °C)
Class IC	≥ 73 °F (22.8 °C)	
Combustible		
Class II	≥ 100 °F (37.8 °C) & < 140 °F (60 °C)	
Class IIA	≥ 140 °F (60 °C) & < 200 °F (93 °C)	
Class IIIB	≥ 200 °F (93 °C)	

These classes give a measure of the fire risk. Appendix D in ***http://www.ehs.msu.edu/chemical/programs_guidelines/chem_hygiene/chem_hygiene_plan/chp_full.pdf*** lists some common flammable and combustible chemicals.

Note: the flash point is defined as the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. For handling Flammable/Combustible materials, observe the following guidelines:

A. Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity.
B. Store in NFPA approved flammable liquid containers or storage cabinets, in an area isolated from ignition sources or in a special storage room designed for flammable materials.
C. Ensure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Assure bonding and grounding is checked periodically.
D. Assure appropriate fire extinguishers and/or sprinkler systems are in the area.

3.6.2 Corrosives: materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface. See Appendix F in ***http://www.ehs.msu.edu/chemical/programs_guidelines/chem_hygiene/chem_hygiene_plan/chp_full.pdf***.

A. Containers and equipment used for storage and processing of corrosive materials should be corrosion resistant.
B. Eye protection and rubber gloves should always be used when handling corrosive materials. A face shield, rubber apron, and rubber boots may also be appropriate, depending on the work performed.
C. **Never add water to acid.** When mixing concentrated acids with water, add the acid slowly to water.
D. An eyewash and safety shower must be readily accessible to areas where corrosives are used and stored. In the event of skin or eye contact with corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Obtain medical help. See section 5.3 "Personal Protective and Safety Equipment" for eyewash and safety shower specifications.

3.6.3 Oxidizers: materials which react with other substances by giving off electrons and undergoing reduction. This reaction may result in fire or explosion. The intensity of the reaction depends on the oxidizing-reducing potential of the materials involved. See Appendix G in ***http://www.ehs.msu.edu/chemical/programs_guidelines/chem_hygiene/chem_hygiene_plan/chp_full.pdf***.

A. Know the reactivity of the materials involved in the experiment or process. Ensure there are no extraneous materials in the area which could become involved in a reaction.
B. If the reaction is anticipated to be violent or explosive, use shields or other methods for isolating the materials or the process.

3.6.4 Water Reactive Materials: materials which react with water to produce a flammable or toxic gas or other hazardous condition. Often a fire or explosion results. Safe handling of water reactive materials will depend on the specific material and the conditions of use and storage. Examples of water reactive chemicals include alkali metals such as lithium, sodium, and potassium; acid anhydrides, and acid chlorides.

3.6.5 Pyrophoric Materials: materials which ignite spontaneously upon contact with air. Often the flame is invisible. Examples of pyrophoric materials are silane, silicon tetrachloride, and white or yellow phosphorous. **Pyrophoric chemicals should be used and stored in inert environments.**

3.6.6 Peroxidizable Chemicals (Organic Peroxides): materials which undergo auto-oxidation (a reaction with oxygen in the air) to form peroxides (an O_2 group) which can explode with impact, heat, or friction. Since these chemicals may be packaged in an air atmosphere, peroxides can form even though the container has not been opened, necessitating careful handling. See Appendix H for a list of materials which may form peroxides.

A. Date all peroxidizables upon receipt and upon opening. Dispose of or check for peroxide formation after the recommended time; 3 months or one year depending on the chemical. See Appendix H in ***http://www.ehs.msu.edu/chemical/programs_guidelines/chem_hygiene/chem_hygiene_plan/chp_full.pdf***.
B. Do not open any container which has obvious solid formation around the lid.
C. Addition of an inhibitor to quench the formation of peroxides is recommended.
D. It is recommended to chemically test for peroxides periodically.
E. Follow the same basic handling procedures as for flammable materials.

3.6.7 Light-Sensitive Materials: materials which degrade in the presence of light, forming new compounds that can be hazardous, or resulting in conditions such as pressure build-up inside a container which may be hazardous. Examples of light sensitive materials include chloroform, tetrahydrofuran, ketones and anhydrides.

A. Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers which reduce or eliminate penetration of light.

3.6.8 Unstable Materials: compounds which can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as peroxides, perchlorates (from perchloric acid), picric acid and azides. A list of shock sensitive and explosive materials is provided in Appendix I.

A. Contact the EHS when it is suspected that the inadvertent formation of shock-sensitive materials in ductwork, piping, or chemicals being stored has occurred.
B. Date all containers of explosive or shock-sensitive materials upon receipt and when opened.
C. If there is a chance of explosion, use barriers or other methods for isolating the materials or the process.

3.6.9 Cryogens: liquefied gases that can condense oxygen from the air, create an oxygen rich atmosphere and increase potential for fire if flammable or combustible materials and a source of ignition are present. Pressure is also a hazard due to the large expansion ratio from liquid to gas, causing pressure build up in containers. Many materials become brittle at extremely low temperatures. Brief contact with materials at extremely low temperatures can cause burns similar to thermal burns. Some of the hazards associated with cryogens are fire, pressure, weakening of materials, and skin or eye burns upon contact with the liquid.

A. Equipment should be kept clean, especially when working with liquid or gaseous oxygen.

B. Mixtures of gases or fluids should be strictly controlled to prevent formation of flammable or explosive mixtures.

C. Always wear safety glasses with side shields or goggles when handling. If there is a chance of a splash or spray, a full face protection shield, an impervious apron or coat, cuffless trousers, and high-topped shoes should be worn. Watches, rings, and other jewelry should not be worn. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen spill. Pot holders could also be used.

D. Containers and systems containing cryogens should have pressure relief mechanisms.

E. Containers and systems should be capable of withstanding extreme cold without becoming brittle.

F. Since glass ampoules can explode when removed from cryogenic storage if not sealed properly, storage of radioactive, toxic or infectious agents should be placed in plastic cryogenic storage ampoules.

3.7 RADIOACTIVE MATERIAL HAZARDS

Use of radioactive materials at MSU is strictly controlled. Contact the EHS if you plan to use radioactive materials.

3.8 BIOLOGICAL MATERIAL HAZARDS

Use of biological materials at or above Biosafety Level 2 at MSU is strictly controlled. Contact the EHS if you plan to use biological materials at or above Biosafety Level 2.

3. EMERGENCY / MEDICAL PROCEDURES

4.1 BASIC STEPS FOR EMERGENCY AND SPILL RESPONSE

Releases of hazardous substances that pose a significant threat to health and safety or that, by their very nature, require an emergency response regardless of the circumstances surrounding the release or the mitigating factors are emergency situations. The following definitions designate an **emergency situation**:

1. The situation is unclear to the person causing or discovering the spill.
2. The release requires evacuation of persons.
3. The release involves or poses a threat of
   A. fire, suspected fire, explosion or other imminent danger;
   B. conditions that are Immediately Dangerous to Life and Health (IDLH);
   C. high levels of exposure to toxic substances.
4. The person(s) in the work area is uncertain they can handle the severity of the hazard with the personal protective equipment (PPE) and response equipment that has been provided and/or the exposure limit could easily be exceeded.

Conversely, releases that do not pose significant safety or health hazards to person(s) in the immediate vicinity or to the person(s) cleaning releases, do not have the potential to become emergencies within a short time frame are not emergency situations. The following situations **ARE NOT emergency situations**:

1. The person causing or discovering the release understands the properties and can make an informed decision as to the exposure level.
2. The release can be appropriately cleaned up by the lab personnel using authorized (certified) spill kits.
3. The materials are limited in quantity, exposure potential, or toxicity and present minor safety or health hazards to persons in the immediate work area or those assigned to clean up the activity.
4. Incidental releases of hazardous substances that are routinely cleaned up by EHS or trained custodians from outside the immediate release area need not be considered an emergency.

4.1.1 Emergency Situation – Fire. The following steps are basic protocol for handling a fire or fire-related emergency situation in the laboratory:

1. Pull the fire alarm.
2. Call 9-1-1 from a safe location.
3. Notify the unit emergency coordinator.
4. Evacuate.

4.1.2 Emergency Situation - Spill. If the spill is of high toxicity or flammability or you are unsure of how to proceed or is more than one liter, execute the following:

1. Call 9-1-1.
2. Evacuate personnel from the spill area and alert neighbors to the spill.
3. Isolate the spill area and close doors to the room where the spill occurred.
4. Remove ignition sources and shut down equipment.
5. Establish exhaust ventilation to the outside of the building only. Turn on exhaust equipment. Open windows.

Evacuation of the building is mandatory if chemicals or contaminants could enter the air circulation system of a building.

Attend to victims of a body splash:

1. Remove person(s) from spill area to fresh air only if attempts to rescue victim(s) do not present a danger to the rescuers.
2. Remove contaminated clothing while under an emergency shower.
3. Flood affected area with cold water for at least 15 minutes or longer if pain persists.
4. Wash skin with mild soap and water—do not use neutralizing chemicals, unguents, creams, lotions or salves.
5. Contact emergency response personnel and assure they know the chemical(s) involved.

Attend to victims of an eye splash:

1. Remove victim(s) from spill area to fresh air only if attempts to rescue victim(s) do not present a danger to the rescuers.
2. Lead the victim(s) immediately to an emergency eye wash facility.
3. Hold eye lids open.
4. Flush eyes for at least 15 minutes, or longer if pain persists.

5. Contact emergency response personnel and assure they know the chemical(s) involved.

4.1.3 Mercury Spills. For very small spills, less than 1 cc, such as a broken thermometer, use a trapped vacuum line attached to a tapered glass tube, similar to a medicine dropper, to pick up mercury droplets.

1. Do not use a domestic or commercial vacuum cleaner.
2. Cover small droplets in accessible areas with one of the following:
   - sodium polysulfide solution
   - powdered sulfur
   - silver metal compounds
   - dry ice to freeze the mercury droplets
3. Place residue in container for hazardous waste collection.

For large spills, *i.e*. greater than 1 cc, contact the EHS for spill cleanup, instructions or assistance.

4.1.4 Spill Kits. Ready access to a chemical spill kit is required in laboratories that work with hazardous chemicals. Minimally, such a kit should contain:

- splash resistant goggles
- chemical resistant gloves
- plastic bags
- multi-chemical sorbent (enough for 2 gallon spill)
- scooper

Most spills greater than 1 liter in volume require assistance from trained personnel from the EHS.

Some sorbents are chemically specific. The best sorbents are those which can be used to clean up all types of chemical spills. Check absorbents in spill kits for their absorbency range.

Each laboratory's spill kit should be kept in a readily accessible location and each employee should be trained on how to use the spill kit.

4.1.5 Non-Emergency Situation - Spill. If the spill is less than one liter and the chemical involved is of low toxicity and a low flammable hazard, handle it in the following manner:

If there are questions about proper spill response techniques, call the EHS at 355-0153.

1. Locate the spill kit.
2. Choose the proper protective equipment:
   - Always wear gloves and protective eye wear
   - Use additional protective equipment such as an apron, coveralls, or boots
   - Use a fitted respirator if there is an inhalation hazard above the permissible exposure limit.
3. Confine or contain the spill.

For non-reactive spills:

A. Cover liquid spills with spill kit absorbent and scoop into a plastic disposal bag.
B. Sweep solid materials into a dust pan and place in a sealed container.
C. Dispose of waste as normal trash as long as substance is non-volatile, non-hazardous.

For reactive or potentially reactive spills:

A. Cover liquid spill with spill kit absorbent and scoop into an appropriate disposal container.
B. Wet mop dry substances to avoid spreading hazardous dust, provided it is non-water reactive.
C. If spilled chemical is a volatile solvent, transfer disposal bag to a hood for evaporation of solvent.
D. Follow the MSU Hazardous Waste Disposal Guide for disposal.

4.1.6 Power Outages. If emergency lighting and fire alarms **ARE NOT** operable, evacuate the building after the following steps have been taken:

- Place lids on all open containers of volatile chemicals
- Lower the sash on chemical fume hoods
- Shut down all equipment (leave cooling water and purge gases on as necessary)
- Turn off ignition sources
- Secure or isolate reactions that are underway (boiling liquid on a hot plate, distillations)
- Close fire doors
- Take your books, coats, purse/wallet, keys, etc.
- Lock outside door to lab

In anticipation of possible power outages, do the following:

- Have a flashlight conveniently located or other emergency lighting
- Make sure that all emergency contact numbers on the door are accurate and updated

4.2 INJURY AND ILLNESS

For medical treatment, under current MSU policies and procedures, affected employees must seek care from one of the following facilities:

Primary Facility:	OLIN HEALTH CENTER, East Circle Drive, MSU, 517-355-0219, Monday-Tuesday, 8:00 AM to 7:00 PM Wednesday-Friday, 8:00 AM to 6:00 PM Saturday, 10:00 AM to 1:00 PM
Secondary Facility	The Sparrow Urgent Care After Hours Clinic, 517-381-4001 2248 Mt. Hope Rd. Suite 106 Okemos, MI 48864 Monday - Friday, 5 p.m. - 10 p.m. Saturday and Sunday, 10 a.m. - 10 p.m.
Critical Emergencies (or when first two are closed)	Sparrow Hospital Emergency Room, 517-483-2222 1215 E Michigan Avenue Lansing, MI 48909

The supervisor or instructor must ensure the appropriate injury report forms are completed. See Appendix M for copies of the appropriate forms.

If you have any questions regarding injury and illness procedures, contact your supervisor, instructor or the MSU Department of Police and Public Safety.

Minor First Aid

First Aid Kits. First aid kits are not recommended except for remote operations where emergency care is not readily available. If a unit desires a first aid kit, it must be maintained with essential supplies at all times. See the General Stores Catalog for a list of essential supplies.

Do not dispense or administer any medications, including aspirin.

Do not put any ointments or creams on wounds or burns. Use cool water.

The MSDS contains specific first aid information for a given chemical.

For specific first aid information, contact your supervisor, Olin Health Center or MSU Police and Public Safety.

4.3 MEDICAL CONSULTATIONS AND EXAMINATIONS

1. Health assessments prior to work assignment for new employees will be performed under the following conditions:

    A. When conditions specified by the **Exposure to Health Risks** form (available from department) are met, the employee must send the completed form to the MSU Occupational Health Service and then contact the MSU Olin Health Services to schedule an appointment for a medical examination prior to work assignment. Note that there are separate forms for full-time employees and student employees.

2. Units must provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

    A. When an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee must be provided an opportunity to receive an appropriate examination.

    B. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

    C. Whenever an event takes place in the work area, such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultations shall be for the purpose of determining the need for a medical examination.

    All medical consultations and examinations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place.

3. The unit shall provide the following information to the physician:

    A. The identity of the hazardous chemical(s) to which the employee may have been exposed.

    B. A description of the conditions surrounding the exposure, including available quantitative exposure data.

    C. A description of the signs and symptoms of exposure that the employee is experiencing, if any.

4. The unit shall obtain a written opinion from the examining physician which shall include the following:

    A. Any recommendation for further medical follow-up.

B. The results of the medical examination and any associated tests.

C. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace.

D. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

E. The written opinion of the physician shall not reveal specific finding of diagnoses unrelated to occupational exposure.

4. STANDARD LABORATORY FACILITY REQUIREMENTS

5.1 SIGNS AND INFORMATION

Labels and warning signs should alert employees to potentially hazardous materials and allow those unfamiliar with the laboratory surroundings to identify hazardous chemical use and storage areas, safety facilities, emergency equipment and exits and aid emergency response personnel. Signs and labels are generally available from the EHS.

5.1.1 Material Safety Data Sheets (MSDS's). A Material Safety Data Sheet (MSDS) is a document containing chemical hazard identification and safe handling information and is prepared in accordance with the OSHA Hazard Communication Standard and the Michigan Right-to-Know law.

Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals an appropriate MSDS for each hazardous chemical/product purchased.

The Michigan Right-to-Know law requires that units and/or P.D.s keep MSDS's in a systematic and consistent manner. The system a unit uses to store MSDS's can vary from keeping them in a notebook or file cabinet to using the EHS request system. The system adopted must provide easy access to MSDS's for hazardous chemicals used in the lab. Each unit must post a Michigan Right-to-Know Law poster, which indicates the location of all MSDS's for hazardous chemicals used in the lab.

The EHS is a central repository for MSDS's. If you wish to review a MSDS, contact your P.D., supervisor, instructor or the EHS. If you need MSDS's for your work area file, send a MSDS request form (located at ***http://www.aware.msu.edu/msds_request/new.htm***) to the EHS, between the hours of 8:00 am and 5:00 pm by

FAX: 353-4871

OR

MAIL: EHS, 1449 Engineering Research Court C125, Campus

OR

INTERNET: ***http://www.aware.msu.edu/msds_request/new.htm***

A representative from the EHS will fax, mail or hand deliver the MSDS's. If information from an MSDS is needed in case of an emergency, call the EHS at 355-0153 or dial 911.

Between the hours of 5:00 pm and 8:00 am, please contact MSU Police and Public Safety at 355-2221. The MSU Police will contact a representative from the EHS, who will provide you with a MSDS as soon as you need it.

5.1.2 Generic Signs. Every laboratory shall have the following signs visibly posted:

1. The Michigan Right-to-Know law poster, listing the location of MSDS's for all hazardous chemicals used in the laboratory.
2. Emergency contact numbers (two names, preferably the P.D., head technician or a graduate student) shall be posted on the external doorway to the lab. These names and numbers shall be updated when personnel change. In case of an emergency, responders need this information to contact knowledgeable personnel about specific laboratory hazards.
3. If a laboratory has 10 gallons or more of a flammable liquid, the main doorway to the lab shall have a flammable liquid sticker visibly posted on it. This is an aid to fire response personnel.

5.1.3 Restricted Access and Designated Areas. Facilities containing certain hazards must have warning signs posted at the designated area of the laboratory where the hazard exists, and at the entranceway to the laboratory. Any areas placarded as such are restricted access, designated areas and have certain standards regarding training and use by employees. Such hazards include:

- MIOSHA Class A carcinogens
- HIV and HBV research laboratories and production facilities*
- Biological agents that require Biosafety Level 2 or higher*
- Radioisotopes*

Other chemical hazards will be dealt with on a case-by-case basis, with consultation from the EHS.

*Please contact the Biological Safety Officer or the Radiation Safety Officer at the EHS for requirements on these items.

5.1.4 Storage Areas. Chemicals should be stored according to compatibility (see Appendix C), as designated by hazard classes. Particularly hazardous chemicals should be stored and handled with extreme care. When ordering chemicals that are unfamiliar, review the MSDS before purchase so that use and storage guidelines are understood. Assure that the following areas are labeled and chemicals are stored appropriately:

1. Carcinogens
2. Corrosives
3. Flammable Liquids
4. Flammable Solids
5. Oxidizers
6. Perchloric Acid
7. Biosafety Level 2 or higher

Additionally, storage areas for biohazardous agents and radioisotopes should be appropriately labeled. Please contact the Biological Safety Officer or the Radiation Safety Officer at the EHS for information.

5.2 CONTROL MEASURES

1. The P.D. or lab supervisor must implement control measures to reduce employee exposure to hazardous chemicals. The three types of control measures are:

    A. Administrative Controls: methods of controlling employee exposures to contaminants by job rotation, work assignment or time periods away from contaminant. Examples include Standard Operating Procedures, Chemical Hygiene Plans and Safety Manuals.

    B. Engineering Controls: methods of controlling employee exposures by modifying the source or reducing the quantity of contaminants released into the work environment. Examples include fume hoods and biosafety cabinets.

C. Personal Protective Equipment: personal safety equipment designed for secondary employee protection from hazardous chemicals. Examples include gloves and lab coats.

Note: MIOSHA R 325.51105 regarding air contaminants, states that engineering controls and administrative controls shall first be determined and implemented when feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in the rule.

2. MIOSHA requires control measures when the following circumstances are met:

   A. Whenever employees use hazardous chemicals.

   B. Whenever employee exposures exceed the action level (or, in the absence of an action level, the Permissible Exposure Limit, the published exposure limit or the Threshold Limit Value).

   C. Upon addition of new chemicals or changes in procedures.

Other situations should be dealt with on a case-by-case basis. Please consult the EHS for assistance in establishing control measures.

3. The following general control measures are recommended for use in most situations requiring the use of hazardous chemicals:

   A. Use the following primary methods for detecting exposures:
      i. Determine the source of exposure.
      ii. Determine the path the contaminant follows to reach the employee.
      iii. Determine the employee's work pattern and use of personal protective equipment.
      iv. Change one or more of the above pathways to reduce or eliminate exposure.
   B. Substitute less harmful chemicals for more harmful chemicals whenever possible.
   C. Change or alter processes to minimize exposure.
   D. Isolate or enclose a process or work operation to reduce the number of employees exposed (for example, use a fume hood).
   E. Use wet methods to reduce the generation of dust.
   F. Use local exhaust ventilation (hoods) at point of generation or dispersion of contaminants and use dilution (general) ventilation to reduce air contaminants.
   G. Practice good housekeeping procedures to reduce unnecessary exposures.
   H. Use training and education as primary administrative controls for reducing exposures.
   I. Use special control methods such as shielding and continuous monitoring devices to control exposures in special situations.

5.3 PERSONAL PROTECTIVE AND SAFETY EQUIPMENT

Maintaining a safe laboratory environment is the responsibility of the P.D., but all employees play a role in observing safety guidelines. Personal protective devices and safety equipment must be provided to all employees under the appropriate circumstances and employees have the responsibility of properly using such equipment.

The MSDS will provide some information on the personal protective equipment and safety procedures recommended for a given chemical, though the MSDS may not provide sufficient information concerning the specific type of safety equipment required (for example, it may say "use gloves" but not list the best glove to use).

MIOSHA has adopted the American National Standards Institute (ANSI) consensus standards for eye protection and emergency shower and eyewash facilities.

5.3.1 Personal Protective Equipment

Eye Protection. Eye protection must be made available to all employees or visitors to laboratories where chemicals are used and stored. Protective eye and face equipment must be used where there is a reasonable probability of injury from hazardous chemicals that can be prevented from such equipment. The minimum acceptable requirements are for hardened glass or plastic safety spectacles. **The P.D. or laboratory supervisor should establish the level of eye protection needed per laboratory activity. Specialized types of eye protection, such as ultraviolet light restricting safety glasses, are available.** The following types of eye protection are recommended for use in the laboratory by ANSI:

All eye protective devices must be stamped with "Z87" by the manufacturer if they meet ANSI standards. If the eye protection is not marked, it may not be the most effective protection available.

1. Safety glasses with side shields offer minimal protection against flying fragments, chips, particles, sand and dirt. When a splash hazard exists, other protective eye equipment should be worn.

2. Safety goggles (impact goggles) offer adequate protection against flying particles. These should be worn when working with glassware under reduced or elevated pressure or with drill presses or other similar conditions.

3. Chemical splash goggles (acid goggles) have indirect venting for splash proof sides, which provide adequate protection against splashes. **Chemical splash goggles offer the best eye protection from chemical splashes. Impact goggles should not be worn when danger of a splash exists.**

4. Face shields protect the face and neck from flying particles and splashes. Always wear additional eye protection under face shields. Ultra-violet light face shields should be worn when working over UV light sources.

Protection of Skin and Body. Skin and body protection involves the use of protective clothing to protect individuals from chemical exposure. Determine clothing needed for the chemical being used, as protective garments are not equally effective for every hazardous chemical. Some chemicals will permeate a garment in a very short time, whereas others will not.

The basic and most effective forms of protection are gloves and lab coats.

Protect exposed skin surfaces when there is a reasonable anticipation of a splash. Avoid wearing open-toed shoes, sandals, shorts, etc. when working with injurious or corrosive chemicals.

Even when there is minimal danger of skin contact with an extremely hazardous substance, lab coats, coveralls, aprons, or protective suits should be utilized. **These garments should not leave the work site.**

Exposures to strong acids and acid gases, organic chemicals and strong oxidizing agents, carcinogens, and mutagens require the use of specialized protective equipment that prevents skin contamination. Impervious protective equipment must be utilized. Examples include: rubber gloves, aprons, boots and protective suits.

Respirators. Michigan State University currently follows a respiratory protection program developed by the EHS in accordance with MIOSHA R3501 and 3502. Use of respirators in laboratories is strongly

discouraged. Respiratory use is only allowed where engineering controls are not feasible or where they are being installed.

Prior to using a respirator for the first time or for a new activity, employees must receive a medical exam from Olin Health Center, attend an EHS respiratory training session, undergo a fit test and complete an EHS respirator wearer questionnaire. Please contact the EHS for a copy of the MSU Respiratory Protection Program.

5.3.2 Safety Equipment

Safety Showers. Safety showers provide an immediate water drench of an affected person. MIOSHA has adopted the following ANSI standards for location, design and maintenance of safety showers:

1. Showers shall be located within 25 feet of areas where chemicals with $2.0 \geq pH \geq 12.5$ are used.

2. Showers shall be located within 100 feet of areas where chemicals with $2 < pH < 4$ or $9 \leq pH < 12.5$ are used.

3. The location of the shower should be clearly marked, well lighted and free from obstacles, closed doorways or turns.

Safety showers should be checked and flushed periodically.

Eye Wash Facilities. Eye wash facilities are required in all laboratories where injurious or corrosive chemicals are used or stored and are subject to the same proximity requirements as safety showers. MIOSHA has adopted the following ANSI standards for location, design and maintenance of emergency eyewash facilities:

1. Optimally, those affected must have both hands free to hold open the eye to ensure an effective wash behind the lids. This means providing eye wash facilities that are operated by a quick release system and simultaneously drench both eyes.

2. Eye wash facilities must provide the minimum of a 15-minute water supply at no less than 0.4 gallons per minute.

3. Eye wash facilities should be flushed out for five minutes at a time, once per week. A log documenting flushes is recommended.

Please call the EHS regarding specific designs for eye wash facilities.

5.4 VENTILATION CONTROLS

Ventilation controls are those controls intended to minimize employee exposure to hazardous chemicals by removing air contaminants from the work site. There are two main types of ventilation controls:

1. General (Dilution) Exhaust: a room or building-wide system which brings in air from outside and ventilates within. Laboratory air must be continually replaced, preventing the increase of air concentration of toxic substances during the work day. General exhaust systems are not recommended for the use of most hazardous chemicals.

2. Local Exhaust: a ventilated, enclosed work space intended to capture, contain and exhaust harmful or dangerous fumes, vapors and particulate matter generated by procedures conducted with hazardous chemicals. To determine ventilation requirements, assess the MSDS. Some MSDS terminology, as listed below, may indicate a need for special ventilation considerations beyond general exhaust ventilation:

- *use with adequate ventilation*
- *avoid vapor inhalation*
- *use in a fume hood*
- *provide local exhaust ventilation*

Proper Use of Local Ventilation Systems: Once a local ventilation system is installed in a work area, it must be used properly to be effective. For use of hazardous chemicals warranting local ventilation controls, the following guidelines should be observed:

1. Conduct all operations which may generate air contaminants at or above the appropriate PEL or TLV inside a fume hood.

2. Keep all apparatus at least 6 inches back from the face of the hood and keep the slots in the hood baffle free of obstruction by apparatus or containers. Large equipment should be elevated at least two inches off the base of the fume hood, to allow for the passage of air underneath the apparatus.

3. Do not use the hood as a waste disposal mechanism except for very small quantities of volatile materials.

4. Minimize storage of chemicals or apparatus in the hood.

5. Keep the hood sash closed at all times except when the hood is in use.

6. Minimize foot traffic and other forms of potential air disturbances past the face of the hood.

7. Do not have sources of ignition inside the hood when flammable liquids or gases are present.

8. Use sash as a safety shield when boiling liquids or conducting an experiment with reactive chemicals.

9. Periodically check the air flow in the hood using a continuous monitoring device or another source of visible air flow indicator. If air flow has changed, contact the EHS for an inspection or Physical Plant for repair.

The system must be checked prior to each use to assure it is operating. **Never work with hazardous chemicals if the required ventilation system is not working.**

The EHS performs hood inspections **annually**. After an inspection, hoods are passed or failed for use based on the following criteria:

1. The face velocity of air being drawn into the hood at maximum sash height is measured quantitatively in feet per minute (fpm) by a thermoanemometer (a hot wire). One measurement is taken per square foot of face space and averaged. Hoods must have an average face velocity of 60-150 fpm, depending on their design, with 100 fpm being the ideal average face velocity.

2. The turbulence of the air is measured qualitatively by releasing smoke from a smoke tube. The smoke must be captured by the hood, with a minimum of turbulence.

If the exhaust system does not pass the face velocity test and/or has excessive turbulence, it will be posted as "failed" by the inspector. The P.D. must contact Physical Plant to have the system repaired before hazardous chemicals can be used in the hood.

If the exhaust system does pass, the inspector will post the date of inspection and will mark the hood to indicate proper sash position for optimum hood performance. The hood sash should be set at this point for procedures which could generate toxic aerosols, gases or vapors. In general, the sash height should be set at a level where the operator is shielded to some degree from any explosions or violent reactions which could occur and where optimum air flow dynamics are achieved. If a fume hood has no markings regarding sash height or inspection dates, please contact the EHS to arrange for an inspection.

Certain types of local exhaust systems are not designed for the use of hazardous chemicals. If a local exhaust system's capabilities are not fully understood, check the manufacturer's specifications or call the EHS before using hazardous chemicals in the system.

Proper use of Ductless Ventilation Systems: Ductless, or portable fume hoods, which employ filtration media, may be an option to conventional local exhaust hoods. Contact the EHS for consultation before acquiring any ductless fume hood.

5.5 SPILL KITS

Refer to Section 4.1.4.

5. STANDARD REPAIR / CLOSE-OUT / DECOMMISSIONING PROCEDURES

6.1 DECONTAMINATION OF EQUIPMENT

When a request for equipment repair or transfer to another location is initiated, the following steps must be undertaken to ensure the safety of the employees responsible for repair or transfer if the equipment has been contaminated by hazardous chemicals:

A. Remove chemical contaminants with an appropriate solvent or cleaning solution.

B. Once contaminants have been eliminated, fill out an "Equipment Release Form" (***http://www.ehs.msu.edu/chemical/programs_guidelines/chem_hygiene/chem_hygiene_plan/chp_app_p.pdf***) and place in a prominent position on the equipment to be repaired or transferred. **The equipment must have the Equipment Release Form affixed for initiation of repair or transfer.**

Appendix A: Graduate Student Forms

All original forms can be downloaded via the electronic version of the Chemistry Graduate Program Guide, which is available on the Chemistry Department website.

Ph.D. Degree Forms

M.S. Degree Forms

Evaluation and Status Report Forms

Application for Graduation and Check Out Form

DEPARTMENT OF CHEMISTRY
MICHIGAN STATE UNIVERSITY

ACKNOWLEDGEMENT STATEMENT
GUIDELINES FOR INTEGRITY IN RESEARCH AND CREATIVE ACTIVITIES

The *Guidelines for Integrity in Research and Creative Activities* are intended to promote high professional standards by all personnel of the Department of Chemistry performing research. To foster awareness of the principles of proper professional conduct, the Chemistry Department requires all personnel engaged in research to read these Guidelines (Page 13 of the Chemistry Graduate Program Guide), to discuss them with the Graduate Program Director or Research Advisor, and to acknowledge that they have done so. The signed acknowledgement form must be returned to the Chemistry Graduate Office, who is responsible for keeping this record.

I hereby acknowledge that I have read and understood the *Guidelines for Integrity in Research and Creative Activities:*

Signature Date Title/Function

I hereby acknowledge that I have discussed with the Associate Chair for the Chemistry Graduate Program, the *Guidelines for Integrity in Research and Creative Activities:*

Signature Date Title/Function

RESEARCH ADVISOR SELECTION

Department of Chemistry

Please rank your choices below and return this form to your initial advisor by the Friday before Thanksgiving. Do not fill in the shaded area until instructed to do so.

Student Name: _____

1st Choice:	Professor_____
2nd Choice:	Professor_____
3rd Choice:	Professor_____

I have interviewed and consulted with the following faculty with respect to their research interests:

	Signed	Date
1.	_____	_____
2.	_____	_____
3.	_____	_____
4.	_____	_____
5.	_____	_____
6.	_____	_____

My advisor will be Professor _____

My major area will be _____

My desk will be located in room _____

My telephone extension will be _____

Date _____

_____ _____

Advisor's Signature *Student's Signature*

Approved: _____ _____

Associate Chair for the Graduate Program *Date*

cc: Chemistry Business Office
Chemistry Main Office
Major Advisor
Student

SELECTION OF GUIDANCE COMMITTEE (Ph.D.)

Department of Chemistry

TO: Associate Chair for the Graduate Program

FROM: _____

Student's Name (First/Last) *Signature* *Student Number (PID)*

I am recommending for your approval the following faculty as members of my Guidance Committee:

Research Advisor: _____

Printed Name

Second Reader: _____ _____

Printed Name *Signature*

_____ _____

Printed Name *Signature*

_____ _____

Printed Name *Signature*

_____ _____

Printed Name *Signature*

_____ _____

Research Advisor's Signature *Date*

APPROVED:

_____ _____

Associate Chair for the Graduate Program ***Date***

cc: Advisor
Dean
Student

FIRST COMMITTEE MEETING REPORT (Ph.D.)

Department of Chemistry

Student: _____ _____

Student's Name (First/Last) *Student Number (PID)*

Date: _____

Research Advisor: _____

Signatures of Committee Members:

Second reader _____ _____

_____ _____

_____ _____

_____ _____

The following is to be completed by the Research Advisor:

Checklist for topics to be covered:

- ☐ Courses to be completed were discussed.
- ☐ A rough draft of the Guidance Committee Report was completed and is enclosed.
- ☐ First seminar was discussed.
- ☐ The student's research project was discussed.
- ☐ The student's research progress to date was discussed.
- ☐ The student has currently accrued a total of _____ Cumulative Exam Points, and this requirement was discussed. The Cumulative Exam requirement was passed on: _____
- ☐ Goals to be achieved by the Second Year Oral Exam, and longer-term goals, were discussed.

The expectations for progress prior to the Second Year Oral Exam are as follows:

_____

_____

_____

_____

_____

Tentative date for Second Year Oral Exam:_____

_____ _____

Research Advisor's Signature *Date*

c: Advisor
Student

MICHIGAN STATE UNIVERSITY

Copies to: Dean
Department
Guidance Committee
Student

REPORT OF THE GUIDANCE COMMITTEE – DOCTORAL AND OTHER PROGRAMS

See the catalog (Academic Programs) regarding composition of guidance committee and deadlines for its formation and for filing this report listing all degree requirements.

Ph.D X D.M.A. ____

Name Dingleberry (Last) Chauncey (First) Philbert (Middle) Student No. A12345678 Ed.D ____ Ed.S. ____

First Semester in Doctoral Program FS (Semester) 2012 (Year) Dept. Chemistry Major Chemistry

Bachelor of Science, U. of E. Timbuktoo (Institution) 2012 (Year) Chemistry (Major) Master of ____ (Institution) (Year) (Major)

Tentative Dissertation Subject Chemistry of Floor Sweepings

Director Professor Fumblebutt Languages or Course Substitutes ____

Will the student's research involve the use of		
human subjects of human materials?	☐ Yes	☑ No
warm-blooded animals?	☐ Yes	☑ No
or hazardous substances?	☐ Yes	☑ No

I understand it is necessary to obtain institutional review and approval prior to initiating any research involving the use of human or animal subjects or hazardous materials.

(STUDENT'S SIGNATURE) Mo./Day/Yr.

DOCTORAL PROGRAM

PLEASE PRINT OR TYPE AND CLUSTER BY FIELD

Dept.	Course No.	Semester	Title	No. CR	Dept.	Course No.	Semester	Title	No. CR
CEM	890		Chem. Problems and Reports	1					
CEM	958		Organic Chemistry Seminar	1					
CEM	958		Organic Chemistry Seminar	1					
CEM	845		Struc Spect Organic Compounds	3					
CEM	851		Advanced Organic Chemistry	3					
CEM	852		Methods of Organic Synthesis	3					
CEM	956		Special Topics in Organic Syn	1					
CEM	811		Advanced Inorganic Chemistry	3					
CEM	820		Organometallic Chemistry	3					

Approved

(Please TYPE guidance committee member's names below signatures)

1. ____ Chairperson: Robert E. Maleczka Mo./Day/Yr.
2. ____
3. ____
4. ____
5. ____
6. ____

Course Credits *(in addition to at least 24 credits of 999)* ____

Comprehensive examination areas:

The candidate expects to pass the Comprehensive Examination by ____ Semester, ____ Year.

____ Student Mo./Day/Yr.

____ Department Chairperson Mo./Day/Yr.

____ College Dean Mo./Day/Yr.

MSU is an affirmative action/ equal opportunity employer.

HOW AND WHEN TO SUBMIT THE Ph.D. GUIDANCE COMMITTEE REPORT

(The Ph.D. Guidance Committee Report can be accessed through The Graduate School and/or Department of Chemistry Websites.)

---

1. A rough draft of the Guidance Committee Report should be completed at the First Committee Meeting and placed in the student's file with the First Committee Meeting Report. **A typed final version of the report must be signed by the student and their Guidance Committee Members and submitted to the Chemistry Graduate Office at the time of the Second Year Oral Exam.**

2. **Do not list CEM 999 credits.** List only those courses that will be required for your Ph.D. degree in Chemistry (courses that have been taken and also need to be taken). These courses are selected by you and your Guidance Committee Members.

3. **Do not include 200 and 300 level courses** or language courses taken.

4. **All Ph.D. students are required to take six (6) Graduate Level Courses** and it is strongly recommended that one of the courses be a Special Topics Course.

5. **Two credit hours of CEM 890 are required**; one credit for faculty research seminars in the Fall Semester of your first year in the Graduate Program and one for the Second Year Oral Exam. **These credits should be listed separately** on the Guidance Committee Report Form.

6. Ph.D. students are required to present TWO seminars in their major area of interest. **The two credits of seminar should be listed individually on the Guidance Committee Report Form** and the student must enroll for two credits of seminar during their time in the Chemistry Graduate Program. If you received your M.S. from Michigan State, you only need to list one credit of seminar.

At Second Year Oral Exam:

1. Verify that all courses listed are correct.

2. Be sure to sign the Guidance Committee Report in both **(two) places** (top and bottom of the form).

3. **ALL** of your Guidance Committee Members, must sign the report before delivering it to the Chemistry Graduate Office for approval.

4. The Guidance Committee Report will be forwarded to the Dean of the College of Natural Science for his/her signature. A copy of the signed Report will be put in your student file in the Department of Chemistry, and given to you as well.

The above information is included in the Chemistry Graduate Program Guide and further information may be found in the Academic Programs catalog.

SECOND YEAR ORAL EXAM (Ph.D.)
Department of Chemistry

TO: Associate Chair for the Graduate Program

FROM: _____ (Second Reader)

RE: _____ (Student)

A research oral examination was held on _____ by the Guidance Committee members listed below.
(date)

The student has _____ points in cumulative exams to date. This progress is considered to be:

- ☐ Complete as of _____
- ☐ Satisfactory
- ☐ Unsatisfactory, and the Guidance Committee recommends:

_____

_____

_____

ORAL EXAM REPORT:

- ☐ Satisfactory performance. CEM 890 grade: _____ for the _____ Term.
- ☐ Unsatisfactory performance. Re-examination to be tentatively held on:_____

  Reason for Re-examination: _____

  _____

  _____

  _____

- ☐ Unsatisfactory performance. Transfer the student to the M.S. program.

  CEM 890 grade: _____ for the _____ Term.

- ☐ Unsatisfactory performance. Termination at the end of _____ Term.

Guidance Committee:

_____	_____
Advisor	*Signature and date*
_____	_____
Second Reader	*Signature and Date*
_____	_____
	Signature and Date
_____	_____
	Signature and Date
_____	_____
	Signature and Date

cc: Advisor
Second Reader
Student

Ph.D. GUIDANCE COMMITTEE REPORT/CHANGE IN MEMBERSHIP
Department of Chemistry

Select one: ☐ **Change to the Guidance Committee Report**
☐ **Change in Guidance Committee Membership**

TO: The Associate Chair for the Graduate Program

FROM: _____ _____ _____

Student's Name (First/Last) Signature Student Number (PID)

The following change(s) are recommended to the student's Guidance Committee Report:

A. Recommended Change: _____

_____

_____

_____

B. Reason for Recommended Change: _____

_____

_____

_____

(NOTE: The change(s) will be recorded on the Final Certification Form for the student's Ph.D. Degree.)

Current Guidance Committee:

_____ _____
Advisor *Signature and date*

_____ _____
Second Reader *Signature and Date*

_____ _____
Signature and Date

_____ _____
Signature and Date

_____ _____
Signature and Date

New Guidance Committee (if applicable):

_____ _____
Advisor *Signature and date*

_____ _____
Second Reader *Signature and Date*

_____ _____
Signature and Date

_____ _____
Signature and Date

_____ _____
Signature and Date

Approved: _____ _____
Associate Chair for the Graduate Program Date

_____ _____
College Dean Date

c: Advisor
Dean
Student

MICHIGAN STATE
UNIVERSITY

RECORD OF COMPREHENSIVE EXAMINATIONS
for
DOCTORAL DEGREE AND EDUCATIONAL
SPECIALIST DEGREE CANDIDATES

☐ **Check if this is a re-examination because of expired time limits.**

Department of Chemistry

Student's Name _____ **Student Number** _____
Last, First, Middle Initial

Term and Year of First Course Counted towards this Degree _____

Result of Written Comprehensive Examinations:

Field	Examiner(s)	Examination Date (MM-DD-YY)	Passed or Failed

Result of Oral Comprehensive Examination

Field	Examiner(s)	Examination Date (MM-DD-YY)	Passed or Failed

_____ _____
Chairperson of Examination Committee Signature Date

Signed _____ _____
Chairperson of the Department Date

Signed _____ _____
Dean of College Date

Copies to: Registrar
Dean

MICHIGAN STATE UNIVERSITY - DEPARTMENT OF CHEMISTRY

RECOMMENDATIONS OF GUIDANCE COMMITTEE

FOR

STUDENTS IN THE SIXTH YEAR OF STUDY OR BEYOND

Student:_____ Advisor:_____

Guidance Committee:_____

Entered Program: _____Cumulative Exam Points: _____ Meeting Date:_____

Recommendations:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Guidance Committee:

Advisor	*Signature and date*
Second Reader	*Signature and Date*
	Signature and Date
	Signature and Date
	Signature and Date

c: Research Advisor
Second Reader
Student

MICHIGAN STATE UNIVERSITY

Copies to: Dean
Department
Guidance Committee
Student

RECORD OF DISSERTATION AND ORAL EXAMINATION REQUIREMENTS FOR DOCTORAL DEGREE CANDIDATE

Department of: _____

Student's Name: _____ **Student Number:** _____

1. **Dissertation Title:**

2. **Dissertation has been:** ☐ **Accepted** ☐ **Rejected** ☐ **Accepted subject to revisions (beyond minor editorial changes) required by the Committee.**

3. **Oral examination in defense of the dissertation was conducted on:** _____
Date

The student ☐ **Passed**

☐ **Failed** **Reason:**

4. **Dissenting opinions and signatures of dissenting examiners, if any:**

5. **Subject to the satisfactory completion of other requirements, this student is recommended for the degree Doctor of:**

☐ **Philosophy** ☐ **Education** ☐ **Musical Arts**

Signatures of Guidance Committee Members: **Printed names of Guidance Committee Members:**

	Chairperson of Guidance Committee	Date

6. **Major revisions required:**

7. **Revisions, if any, approved:** _____
Chairperson of Guidance Committee Date

Approved: **Department Chairperson:** _____

Associate/Assistant Dean: _____

MSU IS AN AFFIRMATIVE ACTION/EQUAL OPPORTUNITY INSTITUTION

DISTRIBUTION OF UNBOUND COPY OF DISSERTATION (Ph.D.)

Department of Chemistry

Student_____

Scheduled Oral Date_____

Dissertation Distribution Date_____

This form must be signed by each member of the student's Guidance Committee when (s)he delivers the unbound copy of their dissertation and a copy of their preprint(s) or reprint(s) of published work based on their dissertation research.

The dissertation should be in final form, except for changes that may be suggested at your oral exam by your Guidance Committee. All chapters, references and appendices should be in final, typed form. All figures should be clearly drawn, with complete labels and figure captions. This form must be returned to the Chemistry Graduate Office with all signatures prior to the scheduled oral date. This completed form is required in order to hold your final defense.

Research Advisor: I have read this dissertation, scientifically critiqued its contents, recommended corrections, and the changes that I have suggested have been made. Thus, I approve its distribution to the committee.

_____ _____

Research Advisor *Signature and date*

Second Reader: I have read this dissertation, scientifically critiqued its contents, recommended corrections, and the changes that I have suggested have been made. Thus, I approve its distribution to the committee.

_____ _____

Second Reader *Signature and date*

Other Committee Members:

_____ _____

Committee Member *Signature and date*

_____ _____

Committee Member *Signature and date*

_____ _____

Committee Member *Signature and date*

_____ _____

Committee Member *Signature and date*

CHANGE IN DEGREE PROGRAM (Ph.D. to M.S.)
Department of Chemistry

DATE: _____ TERM: _____

Student: _____ _____ _____
Name *Student's signature* *PID*

Change of program status, from the Ph.D. program to the:
☐ Plan A (Thesis) M.S. Program in Chemistry
☐ Plan B (Coursework) M.S. Program in Chemistry

Reason for Change: _____

_____

_____

_____

_____

Changing degree programs must be approved by your Ph.D. Guidance Committee:

_____ _____
Advisor *Signature and date*

_____ _____
Second Reader *Signature and Date*

_____ _____
Signature and Date

_____ _____
Signature and Date

_____ _____
Signature and Date

List all of the courses that you have taken, the term in which they were taken, and all of the courses you intend to take.

credits required for an M.S. degree: 30

Plan A: Minimum # of research credits required: 8
Maximum # of research credits allowed: 15
CEM 899 credits must be used instead of CEM 999.
CEM 999 credits can be converted to CEM 899.

Plan B: Research credits aren't needed, but CEM 890 can be used. Your Advisor must submit a grade for this.

Be sure to list research credits as CEM 899 or CEM 890.

CEM 999 credits cannot be converted to CEM 890 credits.

Please indicate the # of CEM 999 credits to be converted to CEM 899 credits: _____

COURSE #	TERM	# CREDITS
		Total: 30

Approval of the proposed M.S. program as listed here by the members of the M.S. Guidance Committee:

_____ _____
Advisor *Signature and date*

_____ _____
Signature and Date

_____ _____
Signature and Date

_____ _____
Signature and Date

_____ _____
Associate Chair for the Graduate Program *Date*

c: Advisor
Dean
Student

CHANGE IN M.S. ORAL COMMITTEE
Department of Chemistry

TO: The Associate Chair for the Graduate Program TERM: _____

FROM: _____ _____ _____

Student's Name (First/Last) Signature Student Number (PID)

I am recommending for your approval the following changes in membership of my M.S. Oral Committee.

Original Committee: (the signatures of all faculty involved are required:)

_____ _____
Advisor *Signature and date*

_____ _____
Second Reader *Signature and Date*

_____ _____
Signature and Date

_____ _____
Signature and Date

_____ _____
Signature and Date

New Committee:

_____ _____
Advisor *Signature and date*

_____ _____
Second Reader *Signature and Date*

_____ _____
Signature and Date

_____ _____
Signature and Date

_____ _____
Signature and Date

_____ _____ _____
Guidance Committee Chairperson *Signature* *Date*

Approved: _____ _____
Associate Chair for the Graduate Program *Date*

c: Advisor
Dean
Student

ORAL EXAMINATION REPORT

Master Of Science – Plan A (Thesis)

Department of Chemistry

TO: Associate Chair for the Graduate Program

FROM: _____ (Advisor)

RE: Oral Examination of _____ (Student)

A research oral examination for the degree of Master of Science for the above named student is scheduled for

Date _____

Time _____

Room _____

before an examining committee consisting of Professors:

_____ **The Major field is** _____

Advisor

_____

Second Reader

_____

_____

_____

The approved thesis title is: _____

_____

Cumulative Exam points: _____

Report on Exam: ☐ Failed _____

☐ Passed with a Grade of _____ for CEM 899 (will appear on Transcript).

Recommendations for continuance of graduate studies toward Ph.D. Degree:

Move to the Ph.D. Program	☐ Yes	☐ No
Use this Examination as Second Year Oral	☐ Yes	☐ No
Terminate at M.S.:	☐ Yes	☐ No

_____ _____

Advisor *Signature and date*

_____ _____

Second Reader *Signature and Date*

_____ _____

Signature and Date

_____ _____

Signature and Date

_____ _____

Signature and Date

Approved: _____ _____ _____

Associate Chair for the Graduate Program *Signature* *Date*

cc: Advisor
Dean
Student

DISTRIBUTION OF UNBOUND COPY OF THESIS (M.S.)

Department of Chemistry

Student Name _____ PID _____

Scheduled Oral Date _____

Thesis Distribution Date _____

This form must be signed by each member of the student's Guidance Committee when she/he delivers the unbound copy of their thesis and a copy of their preprint(s) or reprint(s) of published work based on their thesis research.

The thesis should be in final form, except for changes that may be suggested at your oral exam by your Guidance Committee. All chapters, references and appendices should be in final, typed form. All figures should be clearly drawn, with complete labels and figure captions. This form must be returned to the Chemistry Graduate Office with all signatures at least one day prior to the scheduled oral date. This completed form is required to hold your M.S. defense.

Research Advisor: I have read this dissertation, scientifically critiqued its contents, recommended corrections, and the changes that I have suggested have been made. Thus, I approve its distribution to the committee.

_____ _____

Research Advisor *Signature and date*

Other Committee Members:

_____ _____

Committee Member *Signature and date*

_____ _____

Committee Member *Signature and date*

_____ _____

Committee Member *Signature and date*

_____ _____

Committee Member *Signature and date*

ORAL EXAMINATION REPORT
Master of Science
Plan B (Coursework)

Department of Chemistry

Student's Name:_____PID:_____

M.S. Plan B Oral Evaluation Date: _____

Evaluation Completed by the Associate Chair for the Graduate Program.

Report on exam: Failed _____

Passed _____

Recommend Re-examination_____

_____ _____

Signature of the Associate Chair for the Chemistry Graduate Program Date

c: Dean

Student

STUDENT RESEARCH EVALUATION
Department of Chemistry

Name: _____ Entered: _____

Advisor: _____ Program: _____

Semester Evaluated: _____

Please comment below on the student's research performance during the past semester. Consider in your comments motivation, independence, productivity, efficiency in performance of research, breadth and originality of thought, knowledge of literature in the area, performance in research group meetings and any other important items.

(Please submit the completed evaluation to the Chemistry Graduate Office.)

During this semester, this student accomplished the following:

_____

_____

_____

_____

_____

Evaluation:

_____

_____

_____

_____

_____

Student was appointed as a: ☐ TA ☐ RA this term.

Course Load: _____

OVERALL EVALUATION:

☐ Excellent Progress (Exceeds the productivity expected from most graduate students at this stage of their career.)

☐ Good Progress (At this rate the student should have no difficulty in completing dissertation research within the accepted time limit.)

☐ Marginal Progress (Below average productivity. Improvement is necessary to avoid a rating of unsatisfactory.)

☐ Unsatisfactory Progress (Unacceptable research performance. A rating of unsatisfactory in two of any four successive semesters requires a meeting of the Guidance Committee.)

Research Advisor Signature: _____

c: Advisor
Student

TEACHING ASSISTANT EVALUATION

IMPORTANT: In accordance with the Graduate Employee Union Contract, it is MANDATORY that TA Evaluations be completed and maintained in the TA's personnel file. Please return the completed evaluations to the Chemistry Graduate Office.

TA's Name: _____ Instructor(s): _____ Semester: _____

Course: _____

Teaching

1.	Competence	O	G	S	P	No Eval.
2.	Communication	O	G	S	P	No Eval.
3.	Attitude toward students	O	G	S	P	No Eval.
4.	Lab Safety	O	G	S	P	No Eval.
5.	Extra efforts with students	O	G	S	P	No Eval.

Course Operations

6.	Responsibility toward duties	O	G	S	P	No Eval.
7.	Contributions to teaching meetings	O	G	S	P	No Eval.
8.	Provides student feedback	O	G	S	P	No Eval.
9.	Extra contribution to the course	O	G	S	P	No Eval.

Did you attend any sections assigned to this TA? ☐ **YES** ☐ **NO**

OVERALL RATING (Please Circle One):

Outstanding: Does a superior job with extra effort provided.

Good: Exceeds minimum expected requirements.

Satisfactory: Does neither more nor less than the minimum required.

Poor: Unacceptable performance of duties. Please provide specific examples under "Comments" listed below.

No Evaluation

Comments

c: Student

CHEMISTRY GRADUATE PROGRAM
STUDENT STATUS REPORT

Name: _____ **Advisor:** _____

PID: **Area:**

Entered: **Program:**

Progress of Degree Requirements

First Committee Meeting:

 # CUME Points:

CUME Completeion Date:

Second Year Oral: **Grade:**

Guidance Committee Report:

Comprehensive Exam Date:

TA Requirement 1:

TA Requirement 2:

Area Seminar 1:

Area Seminar 2:

Sixth Year Meeting:

GPA

Term:	GPA:

Cumulative Exam Points

CumeDate	Area	#Points

Guidance Committee Members:

GC Position	Name

Please check the Status Report for accuracy. If there are any discrepancies, highlight them, write a brief explanation on this report, and return it to the Graduate Office. The correction will be made and a new copy of the report will be given to you and to your advisor.

c: **Advisor**
Student

Date of Report:

http://www.reg.msu.edu/StuForms/GradApp/GradApp.asp

Office of the Registrar

MSU Home | Site Map | Contact Us | Search

Application for Graduation

Top of Form

Application for Graduation	
Request Date: 2/13/2003	
Submit by first week of semester you expect to complete degree requirements. Summer candidates should submit by first week of Spring Semester.	
PID	
Name - as you want it to appear on Diploma	(Be sure to use exact spacing and capitalization)
Semester and Year that you expect to complete requirements	Fall 2002
Mailing Address for Diploma	
Street	
Apt	
City/State/Zip	
Country	US
Note: Your Diploma and a complimentary copy of your transcript will be mailed 4 weeks after the end of the semester.	
Newspaper Notification	● Yes - I want notification of my graduation sent to the newspaper of the city listed above. (You must notify any additional newspapers directly.)
	● No - I do not want notification of my graduation sent to the newspaper.
Candidate For ...	
Bachelor of	
Master of	
Doctor of	
Educational Specialist	
Major	

Major	
College	
Any other information the Registrar's Office should know: i.e., are you completing an additional major, a thematic program, an option, a specialization, or MBA concentration?	
Note: All of the above, when completed, will appear on your MSU transcript. They do not show on the Diploma. (You are limited to 255 characters)	
Local Phone ###-###-####	- -
Email Address	

Verify Application for Graduation | Reset Form

Street *Apt.* *City* *State* *Country* *ZIP*

Graduate Student Check Out Form

Department of Chemistry ❖❖ Michigan State University

(Please note: Final Certification of your degree will not be processed until the Graduate Office receives this completed Check Out Form.)

1. **Name:** _____ **Advisor:** _____ **Date:** _____

2. All books borrowed from the MSU Library have been returned in acceptable condition.

   Signature _____ (Kriss Ostrom, 884-1943, Circ. Desk, ***kriss@mail.lib.msu.edu***)

3. Original copies of laboratory notebooks and backup copies of computer files related to research, have been turned in. Supplies and equipment have been checked in. Working space and apparatus is in satisfactory condition, all products are properly labeled, hazardous wastes have been removed, and desk is clean and in satisfactory condition. Keys for desk/file cabinets/etc. have been returned to Professor.

   Signature _____ **(Major Professor)**

4. BPS Access Card returned to the Chemistry Graduate Office.

   Signature _____ **(Graduate Office, Room 381)**

5. All keys and have been turned in and/or accounted for.

   Signature _____ **(Sub-Basement Stockroom)**

6. Business Office Accounts closed.

   Signature _____ **(Business Office, room 324)**

7. Chemistry Computer Accounts attended to.

   Signature _____ **(IT Support, room 383)**

8. All data stored on any instrument in the Max T. Rogers NMR Facility has been backed up and may be deleted (if applicable).

   Signature _____ **(NMR)**

9. X-ray Ring/Badge has been returned to Environmental Health & Safety (if applicable).

   Signature _____ **(EHS, C124 Res. Complex-Engr.)**

10. All chemical containers have been properly labeled and stored. All hazardous waste has been picked up by EHS.
    Signature _____ **(EHS, 355-0153)**

Employment: Please list the name of the institution or company where you will be employed after you receive your degree and the position you will hold (*e.g.*, postdoc, research scientist, etc.).

Employed By: _____

Position Title: _____

Forwarding Address: _____

_____

Telephone: _____ **E-Mail:** _____

Received _____ **(Graduate Office Signature)** _____ **(Date)**

c: Business Office, IT Support-Carter, Main Office

Appendix B: Chemical Physics Degree Requirements in Chemistry

A. The general requirements for the College of Natural Science for the Ph.D. degree apply.

B. Specific requirements of the Ph.D. degree Program in Chemical Physics are as follows:

1. Students must satisfy the admission and qualification requirements for the Ph.D. degree of either the Department of Chemistry or of the Department of Physics. Prospective students should request admission into the Chemical Physics Program in a letter to the Committee on Chemical Physics.
2. The Ph.D. Guidance Committee for each student must have at least two members from the Department of Chemistry and at least two members from the Department of Physics. The Major Professor serves as chair. Another committee member is designated as Second Reader. The Guidance Committee Report must be completed within two semesters after admission into the Chemical Physics Program. Copies are to be filed with the Director of the Chemical Physics Program, the Graduate Office of the admitting Department, and the Dean of the College of Natural Science.
3. At least six credits of coursework from each department must be included in the student's course program. The courses chosen, and any changes in the program made thereafter, are to be approved by the student's Guidance Committee. (Changes are made on a form available from Department Graduate Offices.) In meeting these credit requirements, candidates should be enrolled in courses that are recognized as being graduate level unless the Committee on Chemical Physics has granted written permission for course work constituting an exception to this rule.
4. Students must hold a graduate teaching assistantship for a minimum of one semester during their tenure in the Chemical Physics Program.
5. One portion of the Comprehensive Examination is of the cumulative type. The requirements of the department into which the student was admitted apply. The Comprehensive Examination in the Department of Physics and Astronomy is based on passing the final examinations in a core set of entry-level graduate courses. In the Chemistry Department, Chemical Physics cumulative exams are given THREE times each academic year and are graded on a pass-fail basis. The Chemical Physics exams are aimed to test the student's problem-solving capabilities at the interface of chemistry, physics, and mathematics at the graduate level. The exam topic is usually announced no later than one week in advance of the examination. Candidates for the Ph.D. degree may begin these examinations immediately after they have enrolled in the graduate program and must be continued without interruption. A grade of 2 or 3 on the designated Physical Chemistry exams is equivalent to a pass for a Chemical Physics student while a grade of 0 or 1 is a fail. By the end of the second year, it is expected that at least two cumulative exams (either Chemical Physics or designated Physical Chemistry or Nuclear Chemistry) have been passed. Students who fail to meet this minimum requirement will be removed from the Chemical Physics Program. The candidate must pass four cumulative exams; a minimum of two Chemical Physics exams and the remainder designated Physical Chemistry or Nuclear Chemistry exams.
6. No later than the midpoint of the third semester (not including Summer semesters) each graduate student must meet with his/her Guidance Committee. The research advisor will call and preside over this short meeting. The purpose of the meeting is to:
    a. Discuss course measurements and the Guidance Committee Report. The Guidance Committee Report will be completed, but not signed until the Second Year Oral Examination.

b. Present the plan for the student's second year, focusing on the work to be completed to prepare for the Second Year Oral. The advisor will present his/her goals for the student for his/her second year and beyond. In some cases, the goals for the student may be to perform certain experiments, learn certain instrumental methods, build an instrument, make compounds, etc. In other cases, the goal may be to master certain concepts required for pursuing the research. In this way, the student and the committee members will clearly know what will be expected by the time of the Second Year Oral Examination.

c. The first seminar (scheduling, content) should be discussed at this meeting.

d. Progress on the Chemical Physics Cumulative Examinations will be discussed.

e. There should be some preliminary planning of the time of the Second Year Oral.

7. An oral examination, intended to provide an assessment of a student's preparation for his or her independent research project, forms the remaining component of the Comprehensive Examination. This oral examination is administered by the student's Guidance Committee, under the supervision of the Second Reader; it is normally taken in the second year and must occur before the end of the fourth semester in residence (not including Summer semesters). The oral examination can only be scheduled after the student has passed two cumulative exams (either Chemical Physics or designated Physical Chemistry). A research proposal is to be prepared by the student and distributed to the members of the Guidance Committee at least 14 days prior to the oral examination date. The results of the exam are transmitted by the Second Reader to the Graduate Office of the admitting Department and to the Director of the Chemical Physics Program, on a form provided by the latter. If the examining committee determines that a student's research preparedness and/or progress is unsatisfactory, the graduate program may be terminated or specific recommendations for a course of remedial action, including re-examination, will be given.

8. Each student must pass two seminars (graded on a pass/fail basis) presented before appropriate groups in the physics or chemistry departments – the Physical Chemistry Seminar (CEM 998) or the regular solid state or Cyclotron seminar series.

9. The final oral defense of the dissertation research is presented before the Guidance Committee; the seminar portion of the final oral defense will be open to all members of the university community. A manuscript, reprint, or similar evidence of the student's participation in the dissemination of the research results must be submitted, with the thesis draft previously approved by the Major Professor and Second Reader, to the members of the Guidance Committee at least one week prior to the scheduled defense. A form to be signed by each Committee member at that time, as well as the MSU form to be completed after successful thesis defense, is available from the Director of the Chemical Physics Program.

10. The Guidance Committee of every student beginning their sixth year of study and every year thereafter must meet during the first semester of every year. The purpose of this meeting will be to assess the progress of the student and could be the final oral defense. The meeting will normally be called by the Major Professor. If the Guidance Committee does not meet during the first semester of the year, the Director of the Chemical Physics Program will call a meeting of the Committee during the first month of the following semester.

Appendix C: Guidelines for Students at NSCL

(1) Graduate students at NSCL must submit a yearly progress report to be reappointed for the next year. This report (one page) should include a list of courses you took, course grades, exam grades, and a brief summary of your research activities.

   a. Reappointments for the next academic year have to be decided by the end of March each year. The progress report should be submitted to the NSCL Associate Director for Education no later than March 15, or earlier if requested.

(2) Graduate students at NSCL are required to have an annual meeting of their guidance committee. As a chemistry graduate student:

   a. You are required to have the first meeting of your guidance committee by the mid-point of your third semester of study. This committee meeting will fulfill the annual meeting requirement for your first year of study at NSCL.

   b. You are required to have a second-year oral examination by the end of the fourth semester of study. This examination will fulfill the annual meeting requirement for your second year of study at NSCL.

   c. You are required to have an annual guidance committee meeting if your stay in the graduate program extends beyond the fifth year. These required annual meetings will also fulfill the annual meeting requirements established for NSCL graduate students.

   d. Between the second and sixth years of study, you should schedule a meeting of your guidance committee. The NSCL Guidance Committee Meeting Report Form should be completed and submitted to your advisor, with copies to the Chemistry Graduate Office and the NSCL Associate Director for Education.

NSCL Guidance Committee Meeting Report Form

Student Name: _____

Date: _____

Research Advisor: _____

One page progress report is attached and was discussed:

- ☐ Yes
- ☐ No

Recommendation for continuing support:

_____

Goals for next year:

_____

Goals for graduation:

_____

Career plan and other activities:

_____

Approved by the Guidance Committee:

Name:	Signature:
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Student Signature:

_____

The student should give copies of the signed form to the advisor, the Chemistry graduate office, and the NSCL Associate Director for Education

Appendix D: Graduate Student Rights and Responsibilities

For general information (policies, regulations, *etc.*), check the Graduate School's website at:

http://grad.msu.edu/

and the office of the Ombudsperson at:

129 N. Kedzie Hall

(517) 353-8830

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The Graduate Student Rights and Responsibilities at MSU can be found at:

http://grad.msu.edu/gsrr/docs/GSRR.pdf

From the Graduate School website (***http://grad.msu.edu/publications/docs/integrityresearch.pdf***)

Appendix E: Guidelines For Integrity In Research And Creative Activities

The conduct of research and creative activities by faculty, staff, and students is central to the mission of Michigan State University[6] and is an institutional priority.

Faculty, staff, and students work in a rich and competitive environment for the common purpose of learning, creating new knowledge, and disseminating information and ideas for the benefit of their peers and the general public. The stature and reputation of MSU as a research university are based on the commitment of its faculty, staff, and students to excellence in scholarly and creative activities and to the highest standards of professional integrity. As a partner in scholarly endeavors, MSU is committed to creating an environment that promotes ethical conduct and integrity in research and creative activities.

Innovative ideas and advances in research and creative activities have the potential to generate professional and public recognition and, in some instances, commercial interest and financial gain. In rare cases, such benefits may become motivating factors to violate professional ethics. Pressures to publish, to obtain research grants, or to complete academic requirements may also lead to an erosion of professional integrity.

Breaches in professional ethics range from questionable research practices to misconduct.[7] The primary responsibility for adhering to professional standards lies with the individual scholar. It is, however, also the responsibility of advisors and of the disciplinary community at large. Passive acceptance of improper practices lowers inhibitions to violate professional ethics.

Integrity in research and creative activities is based not only on sound disciplinary practice but also on a commitment to basic personal values such as fairness, equity, honesty, and respect. These guidelines are intended to promote high professional standards by everyone— faculty, staff, and students alike.

Key Principles

Integrity in research and creative activities embodies a range of practices that includes:

- Honesty in proposing, performing, and reporting research
- Recognition of prior work • Confidentiality in peer review
- Disclosure of potential conflicts of interest
- Compliance with institutional and sponsor requirements
- Protection of human subjects and humane care of animals in the conduct of research
- Collegiality in scholarly interactions and sharing of resources
- Adherence to fair and open relationships between senior scholars and their coworkers

Honesty in proposing, performing, and reporting research. The foundation underlying all research is uncompromising honesty in presenting one's own ideas in research proposals, in performing one's research, and in reporting one's data. Detailed and accurate records of primary data must be kept as unalterable documentation of one's research and must be available for scrutiny and critique. It is expected that researchers will always be truthful and explicit in disclosing what was done, how it was done, and what results were obtained. To this end, research aims, methods, and outcomes must be described in sufficient detail such that others can judge the quality of what is reported and can reproduce the data. Results from valid observations and tests that run counter to expectations must be reported along with supportive data.

Recognition of prior work. Research proposals, original research, and creative endeavors often build on one's own work and also on the work of others. Both published and unpublished work must always be properly credited. Reporting the work of others as if it

were one's own is plagiarism. Graduate advisors and members of guidance committees have a unique role in guiding the independent research and creative activities of students.

Information learned through private discussions or committee meetings should be respected as proprietary and accorded the same protection granted to information obtained in any peer-review process.

Confidentiality in peer review. Critical and impartial review by respected disciplinary peers is the foundation for important decisions in the evaluation of internal and external funding requests, allocation of resources, publication of research results, granting of awards, and in other scholarly decisions. The peer-review process involves the sharing of information for scholarly assessment on behalf of the larger disciplinary community. The integrity of this process depends on confidentiality until the information is released to the public. Therefore, the contents of research proposals, of manuscripts submitted for publication, and of other scholarly documents under review should be considered privileged information not to be shared with others, including students and staff, without explicit permission by the authority requesting the review.

Ideas and results learned through the peer-review process should not be made use of prior to their presentation in a public forum or their release through publication.

Disclosure of potential conflicts of interest. There is real or perceived conflict of interest when a researcher has material or personal interest that could compromise the integrity of the scholarship. It is, therefore, imperative that potential conflicts of interest be considered and acted upon appropriately by the researcher. Some federal sponsors require the University to implement formal conflict of interest policies. It is the responsibility of all researchers to be aware of and comply with such requirements.

Compliance with institutional and sponsor requirements. Investigators are granted broad freedoms in making decisions concerning their research. These decisions are, however, still guided, and in some cases limited, by the laws, regulations, and procedures that have been established by the University and sponsors of research to protect the integrity of the research process and the uses of the information developed for the common good. Although the legal agreement underlying the funding of a sponsored project is a matter between the sponsor and the University, the primary responsibility for management of a sponsored project rests with the principal investigator and his or her academic unit.

Protection of human subjects and humane care of animals in the conduct of research. Research techniques should not violate established professional ethics or federal and state requirements pertaining to the health, safety, privacy, and protection of human beings, or to the welfare of animal subjects. Whereas it is the responsibility of faculty to assist students and staff in complying with such requirements, it is the responsibility of all researchers to be aware of and to comply with such requirements.

Collegiality in scholarly interactions and sharing of resources. Collegiality in scholarly interactions, including open communications and sharing of resources, facilitates progress in research and creative activities for the good of the community. At the same time, it has to be understood that scholars who first report important findings are both recognized for their discovery and afforded intellectual property rights that permit discretion in the use and sharing of their discoveries and inventions. Balancing openness and protecting the intellectual property rights of individuals and the institution will always be a challenge for the community. Once the results of research or creative activities have been published or otherwise communicated to the public, scholars are expected to share materials and information on methodologies with their colleagues according to the tradition of their discipline.

Faculty advisors have a particular responsibility to respect and protect the intellectual property

rights of their advisees. A clear understanding must be reached during the course of the project on who will be entitled to continue what part of the overall research program after the advisee leaves for an independent position. Faculty advisors should also strive to protect junior scholars from abuses by others who have gained knowledge of the junior scholar's results during the mentoring process, for example, as members of guidance committees.

Adherence to fair and open relationships between senior scholars and their coworkers. The relationship between senior scholars and their coworkers should be based on mutual respect, trust, honesty, fairness in the assignment of effort and credit, open communications, and accountability. The principles that will be used to establish authorship and ordering of authors on presentations of results must be communicated early and clearly to all coworkers. These principles should be determined objectively according to the standards of the discipline, with the understanding that such standards may not be the same as those used to assign credit for contributions to intellectual property. It is the responsibility of the faculty to protect the freedom to publish results of research and creative activities. The University has affirmed the right of its scholars for first publication except for "exigencies of national defense".[8] It is also the responsibility of the faculty to recognize and balance their dual roles as investigators and advisors in interacting with graduate students of their group, especially when a student's efforts do not contribute directly to the completion of his or her degree requirements.

Misconduct in Research and Creative Activities

Federal[9] and University[7] policies define misconduct to include *fabrication* (making up data and recording or reporting them), *falsification* (manipulating research materials, equipment or processes, or changing or omitting data such that the research is not accurately represented in the record), and *plagiarism* (appropriation of another person's ideas, processes, results, or words without giving appropriate credit). Serious or continuing non-compliance with government regulations pertaining to research may constitute misconduct as well. University policy also defines retaliation against whistle blowers as misconduct. Misconduct does not include honest errors or honest differences of opinion in the interpretation or judgment of data.

The University views misconduct to be the most egregious violation of standards of integrity and as grounds for disciplinary action, including the termination of employment of faculty and staff, dismissal of students, and revocation of degrees. It is the responsibility of faculty, staff, and students alike to understand the University's policy on misconduct in research and creative activities[7], to report perceived acts of misconduct of which they have direct knowledge to the University Intellectual Integrity Officer, and to protect the rights and privacy of individuals making such reports in good faith.

Resources

"Guidelines on Authorship", Endorsed by the University Research Council, January 15, 1998 (***http://rio.msu.edu/authorshipguidelines.htm***)

"Integrity in Scientific Research: Creating an Environment that Promotes Responsible Conduct", National Academies Press, Washington, D.C., 2002, 216 pp (***http://www.nap.edu/books/0309084792/html***)

"Research Data: Management, Control, and Access Guidelines", Endorsed by the University Research Council, February 7, 2001 (***http://rio.msu.edu/research_data.htm***)

Footnotes

1. The Graduate School, "Graduate Handbook Template"(***http://grad.msu.edu/staff/handbook.pdf***)
2. Michigan State University "Academic Programs" (***http://www.reg.msu.edu/ucc/AcademicProgramsUpdated.asp***)
3. Spartan Life: Student Handbook and Resource Guide, Part II Rights and Responsibilities, "Graduate Student Rights and Responsibilities" (***http://splife.studentlife.msu.edu/rights-and-responsibilities***)
4. Spartan Life: Student Handbook and Resource Guide, Part II Rights and Responsibilities, "Medical Student Rights and Responsibilities" (***http://splife.studentlife.msu.edu/rights-and-responsibilities***)
5. Spartan Life: Student Handbook and Resource Guide,Part II Rights and Responsibilities, "Academic Freedom for Students at Michigan State University" (***http://splife.studentlife.msu.edu/academic-freedom-for-students-at-michigan-state-university***)
6. Michigan State University "Mission Statement" approved by the Board of Trustees on April 18, 2008 (***http://president.msu.edu/mission/***)
7. MSU Faculty Handbook, Chapter VI, "Research andCreative Endeavor—Procedures Concerning Allegations of Misconduct in Research and Creative Activities" (***http://www.hr.msu.edu/documents/facacadhandbooks/facultyhandbook/misconductproc/index.htm***)
8. MSU Faculty Handbook, Chapter VI, "Research andCreative Endeavor—Sponsored Research and Creative Endeavor" (***http://www.hr.msu.edu/documents/facacadhandbooks/facultyhandbook/sponsoredresearch.htm***)
9. Office of Science and Technology Policy, "Notice of Final Policy", 65 CFR 76260

Appendix F: Responsible Conduct of Research (RCR) — Chemistry Plan

Initial Training

1. **Introduction to RCR —** a discussion of research misconduct issues
    a. Graduate Students (GS) — orientation program – 1 hour
    b. Post-docs and mid-year graduate student admissions — GS presentation
    c. Undergrads — GS presentation

    Currently, we run an introduction to RCR during our graduate student orientation week prior to the start of the fall semester. Because the students have not joined research groups, the presentation is general. It is based on a document that the CNS Dean's Office made available to departments several years ago. We have the students sign a form at the end of this session and that is kept in their academic file. For post-docs, out-of-cycle graduate admissions and undergraduates, the records for this initial training will be kept by the graduate school.

2. **Conflict of Interest (COI) training –** this will be accomplished via assigned readings on the GS web site followed by an annual discussion with the department chair at the start of the spring semester. At this point in time, the new students have joined research groups and will have some sense of the groups operation. The point is to make them aware of COI issues that might surface during their research and to let them know that they can talk confidentially to the department chair, or the associate chair for the graduate program, about concerns. Attendance will be taken and records kept by the Department's graduate office.(1 hour)

3. **Initial Discussion with Research Advisors –** Graduate Students, Post-docs and Undergraduate researchers with have an initial meeting with their research advisors where specific issues of RCR that pertain to the group are discussed. These include expectations for record keeping and data management, ownership of data, authorship policies, honesty in recording/reporting experimental observations, and possible COI concerns. The student will be instructed to take the GS Research Misconduct training and the programs on responsible research with Human and Animal subjects if needed. The graduate office will issue forms to the research advisors to remind them of this requirement. The meeting will be documented through completion of a topic checklist on this form and its signing by both the student and research advisor. Completed forms will be maintained with the students/post-docs academic records. (1 hour)

4. **GS Program on Research Misconduct –** follow-up to the initial discussion with research advisors for graduate students, post-doctoral researchers and undergraduates. The responsible conduct of research involving Human/Animal subjects will be inserted into this phase of training as needed. Documentation will be completed by the GS. (2 hours)

5. **Research Group Refresher –** One group meeting will be set aside each semester to discuss RCR issues pertinent to the group. Each research advisor will receive a reminder from the graduate office regarding their obligation to hold these meetings and they will be given a form to complete that provides a brief summary of the discussion and documents those in attendance. (1 meeting during fall, spring and summer semesters – 3 hours total)

During their first year in a research lab, all researchers will receive 8 hours of training: five hours through a combination of departmental and Graduate School based programs, and three hours through regular research group meetings. After the first year, research group meetings devoted to RCR issues will deliver 3 hours of reinforcement. The annual COI meeting held by the Department Chair will be open to all graduate students, not just those who are new to our program.