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Combining Chemistry and College Writing: A New Model for an Honors Undergraduate Chemistry Course

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Faculty in the Departments of Chemistry and English at Florida Atlantic University (FAU) have designed and implemented an innovative, writing-intensive, advanced, second-semester chemistry course combined with a laboratory component that satisfies both second semester General Chemistry and College Writing criteria. This unusual configuration differs from typical honors chemistry courses because of its "writing to learn" approach to teaching in-depth scientific content, the nature of research, and research methods. The opportunity to develop this course emerged from a collaborative relationship between our institution's Writing Across the Curriculum (WAC) program and our chemistry department.

While most writing intensive initiatives, such as the "Writing like a Chemist" project (Stoller, Jones, Costanza-Robinson, & Robinson, 2005), are designed for upper-division courses (Goodman & Bean, 1983; Paulson, 2001; Stoller, 2005; Shibley, 2001; Whelan & Zare, 2003), some attempts have been made to incorporate writing at the freshman level; these include parallel courses that require students to be "co-registered" in a writing course that is linked with a science course taught by professors of the respective disciplines (Griffin, 1985; Wilkinson, 1985). Other initiatives include using laboratory reports that incorporate more extensive writing than traditional laboratory reports (Kovac & Sherwood, 1999; Tilstra, 2001). The Science Writing Heuristic (SWH) is an example of this approach (Greenbowe & Hand, 2005; Hand & Keys, 1999; Keys & Hand, 1999; Rudd & Greenbowe, 2001; Rudd & Greenbowe, 2002). To the best of our knowledge, however, no course that combines first-year chemistry and English has been developed before.

We believe that this course creates an excellent foundation for assisting students in acquiring skills for reflection and self-assessment in chemistry and writing, introduces the practice of formulating scientific ideas through writing, improves communication skills between students and professors, and improves professional skills. We discuss the collaborative efforts that resulted in a National Science Foundation (NSF) grant to develop our course, and we provide an overview of our approach, course materials, methods of instruction, and implementation.

APPROACH: WAC

Over the past thirty-five years, the WAC movement emerged in higher education by incorporating writing components into the curriculum across disciplines. The fundamental principles of WAC are that writing is the most efficient tool for acquiring critical-thinking skills and that having students perform well-designed writing assignments is the best way to engage them in the subject matter (Bean, 2001). Barnes and colleagues (1989) demonstrate that writing is a vehicle for learning science meaningfully because it places importance on students being able to understand and explain clearly the meaning of fundamental scientific concepts (Glynn & Muth, 1994; Holliday, Yore, & Alvermann, 1994). Studies indicate that writing affords a "minds-on" emphasis in learning science and can function as a conceptual tool for assisting students in analysis, interpretation, and communication of scientific ideas (Bean, 2001; Beall, 1998; Glynn, 1994). A course that emphasizes writing as a process and develops critical thinking will challenge and motivate students, regardless of the subject matter.

After a three-day Writing Across the Curriculum workshop, participants from chemistry discussed with the director of WAC the possibility of developing an alternative course for College Writing II that would fulfill the university WAC guidelines for such classes. Over the course of a year, we employed these guidelines to develop an innovative six-credit second semester General Chemistry course as a College Writing II equivalent. The syllabus (see Appendix) outlines the scientific topics to be covered as well as the writing components included throughout the course. Table 1 shows the majority of the guidelines for a WAC-equivalent course for College Writing II and how we implemented them.

METHODS OF INSTRUCTION

As in a traditional chemistry course, Advanced General Chemistry II includes both lecture and laboratory components. The content includes the standard subjects covered in second-semester general chemistry, albeit taught in more depth. Substantial, graded writing projects are incorporated in both lecture and lab, but the lab emphasizes writing more than lecture. Rubrics, peer review, and revision are utilized in both. Students are also expected to integrate the knowledge and writing skills gained in lab and lecture.

LECTURE

The lecture classroom sessions are taught primarily utilizing a student-centered problem-based learning (PBL) approach (Allen, Duch & Groh, 1996;

Arambula-Greenfield, 1996; Ram, 1999). During class sessions, students work in groups of three or four on specific problems assigned by the instructor. For example, students are asked to explain why there is no gaseous hydrogen in earth's atmosphere, according to the principles of the Bolzmann distribution. The instructor acts as a facilitator by providing a distribution chart that shows the escape velocity of hydrogen molecules. This information enables each

Table 1: Majority of Guidelines for a WAC-equivalent Course for College Writing II and How Implemented

WAC Guidelines for Equivalent Course	New Chemistry Course
1. Assignments promote critical thinking, reading and analytical writing.	• Research paper based on a case study. • Short-answer examination questions. • Graded and ungraded writing assignments in lecture and laboratory. • Structured narrative lab reports.
2. Encourage students to recognize and examine intellectual and/or cultural assumptions that emerge in reading their own writing.	• Proposing hypotheses and testing them through experimentation in the laboratory. • Assignments in lecture that encourage reflection and metacognition. • Key concepts upon which the laboratory experiments are based are examined and discussed.
3. At least three or more writing assignments with revisions	• 1 research paper with multiple revisions. • 5 complete lab reports with revisions.
4. Course should include both finished as well as preparatory writing (drafts, etc).	• Ungraded lab notebook. • Lab reports each with first draft and finished product. • Research paper with multiple drafts.
5. Class time devoted to discussions on improving writing and how to revise writing assignments.	• Sample "case-based" research paper discussed in classroom session. • Peer review discussion in laboratory which will include using sample papers and evaluation with rubrics.
6. Faculty help students learn to read and comment on one another's papers.	• Peer review discussion in the laboratory. • Peer review of two laboratory experiments.

group to formulate reasonable explanations while acquiring necessary critical-thinking skills.

The goals of PBL include assisting students to develop "flexible knowledge," effective collaboration and problem-solving skills, self-directed learning, and inherent motivation, all skills that are necessary for professional development and success (Allen, 1996; Arambula-Greenfield, 1996; Ram, 1999). In accord with the PBL approach, writing is embedded in the lecture through case-based research papers. For the first year the course has been taught, the assignment asks students to explore the scientific principles involved in the Bhopal disaster, in which thousands of people in a village in India died as a result of an industrial chemical accident. The assignment requires students to use information from *The Black Box of Bhopal* (D'Silva, 2006), the course textbook, and classroom discussions to write a multiple-draft, 1500-word paper to demonstrate how the physical, chemical, and toxicological factors interacted to produce such a disaster. Through this case study, students are able to apply the principles of gas laws and thermodynamics to a real-world example. In future semesters, additional case-based research assignments will be developed.

LABORATORY

In contrast to traditional labs in which ten or more experiments are conducted, students in our class complete five advanced-level laboratory experiments not typically performed in first-year chemistry classes (e.g. phase diagram of a binary mixture). Students are required to keep research laboratory notebooks while performing their experiments and to use them to complete formal laboratory reports. These reports must conform to *The ACS Style Guide* (Dodd, 1997) for research papers, a standard not typically introduced until upper-division courses such as physical chemistry and analytical chemistry.

We incorporate teaching and assessment techniques commonly used in college writing courses. For example, exploratory, ungraded writing assignments are designed to stimulate students to think about questions and issues and to clarify their ideas (Bean, 2001; Thall & Bays, 1989). This kind of writing has proven effective for focusing on the processes of thinking rather than the products (Bean, 2001; Kovac & Sherwood, 2001; Thall & Bays, 1989). In our course, these assignments consist of summaries submitted prior to classroom sessions and in the laboratory notebooks that students keep throughout the semester. The summaries are based on passages read from the textbook, the laboratory manual, and problem-based questions assigned prior to class. Students also use self-reflective, ungraded writing during lab sessions to identify what they intend to revise after receiving peer-feedback. Such reflective work enables them to establish goals for revision before a faculty member ever sees the report. Additional techniques include both instructor and peer review of student papers, use of analytical rubrics for assessing and guiding students through the writing process, and multiple revisions.

RUBRICS

Rubrics have become popular for grading scientific materials (Bean, 2001; Oliver-Hoyo, 2003; Thall & Bays, 1989). One initiative using rubrics gained particular popularity in chemistry education: LabWrite (Ferzli, Carter, & Wiebe, 2005). This program is an online set of instructional materials that guides students through the format of writing a scientific lab report. Incorporated into the LabWrite software is LabCheck, which is, in essence, an embedded rubric for ensuring that students address specific requirements for the report under specific headings.

Our approach is different in that we not only guide students through the structure of the lab reports but also model how the rubrics should be used to produce clearly expressed, concise composition. We use *The ACS Style Guide* (Dodd, 1997) as a basis for the laboratory report rubric. We have modified the ACS criteria to include writing requirement standards and evaluation of critical thinking. Evaluation criteria are formatted as a table and include title, introduction, experimental results and discussion, conclusions, references, and overall assignment. There are subtopics under each primary topic, and there is also a column for comments. A significant percentage of the final grade is assigned for overall quality. This emphasis makes certain that students recognize, as Kovac (2001) eloquently put it, that "an essay is much more than a sum of its individual parts. Just as in chemistry, elements combine into compounds with very different properties from each element."

The rubric we have developed for the laboratory reports is structured for this genre of research writing. In contrast, a checklist was implemented for the case-based research paper adapted from one developed in the English department that focuses on the following areas: overall assessment, opening, body organization, conclusion, argument, using quoted material, formatting, and editing and proofreading. We added a section on chemistry content and modified other sections, tailoring it to the assignments. This checklist engages students in critical thinking through writing that is typically expected in upper-division English classes.

Copies of the rubric and checklist are provided to the students and modeled for them using sample papers from both lab and lecture sections. Students also have the opportunity to employ these respective tools to evaluate their peers' work for three of the five laboratory reports and the research paper as a way to enhance their revisions.

PEER REVIEW

Peer review has been used by the Molecular Science project through Calibrated Peer Review (CPR™) (Russell Chapman & Orville, 2001; Russell, Chapman, & Wegner, 1998; Robinson, 2001) software developed to allow students to write and evaluate other students' materials. Students are provided with "calibration" texts to evaluate their success in grading and then allowed to critique other student writing and eventually their own. This approach is particularly useful for incorporating writing in classes with large enrollments. Our approach is similar in terms of employing rubrics and norming student grading. While CPR uses "calibration" texts, we use a different process; we incorporate an in-class modeling process for peer review within a hands-on workshop during laboratory time. Training includes using rubrics, commenting on both strengths and weaknesses of the material, and using specific examples from actual drafts to ensure helpful responses. We can accomplish this training because our class size is small. If we were to increase class sizes, CPR could be used.

Both instructors and peers review student writing. Instructor review proceeds throughout the semester to focus primarily on higher-order concerns of scientific content, ideas, organization, clarity, and development. We discuss below how we handle sentence-level corrections or grammatical errors.

The peer-review process benefits student reviewers and reviewees by helping them learn content and develop strategies for revision. Simultaneously, the process of reviewing peers' papers facilitates a greater student understanding of how to communicate scientific information effectively; it also models the review process that scientists undergo during manuscript submission. The three laboratory peer-review sessions prepare students for the research paper review session in the lecture. Although the rubric is slightly different, the process is the same.

REVISION

We also require revisions of most assignments to reiterate and demonstrate the importance of writing as a process (Bean, 2001). This approach allows students to use their writing assignments to reflect on the content and to learn to use written language effectively and persuasively.

We stagger revision across the laboratory reports. For the first lab write-up, we model the peer-review process and then ask the students to review each other's work using the lab report rubric before the instructors return the evaluated reports. Students peer-review the second lab reports and revise them based on the peer feedback received before the instructors review the drafts. This process is repeated for the fourth lab report, while the third and fifth lab reports are turned in as final drafts only. Grade points are assigned for all drafts and final reports; the point breakdown can be seen on the syllabus in the Appendix. The laboratory revision rubric provides students with a template for effective revision. Since most students have never revised such scientific reports previously, several iterations are necessary across the term to ensure students revise effectively and consistently.

Revision for the case-based research paper is divided into three stages, including submission of the proposal, first draft, and final draft over the course of five weeks. Students are encouraged to turn in the proposal as the introductory paragraph of their paper, including a thesis statement and organizational statement. This process helps students generate ideas at the beginning of the writing process. The proposal and first draft are returned for revision with comments from both instructor and class peers.

Students face several challenges as they revise their research projects. Because of the nature of the Bhopal disaster, they find themselves drawn to the human impact of the story. Many need to be guided back to the purpose of the assignment, determining how the physical, chemical, and toxicological factors interacted to produce such a disaster. By having students submit the introduction first for feedback, correction of focus takes place early in the writing process.

An additional result of submitting the introduction and full draft early for a grade is that students are forced to read the materials well in advance of the paper deadline. In-class discussions on the book also help foster timely engagement. When complex assignments like the Bhopal research project are not staggered, students do not typically pace their work effectively. A final challenge that students face in revising their research projects concerns fixed attitudes about revision as a requirement. Most first-year students are aware of multiple-draft writing as a result of first-year writing courses. Few students, however, expect that the requirements in an English class will translate to content classes. When they realize that the expectations are nearly the same, they become cognitively better prepared to translate those practices to other contexts. Revision in any discipline requires multiple drafts, not just sentence-level editing.

ERROR LOGS

Chemistry instructors use the same system for helping students track and proofread for patterns of sentence-level errors that instructors of College Writing I and II use. Instructors mark the first couple of occurrences of common patterns of error in student work by circling mistakes. Not all errors are marked, and not all varieties of errors are marked in a given paper. Students are responsible for identifying the mistakes by using *The ACS Style Guide* (Dodd, 1997) as a handbook, visiting the university's writing center, or getting advice from a peer or the instructor. They record the wrong wording, corrected wording, and actual rule they followed to correct the mistake in a tabular log. These error logs are cumulative and are attached to each new submission of a draft. If previously identified mistakes are not addressed in a new draft, the paper is returned to the student for proofreading before it receives a full review. Instructors skim the error logs to ensure accurate corrections. This system ensures that faculty spend purposeful but minimal time on such concerns, and students take responsibility for their own error correction.

COURSE IMPLEMENTATION

Enrollment in the course is restricted to twenty-two students who have achieved grades of B or higher in College Writing I and General Chemistry I.

These students are also selected based on recommendations from both chemistry and English instructors. They evince high potential for success not only in an honors-level course but also for Science Technology, Engineering and Math (STEM) careers.

The course was implemented in spring 2008 with a group of eighteen students. Two chemistry faculty members co-taught this 6-credit course; one was primarily responsible for lecture sessions and the other for laboratory sessions with the support of a trained graduate teaching assistant. We will be teaching this course in spring 2009, and currently twenty-two students are enrolled. The two faculty members intend to merge responsibilities for both lecture and laboratory, with the intent of creating an ideal structure where only one instructor is responsible for the entire course with a trained graduate student as the laboratory teaching assistant.

The Appendix contains a detailed lecture/lab schedule, included within the syllabus, that identifies due dates for all writing assignments including the drafts. We were careful to space writing assignments and course exams to ensure minimal overlap and maximize student success.

After teaching the course for one semester, we solicited student feedback, and the response was overwhelmingly positive. We developed a thirty-question survey based on a Student Assessment of Learning Gains (SALG) (Seymour, E., Wiese, D., Hunter, A., & Daffinrud S, 2008) instrument and the Learning Support Survey at Bowdoin College (Office of Institutional Effectiveness Bowdoin College, 2005). The survey includes questions ranging from students' perceptions of how well the class helped them convey their thoughts in writing to how well they were able to use supporting data effectively. While we do not yet have a large enough pool of participants for statistically valid results, percentages do suggest a high degree of student engagement and satisfaction. For example, the majority of respondents rated highly the degree to which the class helped them convey their thoughts in writing, 22% as extremely well and 44.4% as considerably well. In contrast, comparable students from the regular Chemistry 2 class rated this same item at 6.7% and 21.5 % respectively. The results for the second question are even more telling: 100% of students in the honors section rated their abilities to present, assess, and analyze appropriate supporting data as either extremely well (22.3%) or considerably well (77.7%) whereas corresponding figures for the traditional group were 12.1% and 22.8%. Students felt that the writing-to-learn approach was a new and interesting way to learn chemistry, and they enjoyed the small class size and more direct interaction with faculty. Students felt they had enhanced both their understanding of chemistry and their writing skills. They also indicated that this course better prepared them for subsequent chemistry courses, especially those which have a laboratory component. Although students did express some concerns over the calculus-based textbook chosen and the order of the laboratory experiments, they enjoyed the active-learning approach and opportunities for multiple reviews of their work.

Based on feedback from the students, comments from external evaluators, and experience in teaching the course for one semester, we have modified several components of the course but have also realized how exciting and successful this model can be. We are changing the textbook, replacing one of the experiments with another that is better synchronized with the lecture material, and revising the laboratory rubric to include a pre-write assignment for data and observations. Our experience has demonstrated that, with effective training and strong collaborative relationships, faculty in chemistry are capable of teaching writing in their own discipline. We have found, furthermore, that combining second-semester chemistry and college writing does not detract from learning chemistry content; rather it significantly enhances student learning.

FUTURE DIRECTIONS

With each iteration of the course, we continue to revise rubrics, laboratory experiments, writing-to-learn strategies, and peer-review techniques to better achieve our main objective: using WAC strategies as a primary technique for engaging students in advanced General Chemistry. By including problem-based learning strategies, requiring writing and revision components throughout the course, and offering fewer, more advanced chemistry labs that require substantial laboratory reports, we hope that students become intellectually challenged in a small-class environment and obtain additional opportunities for transfer of skills to future courses.

We are implementing some of the most successful strategies from this course in other courses as well. For example, the laboratory rubric has already been implemented in other courses at FAU such as Inorganic Chemistry and Instrumental Analysis, and faculty and students have offered positive feedback on its usefulness in these courses. We intend to continue evaluating this project by comparing student performance and attitudes in this course to a comparable group of students taking the traditional course and by conducting a longitudinal study of student performance in subsequent chemistry and writing courses. After two years of testing, we will begin developing manuals to include implementation criteria, lecture and laboratory assignments, and corresponding rubrics developed through this project. We have already begun to solicit participation from departments at several universities to have this course serve as a model for implementing this innovative honors approach to second-semester general chemistry and college writing.

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APPENDIX

Florida Atlantic University: CHMC 2051: Advanced General Chemistry 2, Spring 2009

Course Times

- **Lecture:** T/Th 12:30—1:50 in SC 178
- **Lab:** Th 2:00—4:50 in PS 209

Instructors

- Dr. Jerry Haky; Office: SE 122; Phone: 561-297-3338; Email hakyj@fau.edu; Office Hrs: M,W 4:00–5:00 PM or by
- Dr. Donna Chamely-Wiik: PS 216; Phone: 561-297-0046; Email: dchamely@fau.edu; Office hrs. M, W 11:00–12:00 PM or by appointment.

Teaching Assistant

- Ms. Samantha Friedman; Email: sfried22@fau.edu; Office Hours: TBA

Prerequisites

1. General Chemistry I: CHM 2045, with a grade of B or better.
2. General Chemistry I Laboratory: CHML 2045, with a grade of B or better.
3. College Writing I: ENC 1101 with a grade of C or better.

Required Texts

1. *University Chemistry*, by Brian Laird,
2. *The Black Box of Bhopal*, by Themistocles D'Silva
3. *The ACS Style Guide*, third edition, ACS Publishing. (on reference at FAU Library)
4. Laboratory notebook

Course Website

The course website can be reached using the address **<http://blackboard.fau.com>**. Your user name is the same as your FAUNet ID (go to **<http://accounts.fau.edu>** if you do not know this). Your password is the same as your PIN number.

Method of Instruction

This is a writing intensive, "Gordon rule" course. This course will also fulfill the writing across the curriculum (WAC) requirements for second semester College Writing, ENC 1102. The writing assignments during the semester will consist of five formal lab reports and one term paper. These assignments will be evaluated not only for scientific content but also for clarity, composition, spelling and organization of writing.

Course Objectives

By the end of this course, you should:

1. Have a comprehensive understanding of the concepts and principles that describe gases, solutions, chemical kinetics, chemical equilibrium, acid/base reactions, aqueous reaction chemistry, thermochemistry, chemical thermodynamics and electron transfer reactions.
2. Be able to identify relevant problems that involve the above information
3. Be able to formulate appropriate solutions to these problems.
4. Be able to write clearly and convincingly about these concepts and principles shown above.
5. Actively use writing to engage with the course material.
6. Be aware of how experimental procedures, computational tools, and literature references are used to solve a selection of the problems
7. Understand that this knowledge plays an important role in the world today.

Exams

There will be 3 periodic exams and one comprehensive final exam. Periodic exams will be administered in class on the following dates: **Jan. 29, March 10, and April 7**. The final exam will be administered on **April 28** starting at 12:30 PM. No exams will be given at any other times for any reason. Students should bring a calculator, a photo ID, and several pencils to their assigned exam locations. No large-screen or graphing calculators will be allowed.

Any student who does not take an exam at the scheduled time will receive a score of zero on that exam. An exemption from this policy will be considered only for one of the following reasons: (1) Medical emergency or problem; (2) Death in the immediate family; (3) Participation in a FAU-sponsored academic or athletic activity; (4) Required appearance in a civil or criminal court; (5) Religious holiday. A request for an exemption from the exam policy for any of the above reasons will be considered only if written documentation (e.g., a note from the attending physician) is submitted to the instructor no later than 2 days after the scheduled date of the missed exam.

Term Paper

A 1500 word term paper on the factors leading up to the 1984 chemical disaster in Bhopal, India is a requirement for this course. Details of this assignment will be described in a separate handout.

Homework and Class Group Assignments (EXTRA CREDIT)

Homework will consist of written answers to questions to be discussed in class in assigned study groups. They will be posted on the course website and due at the beginning of the next class period, or as otherwise specified. At the beginning of each class session, individual homework will be randomly checked. Students who have not completed the assignment will be asked to complete it during class and hand it in (late). Everyone else will participate in the ensuing discussion in their groups and hand in one set of answers per group. Selected assignments will be graded and points awarded to each student in each group according to the following criteria:

Acceptable:	5 points
Acceptable but late and/or incomplete:	2 points
Unacceptable or absent:	0 points

The maximum number of extra credit points any student can earn is 50 points.

Online Homework

Graded web-based homework problems are to be done using the publisher's ARIS system. Registration for ARIS is required, details of which will be discussed in class. ARIS homework assignments may be repeated the number of times specified by the system. Students who obtain the highest possible scores on all assignments before their due dates (at the time of each exam on material for that exam) will be awarded 45 points at the end of the semester. Those who obtain less than this will receive a lower number of points based on the percentage of assignments and scores on the assignments which they complete by their due dates (no extensions). Questions on ARIS should be directed to the professor. Do not try to contact ARIS directly.

Laboratory Sessions

There will be five formal laboratory reports based on the experiments performed in the lab, each about 1500 words in length. These reports should be written according to the standards of the American Chemical Society (ACS) Style guide. The reports should be typed and submitted to your instructor via Blackboard. A hard copy should also be supplied, no later than the dates listed in the schedule below. All deadline dates assume a 2:00PM deadline.

Pre-Lab

A pre-lab will also be required prior to each laboratory experiment to be written in the laboratory notebook. It will consist of an informal writing assignment describing the procedure and any safety issues associated with that day's lab assignment. The pre-lab will not be graded, but will be evaluated informally. Students who do not complete the pre-lab will not be allowed to perform that day's experiment.

Lab Reports

All lab reports will be graded based on a scoring rubric. The points assigned from the rubric will be normalized to reflect the point distribution shown below. The rubric will be provided to you and discussed at the beginning of the semester. Global revisions will be required for three of the five laboratory experiments. Deadline dates for the lab report drafts and revisions can be seen in the attached schedule. For the three lab experiments that are globally revised, the drafts of the lab reports will be returned with detailed comments for improvement. Students will be required to fill out an error sheet and turn it in with the revised final draft of the lab report, highlighting the corrections made and identifying the grammar rules that were used to correct the error.

Laboratory Notebooks

A laboratory notebook is where students write their pre-labs and record all data collected during the laboratory. The laboratory notebook will be collected two times during the semester to be evaluated and graded based on "acceptable", "needs improvement" and "unacceptable" grading criteria. Use of a laboratory notebook and recording data according to the ACS Style Guide will be discussed at the beginning of the semester and the dates for evaluation of the notebook can be seen in the lecture/lab schedule.

Lab Meetings

Suggestions for improving the written reports will be discussed during the lab meetings with the entire class. There will be a peer review workshop given to train students on the use of a scoring rubric to evaluate peer reports. There will also be time for one-on-one meetings with the instructor during the semester, where individual assessment of the reports will occur.

Peer Review Requirement

Throughout the semester, each student is required to grade other students' lab reports as part of the requirement for this course. Students will be graded based on the degree to which the scoring rubric was followed to evaluate their peers' lab reports.

Scores

Classroom Sessions

Exam 1	85 points
Exam 2	85 points
Exam 3	85 points
Final Exam	100 points
Term Paper (first draft)	100 points
Term Paper (final revision)	100 points
ARIS Online homework	45 points

Laboratory Sessions

Exp. # 1 (draft)	10 points
Exp. # 1 (final)—global rev	50 points

Lab notebook evaluation # 1	10 points
Exp. # 2 (draft)	20 points
Peer Review Lab # 2	10 points
Exp # 2 (final)—global rev	50 points
Peer review Lab # 3	10 points
Exp # 3 (final)	60 points
Lab notebook evaluation # 2	10 points
Exp # 4 (draft)	35 points
Peer review Lab # 4	10 points
Exp # 4 (final)—global rev	50 points
Exp # 5 (final)	75 points

Criteria For Grades

The following point cutoffs may be lowered but will not be raised.

Total Points	Grade
900–1000	A
865–899	A-
833–864	B+
800–832	B
765–799	B-
733–764	C+
700–732	C
667–699	C-
634–666	D+
600–633	D
566–599	D-
Less than 566	F

The "Incomplete" Grade

The "I" grade is used only when a student has not completed some portion of the work assigned to all students as a regular part of the course. It must be compelled by some external and unforeseen circumstance such as illnesses or a death in family. It is not to be used to allow students to do extra work subsequently in order to raise the grade earned during the regular term or to repeat the whole course for a better grade. The instructor is required to record on the 'Report of Incomplete Grade' form, and file with the Registrar, the work that must be completed for a final grade, the time frame for completion, and the grade that will be assigned if the work is not completed. This form must be filed **before** final grades are reported at the end of the semester. It is the student's responsibility to make arrangements with the instructor for the timely completion of this work. Both the student and instructor must sign the 'Report of Incomplete Grade form'. All Incomplete grades must be resolved prior to certification for graduation.

Academic Integrity

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. The FAU Honor Code requires a faculty member, student, or staff member to notify an instructor when there is reason to believe an academic irregularity is occurring in a course. The instructor must pursue any reasonable allegation, taking action where appropriate. The following constitute academic irregularities:(a) The use of notes, books or assistance from or to other students while taking an examination or working on other assignments unless specifically authorized by the instructor are defined as acts of cheating; (b) The presentation of words or ideas from any other source as one's own are an act defined as plagiarism;.(c) Other activities that interfere with the educational mission of the university. For full details of the FAU Honor Code, see University Regulation 4.001 at: <http://www.fau.edu/regulations/chapter4/4.001_Honor_Code.pdf>.

Classroom Etiquette

Students are expected to attend class and be courteous to others. This means no private conversations, no horseplay or yelling out answers, no cell phones and no pagers. Please turn off your cell phones and pagers before class.

Students with Disabilities

Please contact the Office for Students with Disabilities. They are in SU 133; phone (561) 297–3880, TTY (561) 297-1222. The OSD provides many valuable services for its clients.

CHMC 2051—ADVANCED GENERAL CHEMISTRY SPRING 2009

Lecture Schedule

Days	**Lecture Topic**
Jan 6	Introduction
	Chapter 4:6 : Intermolecular forces
Jan 8	Chapter 4:6 : Intermolecular forces
Jan13–15	Chapter 5: States of Matter
Jan 20–22	Chapter 7: Thermochemistry
Jan 27	Chapter 7: Thermochemistry cont'd
Jan 29	**Exam # 1 (Chs 4.6, 5 and 7)**
Feb 3–5	Chapter 8 : Entropy and Free Energy
	Discussion of term paper
Feb 10	Chapter 8 : Entropy and Free Energy
Feb 12	Chapter 9: Physical Equilibrium
Feb 17	Chapter 9: Physical Equilibrium
	Draft introduction of term paper due
Feb 19	Chapter 9: Physical Equilibrium
Feb 24	Chapter 10: Chemical Equilibrium
Feb 26	Chapter 10: Chemical Equilibrium
	Draft introduction of term paper returned with comments
Mar 2–6	Spring Break
Mar 10	**Exam # 2 (Chs. 8,9 and 10)**
Mar 12	Chapter 11: Acids and Bases
Mar 17	**First draft term paper due**
	Chapter 11: Acids and Bases
Mar 19	Chapter 11: Acids and Bases
Mar 24–26	Chapter 12: Acid Base Equilibria and Solubility
Mar 31	Chapter 12: Acid Base Equilibria and Solubility
	First draft term paper returned with comments
Apr 2	Chapter 12: Acid Base Equilibria and Solubility
Apr 7	**Exam # 3 (Chs 11 and 12)**
Apr 9–14	Chapter 13: Electrochemistry
Apr 16	Chapter 14: Kinetics
Apr 21	Chapter 14: Kinetics
	Final draft term paper due
Apr 23	Reading Day: No class
Apr 28	**Final Exam**
TBA	*Individual meetings with faculty*

CHM 2051C—ADVANCED CHEMISTRY COURSE

Laboratory Schedule—Spring 2009

Lab Dates	**Lab Topic**
Jan 8	Introduction and Safety
Jan 15	Exp. 1: Ideal Gas Law
Jan 22	Exp. 1: Ideal Gas Law (cont'd) *Work on Lab Report 1 using Lab report pre-write assignment*
Jan 29	Exp. 2: Hess' Law Lab notebook evaluation.
Jan 30	**Draft Lab Report 1 due**
Feb 5	Draft Lab Report 1 returned with comments Peer Review Workshop on Lab 1 draft
Feb 12	**Final Lab Report 1 due** **Exp. 2: Hess' Law (cont'd)** *Work on Lab Report 2 using Lab report pre-write assignment*
Feb 17	Final Lab Report 1 returned with comments
Feb 19	**Three copies of Draft Lab Report 2 and Rubrics due in lab In-lab peer review of Draft Lab Report 2.**
Feb 26	**Exp. 3 Phase Diagram of a binary mixture** **Final Lab report # 2 due**
Mar 2–6	Spring Break
Mar 12	Final Lab Report 2 returned with comments Exp 3: Phase Diagrams (cont'd) *Work on Lab Report 3 using Lab report pre-write assignment*
Mar 19	**Exp. 4: Solubility of Borax** **Final Lab Report 3 due**
Mar 26	Final Lab Report 3 returned with comments Exp. 4 **Solubility of Borax** (cont'd) *Work on Lab Report 4 using Lab report pre-write assignment*
Apr 2	**Three copies of Draft Lab Report 4 due in lab** **In-lab peer review of Draft Lab Report 4.**
Apr 9	**Exp. 5 Electrochemistry** **Final Lab Report 4 due** **Lab notebook evaluation**
Apr 16	Exp. 5 Electrochemistry (cont'd) *Work on Lab Report 5 using Lab report pre-write assignment*
Apr 22	**Final Lab Report 5 due**