Redesign of Introductory Chemistry Courses through a Chemistry Resource Room

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Abstract

We propose to create a Chemistry Resource Room (CRR) to increase the competency and success rate of students enrolled in CHEM 1251. This service course has an enrollment of over 1200 students and currently suffers from a high DFW rate, resulting in large numbers of students who retake the lecture and co-requisite laboratory. The proposed CRR will incorporate technology and invite peer and faculty-student collaboration as methods of remediating the study skills and comprehension of lower-achieving students. By actively targeting students based on performance, we expect to lower the DFW rate, thereby decreasing costs for the University as fewer sections of both lecture and laboratory will be needed if fewer students repeat CHEM 1251. For students, higher passing rates will translate into lower tuition costs and shorter graduation times, while the personalized attention available at the CRR will promote better retention of chemical concepts. To set up the CRR, we will first renovate space in Burson and purchase furnishings and equipment conducive to group study. We will then accumulate and develop paper and online materials and resources that cater to students' specific needs, and train TAs and UAs to administer and assist students with these materials. Low performing students in a pilot section of the course will be required to complete activities in the CRR to boost their participation points, which are initially awarded on performance. The CRR will eventually incorporate computing resources to benefit a broader range of classes offered by the Department of Chemistry.

Budget Request for SOTL Grant
Year 2009

Joint Proposal? X Yes ____ No

Title of Project: Redesign of Introductory Chemistry Courses Through a Chemistry Resource Room

Duration of Project: 18 months

Primary Investigator(s): Kathryn S. Asala, Banita W. Brown, Richard L. Jew, Katharine L. Popejoy

Email Address(es): kasala@uncc.edu, bwbrown@uncc.edu; rjew1@uncc.edu; Kate.Popejoy@uncc.edu

UNC Charlotte SOTL Grants Previously Received (please names of project, PIs, and dates): none

Allocate operating budget to Department of: Chemistry

		Year One	Year Two
Account #	**Award**	**January to June**	**July to June**
Faculty Stipend	Transferred directly from Academic Affairs to Grantee on May 15	$ -	$3000
911250	Graduate Student Salaries		
911300	Special Pay (Faculty on UNCC payroll other than Grantee)		$4500
915000	**Student Temporary Wages**		**$9100**
915900	Non-student Temporary Wages		
920000	Honorarium (Individual(s) not with UNCC)		
921150	Participant Stipends		
925000	Travel - Domestic		$2000
926000	Travel - Foreign		
928000	Communication and/or Printing		$1000
930000	**Supplies**		**$6000**
942000	Computing Equipment		$400
944000	**Educational Equipment**		**$1300**
951000	Other Current Services		
	Subtotal	$ -	$ -
	GRAND TOTAL	$ - **16,400** (27,300)	

Attachments:

1. Attach/provide a narrative that explains how the funds requested will be used.

   The bold-faced items are considered essential items to the success of this project. The student temporary wages will be used to hire undergraduate assistants to staff the Chemistry Resource Room for approximately 25 hours/week for 14 weeks per semester for two semesters. The supplies money will be used to purchase furniture (tables and chairs) and whiteboards to make the CRR amenable to small group work and to re-tile/re-carpet the floors in Burson 237 and 239. The educational equipment to be purchased includes both print and electronic copies of collaborative group work activities and available computer-based animations to help students visualize chemical concepts.

   The faculty stipend will support Kate Popejoy during Summer 2010 while she develops assessment tools and collaborative group activities. The special pay funding is to pay a part-time instructor to provide release time for Richard Jew. Dr. Jew will be the Chemistry Resource Room Coordinator and will need much time to devote to organizing, staffing, and developing materials for the CRR. The domestic travel funds will be used for dissemination purposes.

2. Has funding for the project been requested from other sources? __X__ Yes ____ No. If yes, list sources.

   A similar proposal was submitted to the UNC General Administration for course redesign in March 2009. The proposal was approved to receive funding, but due to the budget freeze funding was never awarded.

UNC CHARLOTTE
College of Education
Office of the Dean

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MEMORANDUM

TO: Scholarship of Teaching and Learning Grants Committee

FROM: Mary Lynne Calhoun, Dean

DATE: October 23, 2009

RE: Support for Proposal: *Increasing Student Success in Introductory Chemistry: Creation of a Chemistry Resource Room*

I am pleased to offer my support for the SOTL proposal submitted by the interdisciplinary team of Drs. Jew, Asala, and Popejoy. This proposal creates a system of support that has the potential to improve student outcomes in Introductory Chemistry and will in all likelihood promote and support persistence in studying the sciences. UNC Charlotte is part of a national initiative called the Science and Mathematics Teacher Imperative, directed by the Association of Public and Land Grant Universities, with University-wide goals to recruit more University students into the sciences and to support their success in preparing for STEM disciplines, including the teaching of science. The proposed project is closely aligned with this important initiative, and I am happy to support this effort.

UNC CHARLOTTE
College of Liberal Arts & Sciences

October 23, 2009

Selection Committee
Scholarship of Teaching and Learning Grants

Dear Committee Member:

At the request of Dr. Bernadette Donovan-Merkert, Chair of the Chemistry Department, I am pleased to offer my strongest support for the proposal *Redesign of Introductory Chemistry Courses through a Chemistry Resource Room*. Funds for this project were awarded by UNC-GA as a course redesign project, but due to the budget freeze, funding was removed before the project could begin. SOTL funding will be used to construct a chemistry resource room to improve student success and retention in introductory chemistry courses, particularly those courses with large lecture sections (180 students per section) and high percentages of DFW course grades. For example, in CHEM 1251, a course required of all science and engineering majors and students pursuing careers in certain health professions, roughly 50% of the students receive final course grades of D, F or W. Many of these students repeat the lecture courses and associated laboratories, which places heavy demands on the university's limited financial resources and faculty time. Moreover, the majority of students who enroll in the course are first-year students who typically lack the study skills needed to succeed in this course.

The Chemistry Resource Room will provide a small-group learning environment for students enrolled in introductory level chemistry courses such as CHEM 1251. It will facilitate student-student, student-teaching assistant, and student-faculty interactions to improve student performance, as has been observed with students who use the resource room established by the Department of Physics and Optical Science.

The proposed Chemistry Resource Room has the potential to make a significant impact on student performance, success, and retention given the large number of students it will serve. I give it my strongest recommendation.

Sincerely,

Nancy A. Gutierrez

Nancy A. Gutierrez, Dean
College of Liberal Arts and Sciences

Project Narrative

A. Specific Aims

The Department of Chemistry offers service courses (e.g. CHEM 1251/1252) to science and engineering majors. The majority of students enrolled in these courses are first-year students, many of whom are not adequately prepared to conduct college-level work. As a result, a high percentage of D, F, and W grades are assigned in these courses (Fall 2008 CHEM 1251 data: 27% D/F and 21% W) Moreover, because these courses are prerequisites for higher level chemistry and biology courses or are gateway courses for many science and engineering majors or pre-professional tracks, there is a significant number of students earning D, F, W, or even C grades who retake these courses. To accommodate these students, increased numbers of sections of these courses must be offered, leading to greater costs to the department and university. Additionally, students who withdraw from the lecture courses are also withdrawn from the corresponding lab courses. These students require a larger expenditure of university resources due to the cost of chemicals and teaching assistant lines. Concurrently, the overall enrollment in these introductory courses is increasing at a rate that exceeds enrollment increase at the University. The shortage of faculty available to teach these courses results in increasing numbers of larger sections of these courses to meet student demand.

To address these issues, we propose to create a Chemistry Resource Room (CRR), where students can study collaboratively with peers, tutors, or faculty in a small-group environment with the aim of increasing student success and retention. Students will receive individual attention and will be taught the skills needed (particularly mathematical and study skills) to succeed in challenging science courses.

Science resource rooms in other departments (such as the UNC Charlotte Physics Resource Room) and at other institutions (such as the University of Illinois Chemistry Learning

Center) are known to contribute to student success when used (Appendix A). We estimate the number of students who will be served in a given Fall semester to be 600 students if the CRR is made available to all introductory chemistry students. Increasing student success in these gateway courses would simultaneously achieve the goal of lowering the cost of delivering these courses, as fewer sections would need to be offered due to fewer students repeating the course. Providing a small learning environment in a large lecture setting will also increase the quality of the courses. Higher passing rates in these courses will lower the withdrawal rate for the corresponding lab classes, which will save the cost of hiring a TA or part-time instructor for the labs, and will alleviate the space constraints the department is currently facing to maintain the high teacher-to-student ratio crucial for any laboratory setting.

The Chemistry Resource Room will focus on several areas critical for improving student learning:

- Communicate high expectations early in the semester. Students often do not understand course expectations until their grades are too low to pass the course. Reiterating the expectations through assignments/quizzes in the CRR earlier in the semester will help students gain a better understanding of what is expected of them.
- Emphasize time on task by intervening with low performers on the first homework assignment or quiz. Students will be required to attend the CRR for 2 – 3 hours per week if they score below 70% on the first homework/quiz or on any exam. Any student whose class average falls below 70% will be required to study in the CRR for2 – 3 hours.
- Increase student retention in introductory chemistry courses, which will lead to progression through the major and timely graduation rates.

- Improve required background knowledge, such as algebra skills, and study skills for students who perform poorly due to inadequate college preparation.
- Restructure our large courses to prevent students from "feeling like a number" by providing a small-group learning environment.
- Increase faculty-student interactions outside the classroom by providing a less intimidating setting for students to ask questions.
- Increase cooperation among students through small group experiences in which collaborative peer-learning is emphasized.

B. Literature Review

After decades of science education reform, "increasingly large numbers of underprepared students are entering college science courses" (Moore, 2006). Even though universities and colleges have created programs to help these students, introductory science courses continue to have failure rates higher than those in other courses (Congos, Langsam, and Schoeps, 1997). These higher failure rates are often blamed on inadequate preparation of students at the secondary level. Though this may be true in some more extreme cases, many average and many highly qualified students continue to struggle in college science courses.

Some researchers have explored this problem through research in student aptitude, motivation, effort, and success. It has been reported that academic success in introductory science courses is strongly associated with effort and motivation-based behaviors, such as homework completion, class attendance, and going to help sessions (Yaworski, Weber, & Ibrahim, 2000). Success is only weakly tied to student aptitude, as measured by college admission scores and academic history (Moore, 2006).

C. Methods

Research demonstrates that most students learn better and retain more in a learning environment that involves small-group, collaborative efforts (Kreke & Towns, 1998; Lyon & Lagowski, 2008; Springer, Stanne & Donovan, 1999). The Chemistry Resource Room will provide a centralized study space where students can access personal instruction from an undergraduate assistant (UA), a Supplemental Instruction (SI) leader, a graduate teaching assistant (TA), or a professor. In addition, electronic chemistry resources, such as problem-solving tutorials and computer animations, will be available. The course syllabus for CHEM 1251/1252 will be redefined so that students will need to make use of the CRR to take advantage of technological and learning resources and the small, active-learning environment of the room (Appendix B). We recognize that not all students need the resources available in the CRR to succeed in the introductory courses. However, we believe that all students can benefit from participation in the resource room. Recognizing that teaching is learning, "good" students will be made better by participating in the collaborative learning activities in the CRR. Furthermore, students who struggle but persevere often understand how to explain the concepts to others who have similar difficulties in understanding the material.

We will use the following methods to achieve our goals:

- require students to view and answer questions regarding a pre-lecture tutorial
- require students to attend the CRR for 2 – 3 hours per week if they score below 70% on the first assignment and/or fall below a class average of 70% at any point during the semester
- require students to complete homework problems in a small-group peer-learning environment
- require students to access weekly online quizzes in the CRR

- offer study skills workshops tailored to chemistry
- provide math tutorials and instruction to improve basic math skills that are necessary for success in the course
- make molecular modeling and laboratory-related chemical software available to aid in visualization of chemical principles
- make solutions guides to textbook problems available in the CRR
- require students to complete pre- or post-lab quizzes
- require students to view pre-lab video instructions/demonstrations prior to their labs

The CRR will also be used as a convenient location for TAs and professors to hold office hours. The space (Burson 237 and 239) is right next to some of the offices of CHEM 1251/1252 instructors and down the hall from the building's main entrance. Many students do not feel comfortable visiting professors or lab instructors in personal offices or laboratories. Having a more formal, welcoming environment may encourage students to seek help during office hours more readily. In addition, small-group learning sessions will be held in this location, which will encourage students to learn collaboratively in groups and provide a consistent, easy to access meeting place for students. Accessibility is a prime factor in encouraging students to seek help, and a combination of extended hours and close proximity to several faculty offices will increase the CRR's attractiveness as a learning location.

The activities required to complete the CRR and its mission include redesigning Burson 237 and 239 to make them amenable to serve the functions described previously; developing small-group activities and assignments (Appendix C); developing online resources and researching the available technological tools with which to supply the CRR; hiring and training undergraduate assistants and graduate assistants that will staff the CRR; collaborating with the Mathematics and Statistics Department to determine available mathematical tools that will increase students' math skills; and collaborating with the University Center for Academic Excellence to develop study skills workshops specifically for science courses.

We also intend to collaborate with the College of Education to strengthen the preparation for secondary and elementary level science teachers by increasing the retention of knowledge of students pursuing educational careers, and hiring these same teacher candidates as undergraduate assistants to teach in the CRR. In addition, we will collaborate with UNC Charlotte's Science and Mathematics Teacher Imperative (SMTI) team to increase the quantity, quality, and diversity of science teachers. Two of this proposal's authors (Drs. Popejoy and Asala) are members of the SMTI team at UNC Charlotte and are actively planning to recruit more math and science teacher candidates through initiatives designed to offer these candidates teaching opportunities, such as those available in the CRR, early in their undergraduate career.

In the long-term, we plan to make the Chemistry Resource Room available to all classes offered in the Department of Chemistry. First, we intend to make the CRR available to all CHEM 1251 and 1252 sections, as these courses constitute the largest number of students and will benefit from similar types of resources. The Department would then like to expand the CRR to serve students who progress on to the organic chemistry sequence (CHEM 2131 and 2132). The size of CHEM 2131 and 2132 lecture sections has increased dramatically (75%) during the last two years due to a shortage of faculty. A large lecture setting is not optimal for organic chemistry lecture; individual attention is often needed for student success. Organic chemistry students could benefit tremendously from the small-group learning environment and resources available in the CRR. In addition, we would like to provide support to the hundreds of pre-nursing students we teach in CHEM 1203/1204 every year.

Another long-term goal is incorporating technology as a tool for learning chemistry through visualization and simulation. Burson 239 is currently a university computer cluster; software and hardware components can easily be added to these computers to increase their functionality for CHEM 1251 students. For example, short pre-lecture videos can be recorded and uploaded to these computers for viewing to increase student preparation before class. In addition, students can control interactive, animated activities and videos associated with their textbook to see a moving picture of concepts that students only see briefly during lecture. Pre-lab and post-lab quizzes and instructional laboratory videos can also be incorporated. Because the CRR will be located adjacent to the laboratories, students will have easy access to these modules before and after their lab periods. Finally, students will benefit from live help from TAs or professors while accessing online homework or while attending hybrid online/live office hours. The computing services offered in the Resource Room can be eventually updated to include 3-D molecular visualizations (1251/1252), workup of nuclear magnetic resonance or other instrumental data (2131/2132/4111), and X-ray crystallographic determination (advanced undergraduates and graduate students), effectively serving a variety of students in one location. Smart technology will also allow staff workers to address any problems that are common to all students using the clusters, and will allow SI leaders to lead groups of students through problem solving techniques in a cooperative environment.

Potential limitations to the CRR include not being able to provide the demand of student hours to implement a redesign of all sections of introductory chemistry courses. Resources for staffing the CRR and the space to accommodate the number of students we anticipate utilizing the CRR are the primary limitations. For this reason, this proposal will support a pilot program in which students in one or two sections of CHEM 1251 in Fall 2010 will be required to use the CRR.

D. Evaluation

Monitoring the D/F/W rate is the primary measure by which we will determine the success of the Chemistry Resource Room. We expect to see higher student retention and a lower D/F/W rate compared to previous years due to more hands-on learning and regular access to live and online resources. We will also compare exam scores for students who utilize the room's resources more often versus those who use the room for minimal amounts of time. Students will be required to log in each time they use the room to monitor both the success of students who regularly use the CRR vs. those who do not, and the anticipated improvement in grades of students over the course of each semester. A comparison of overall performance in sections that require CRR participation vs. sections that do not will also be made.

Attendance at office hours will also be recorded. We expect attendance at both TA and instructor office hours to increase due to the greater visibility and accessibility of the resource room vs. private offices. Grades are expected to improve commensurate with office hour attendance.

Lastly, questionnaires will be administered to students and TAs to gauge the utility of the room. A portion of these questionnaires will be attitudinal surveys. We anticipate that students will develop increasingly positive impressions of chemistry, and that TAs will be cognizant of positive changes in student attitudes and willingness to ask questions, and to be engaged in the material. In addition, we will gauge student success relative to teamwork skills and cooperative learning.

E. Knowledge Dissemination

Through this project, we hope to gain knowledge of best practices for increasing the number of successful students in CHEM 1251/1252. It is crucial that we share our work with colleagues here at UNC Charlotte, but also with Chemistry and Science Education peers at the regional and national level. To that end, we plan to disseminate our work at conferences such as the Association for Science Teacher Education (ASTE), the National Association for Research in Science Teaching (NARST), and the American Chemical Society (ACS). In addition, publications in these organizations' journals, and in the *Journal of College Science Teaching*, the *Journal of Chemical Education*, *Science Education*, and the *Journal of Science Education and Technology* is also planned.

F. Human Subjects

Though we expect this project to have exempt status, per university policy, we are in the process of completing the IRB Approval Application, in conjunction with Dixie Airey in Research Services. We will have the necessary approval by the time we receive notification of this proposal's success.

G. Extramural Funding

The authors anticipate seeking extramural funding opportunities to support the CRR on a larger scale. Submission of a proposal to the National Science Foundation's Course and Curriculum Improvement (NSF CCLI) Program would provide up to $200,000 to fund this project on a larger scale. The CCLI program supports efforts that seek to improve science, technology, engineering, and mathematics (STEM) education for undergraduate students. While SOTL funds will sustain a pilot test for a few sections, CCLI funding will enable us to increase the number of staffed hours for the CRR and to develop virtual laboratories and online resources that will greatly modernize the curricula for both lecture and laboratory classes. Howard Hughes Medical Institute (HHMI) has initiated a program that will challenge research universities to transform science teaching (http://www.hhmi.org/news/undergrad20090415.html). Although proposals are submitted by invitation only, two schools in the UNC System have been invited to compete for these funds. Future collaborations with these institutions may provide opportunities for future support.

H. Timeline

January - May 2010: Construction of Chemistry Resource Room

- Remove of a wall between Burson 237 and 239
- Carpet the entire space (Burson 237 and 239)
- Installation of modular tables and chairs to facilitate group learning
- Installation of departmental computers and software installation

May - June 2010: Development of Resources

- Develop small-group learning activities
- Research and purchase available resources on small-group learning
- Research and purchase technological resources
- Purchase textbooks and study guides

July - August 2010: Hiring and Training of Chemistry Resource Room Staff

- Undergraduate assistants
- Graduate assistants

Fall 2010 - Spring 2011: Implementation of Chemistry Resource Room

- Assign and manage the staff workers for CHEM 1251

  (undergraduate and graduate assistants; faculty office hours)
- Evaluate and assess the resources, activities, participation of students

I. Bibliography

Congos, D,H., Langsam, D.M., & Schoeps, N. (1997). Supplemental instruction: A successful approach to learning how to learn college introductory biology. *Journal of Teaching and Learning, 2*(1), 2-17.

Kreke, K. & Towns, M.H. (1998). Student perspectives of small-group learning activities. *The Chemical Educator, 1*(4), 1-23.

Lyon, D.C. & Lagowski, J.J. (2008). Effectiveness of facilitating small-group learning in large lecture classes. *Journal of Chemical Education, 85*(11), 1571-1576.

Moore, R. (2006). Do introductory science courses select for effort or aptitude? In J.J. Mintzes & W.H. Leonard (Eds.), *Handbook of College Science Teaching* (pp. 137-145). Arlington, VA: NSTA Press.

Springer, L., Stanne, M.E., & Donovan, S.S. (1999). Effects of small-group learning on endergraduates in science, mathematics, and technology: A meta-analysis. *Review of Educational Research, 69*(1), 21-51.

Yaworski, J., Weber, R.M., & Ibrahim, N. (2000). What makes students succeed or fail? The vpices of developmental college students. *Journal of College Reading and Learning, 30*(2), 195-221.

Appendix A

UNC Charlotte Physics Resource Center

In the fall semester 2006 the average number of students using this service per week was approximately 25. In Spring 2007 the average increased to 200. In Fall 2007 and Spring 2008 this number increased to more than 300. Most importantly, data suggests that the students who use this service perform significantly better that the students who do not (Table below).

Data suggests that students who used this service made marked improvement in PHYS 1101, PHYS 1102, PHYS 2101 and PHYS 2102, courses in which they typically do not perform well.

2007-2008

	Average Final Grade *(Used Resource Center)*	Average Final grade *(Did not use Center)*
Physics 2102	2.85	2.01
Physics 2101	2.56	1.97
Physics 1102	3.1	2.48
Physics 1101	2.61	2.25

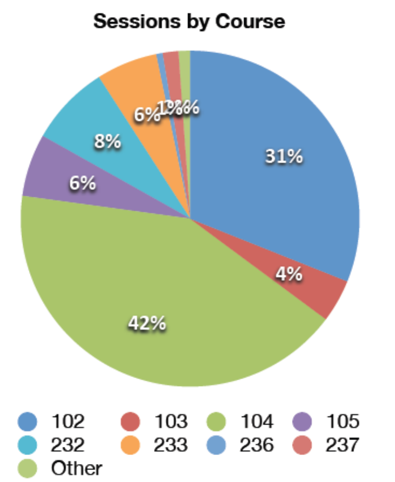
2006-2007

	Average Final Grade *(Used Resource Center)*	Average Final grade *(Did not use Center)*
Physics 2102	2.91	1.98
Physics 2101	2.54	1.94
Physics 1102	3.0	2.44
Physics 1102	3.17	1.82
Physics 1101	2.33	1.75
Physics 1101	2.73	2.03
Physics 1101	2.61	2.45

University of Illinois at Urbana-Champaign Chemistry Learning Center

The University of Illinois at Urbana-Champaign has maintained a Chemistry Learning Center (CLC) since 1972. The Center was first established for electronic resources, and has since been expanded to include tutoring and group study space for chemistry classes ranging from pre-general chemistry to graduate-level courses. The following usage statistics were collected from March 10 – May 8, 2009.

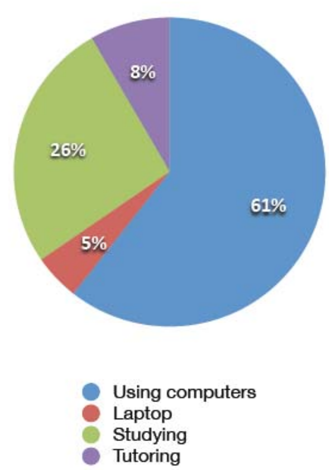
	102	103	104	105	232	233	236	237	Other	Total
Monday	271	29	111	29	22	51	3	5	13	534
Tuesday	201	29	249	40	52	45	6	24	4	650
Wednesday	186	13	303	36	25	21	0	7	5	596
Thursday	79	17	212	30	89	25	5	1	1	459
Friday	69	19	213	21	13	9	2	2	6	354
Total	806	107	1088	156	201	151	16	39	29	2593

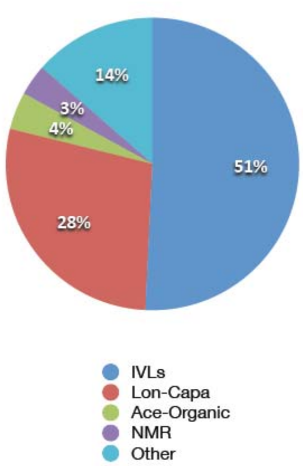


The majority of students using the Chemistry Learning Center were enrolled in Chemistry 102 and 104 (corresponding to CHEM 1251 and 1252, respectively), as most general chemistry sequences have a significantly larger number of students than higher level courses. As expected, the number of students in the on-semester sequence (Chemistry 104 for Spring 2009) were larger. These statistics show that the resource room can be an attractive feature to both 1000- and 2000-level students at UNCC. Although 1251 will be the initial target audience, the utility of the resource room can be easily expanded to accommodate 2000- and higher-level courses.

Total # students	Using computers	IVLs	Lon-Capa	Ace-Organic	NMR	Other	Studying	Tutoring	Laptop
5387	3604	1827	1011	149	123	489	1562	497	286

Students used the CLC for various purposes, as shown to the right. A majority of students used the computing resources located in the CLC, although roughly $^1/_3$ of the population used the room for studying or tutoring sessions.





Of those using the CLC computers or their own laptops, half of the students worked on the Interactive Video Laboratory (IVL) exercises, but roughly $^1/_3$ of students worked on online homework (Lon-CAPA and ACE-Organic) in an environment where they could receive assistance while attempting problems.

APPENDIX B – CURRENT AND FUTURE SYLLABI

CHEM 1251-005
Principles of Chemistry I
Fall 2009

Instructor: Dr. Richard Jew
Office: Burson 224
Office Hours: M, 3-4 pm; W, 10-11 am; and by appt.

Email: richard.jew@uncc.edu
Phone: (704)687-4433
Website: moodle.uncc.edu

Prerequisite: Students planning to take Organic Chemistry (CHEM 2131/2131L) must earn a C or better in CHEM 1251/1251L and CHEM 1252/1252L.

Materials: Brown, T.L.; Lemay, H.E.; Bursten, B.E. *Chemistry (The Central Science)*, 10th ed., Prentice Hall, 2006. (Required)

Scientific or graphing calculator (Required) – no cell phones or PDAs

Interwrite PRS Clicker (Required)

Wilson, R. J., Solutions to Exercises for *Chemistry (The Central Science)*, 10th ed., Prentice Hall, 2006. (Recommended)

Meeting Times		Location
Lecture:	TR 11:00 AM – 12:15 PM	Burson 110
Problem Session:	W 2:00 PM – 2:50 PM	Burson 110
Exams:	W 5:30 PM – 6:50 PM	COED 010 and Rowe 130

Point Distribution	Date	Points
Exam 1 (Chapters 1 & 2)	W, 9/16	100
Exam 2 (Chapters 3 & 4)	W, 10/7	100
Exam 3 (Chapters 5 – 7)	W, 11/11	100
Exam 4 (Chapters 8 & 9)	W, 12/9	100
Comprehensive Final	F, 12/11	200
Clicker-based quizzes	various	100
Total		**700**

Drop Policy and Dates:

- The Add/Drop period ends Wednesday, 9/2/09.
- The last day to submit a grade replacement form is Wednesday, 9/2/09.
- The last day to withdraw from a course (and retain other courses) with a grade of W and no refund is **November 2, 2009**. If you withdraw from Chem 1251, you will also be withdrawn from Chem 1251 Laboratory with a W except by special permission by the instructor. The last day to withdraw from all classes is 11/23/09.

Content: **Exam** topics may be subject to change and may include any material covered in lecture or in the assigned reading. All exams assume an understanding of previously covered material. Exams will consist of both free response and multiple choice. Answer keys for Exams 1-4 will be posted once the exams have been graded. Final exams will be available for students to view until December 21, 2009, but will not be returned to students, nor will a key be posted for the final exam.

Quizzes (3-4 points per lecture meeting) will be given in class starting on Thursday, August 27 using your PRS Interwrite clickers. The format and point values of the quiz questions will vary. Over the semester, approximately 130 quiz points will be possible, but only 100 points will be applied to your overall grade.

Your **final course grade** will be based on your cumulative performance towards the course total of 650 points according to the following percentage scale: ≥ 90 (A), 80-89 (B), 70-79 (C), 60-69 (D), ≤ 59 (F). These are the highest grade cutoffs; the instructors reserve the right to lower the grade cutoffs at the end of the semester as they see fit.

Problem Sessions: Problem sessions are formal meetings devoted to developing problem solving strategies. The instructor reserves the right to use Problem Session time to teach new material as well. Each week, 1-2 Problem Set(s) will be available on the course website. The Problem Set will state specific problems from the text (usually at the end of a chapter) that are considered to be important for the quizzes and exams, but your studying should not be limited only to these problems. The Problem Set itself will include information on solving problems and more example questions. Answer keys to the Problem Sets will be posted sometime after the Problem Session has met.

To get the most out of Problem Session, you should try to do the problems ahead of time. This will help you focus on the concepts or skills that you need to learn, and will help you understand your peers' questions during Problem Session.

Attendance Policy: There are no make-ups for missed quizzes or exams and no extra credit of any kind. In the case of extreme illness or family emergencies, appropriate documentation must be submitted to your instructor as soon as possible; if your documentation is validated, your score for the missing exam will be pro-rated at the end of the semester. Unexcused absences will result in a 0 for that exam or quiz.

Academic Honesty: Students are responsible for knowing and observing the UNC Charlotte Code of Student Academic Integrity (http://www.legal.uncc.edu/policies/ps-105.html). Cheating is intentionally using or attempting to use unauthorized materials in any academic exercise, or altering a response after it has been submitted for evaluation. Intentionally or knowingly helping or attempting to help another student commit an act of academic dishonesty is also a violation. If caught violating the Code of Academic Integrity, you will receive the maximum penalty of an F in the course.

Exam Re-grade Policy: You will have the opportunity to verify that each exam was graded consistently with the rubric. Instructors will only re-grade the original, unaltered exam. Re-grades will be due one class period after exams are returned.

Classroom Etiquette: The classroom needs to be an optimal learning environment for everyone. Please be respectful of your classmates. Some ways this can be achieved:

- Cell phones must be turned off during class time.
- No cell phones may be used as calculators during exams.
- Laptops, if used, should only be used for taking notes.
- Do not talk while the instructor, or a classmate asking a question, is speaking.
- Come to class each day prepared to learn. Sleeping in class, reading other material, texting, and other such behaviors are not conducive to learning.

E-mail Etiquette: E-mails must be sent from your official UNCC e-mail address; e-mails sent from outside addresses may receive no response. The subject line in your e-mail must include "CHEM 1251-005" and your e-mail should include a salutation, body, and signoff to receive a reply. Your e-mail will usually be attended to in 48 business hours. Additionally, e-mails that contain significant spelling and/or grammatical errors to be beyond comprehension will not receive a response.

Learning Resources

- Free tutors are available through the University Center for Academic Excellence (http://www.ucae.uncc.edu/ts/ts_home.html).
- Fee-based tutors are also available. Please see your instructor for a referral.
- Supplemental Instruction (SI) leaders will be holding problem sessions each week, most likely on Thursdays and Fridays. Please check the webpage for information.
- StudySpace (www.wwnorton.com/college/chemistry/gilbert2/welcome.asp) has ChemTour animations and diagnostic quizzes available.
- ChemReview (www.chemreview.net) has written tutorials and problems to solve.

Stress Management and Test Anxiety

- If stress is no longer a motivating factor and prevents you from working, see the Counseling Center (http://www.counselingcenter.uncc.edu; 704-687-2105).

If you have a disability that qualifies you for academic accommodations, please provide a letter of accommodation from Disability Services in the beginning of the semester. For more information regarding accommodations, please contact the Office of Disability Services at 704-687-4355 or stop by their office in 230 Fretwell.

UNC Charlotte strives to create an academic climate in which the dignity of all individuals is respected and maintained. Therefore, we celebrate diversity that includes, but is not limited to ability/disability, age, culture, ethnicity, gender, language, race, religion, sexual orientation, and socio-economic status.

CHEM 1251-00X
Principles of Chemistry I
Fall 2010

Instructor: Dr. Richard Jew
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Point Distribution	Date	Points
Exam 1 (Chapters 1 & 2)		100
Exam 2 (Chapters 3 & 4)		100
Exam 3 (Chapters 5 – 7)		100
Exam 4 (Chapters 8 & 9)		100
Comprehensive Final		200
Participation	various	100
Clicker-based quizzes	various	100
Total		**750**

Quizzes (3-4 points per lecture meeting) will be given in class starting on Thursday, August 27 using your PRS Interwrite clickers. The format and point values of the quiz questions will vary. Over the semester, approximately 130 quiz points will be possible, but only 100 points will be applied to your overall grade.

Your **final course grade** will be based on your cumulative performance towards the course total of 650 points according to the following percentage scale: ≥ 90 (A), 80-89 (B), 70-79 (C), 60-69 (D), ≤ 59 (F). These are the highest grade cutoffs; the instructors reserve the right to lower the grade cutoffs at the end of the semester as they see fit.

Participation points will be earned throughout the semester. 25 points are allocated to each of the periods between (1) Assignment 1 and Exam 1, (2) Exam 1 and Exam 2, (3) Exam 2 and Exam 3, and (4) Exam 3 and Exam 4. Your performance on Assignment 1, Exam 1, Exam 2, and Exam 3, respectively, will determine how many participation points you start out with. Scores of 90% or higher earn you 25 points; 80-89% earn 15 points; 70-79% earn 10 points; 60-69% earn 5 points; and below 60%, you start with zero points. To improve your participation points for each period, you must spend time at the **Chemistry Resource Room (CRR)** completing a number of worksheets and online quizzes. Each worksheet and associated quiz is worth 4 points, and you can earn a maximum of 8 points per week. Students are expected to sign in and out of the Chemistry Resource Room and turn in completed and corrected worksheets to the on-duty Resource Advisor for attendance purposes. Quizzes will be available ONLY at the CRR.

APPENDIX C – SAMPLE WORKSHEETS

Problem Set #1

Week of August 24, 2009 Text Problems: 1.25, 1.29, 1.33, 1.45, 1.47, 1.49, 1.69

Text Reading: Chapter 1

Problem Solving in Chemistry

Most chemistry problems fall into 3 categories: those that can be solved using a mathematical equation, those that can be solved using dimensional analysis, and those problems that require a combination of both approaches.

Temperature conversions are examples of problems that can be solved using a mathematical equation. When a problem can be solved using this approach, we must:

1. Be sure to have the proper mathematical equation available.
2. Include a value from the problem in the equation.
3. Solve for the unknown variable. Include the units in the solution.
4. Evaluate the solution to make sure it is logical. (This is not always an option.)

Carrying out all of these steps on paper is what we term “showing your work”.

Example Problem

The highest recorded temperature on the planet Mars is 268 K. What is this temperature in °C?

1. $T_K = T_{°C} + 273.15$

2. $268\text{ K} = T_{°C} + 273.15$

3. $T_{°C} = \underline{268}\text{ K} - 273.15 = -\underline{5}.15\ °C \approx$ **-5 °C** To check, your temperature in Kelvin should always be higher than your temperature in degrees Celcius. For significant figures, which will be reviewed in more detail in Problem Set #2, remember that 286 K ends at the one’s digit, so your answer should also be rounded to the one’s digit.

Practice Problems

1. The lowest recorded temperature on the planet Mars is 186 K. What is this temperature in °F?

1. $T_K = T_{°C} + 273.15$; $T_{°C} = (T_{°F} - 32\ °F)(5\ °C / 9\ °F)$ Note that you can also rearrange your formulas ahead of time

2. $186\text{ K} = T_{°C} + 273.15$

3. $T_{°C} = 186\text{ K} - 273.15 = -\underline{87}.15\ °C \rightarrow -\underline{87}.15\ °C = (T_{°F} - 32\ °F)(5\ °C / 9\ °F)$
remember order of operations: $-\underline{87}.15\ °C\ (9\ °F / 5\ °C) = -\underline{15}6.87\ °F = T_{°F} - 32\ °F$
$T_{°F} = -\underline{15}6.87\ °F + 32\ °F = -\underline{12}4.87\ °F \approx$ **-120 °F** (2 SF)

2. The outside temperature at my house right now is 54.8 °F. What is this temperature in °C?

$T_{°C} = (T_{°F} - 32\ °F)(5\ °C / 9\ °F)$

$T_{°C} = (\underline{54.8}\ °F - 32\ °F)(5\ °C / 9\ °F) = (\underline{22.8}\ °F)(5\ °C / 9\ °F) = \underline{12.6}6666667\ °C \approx \mathbf{12.7\ °C}$

For formulas and conversion factors, we will assume that the number involved – except for constants – are all exact numbers. Here, we will treat 32 °F, 5 °C, and 9 °F as exact numbers.

The second approach to solving problems involves **dimensional analysis**, a powerful problem solving tool. This process demands that we pay special attention to the dimensions (or UNITS) as we solve a problem.

To apply dimensional analysis successfully, you must be able to simplify fractions that include numbers and units.

Example Problem:

$$\frac{10\ \cancel{zorks}}{2\ \cancel{nobs}} \times \frac{3\ thumbs}{9\ \cancel{nails}} \times \frac{4\ \cancel{nobs}}{5\ \cancel{nails}} \times \frac{6\ \cancel{nails^2}}{2\ \cancel{zorks}} = 4\ \text{thumbs}$$

You must also be able to derive conversion factors. Any two things that are equal in a given context can be made into a conversion factor. For example, 1 inch = 2.54 cm. From this equality, 2 conversion factors may be written.

$$\frac{1\ inch}{2.54\ cm} \quad \text{and} \quad \frac{2.54\ cm}{1\ inch}$$

Define Conversion Factor: A conversion factor is a fraction, including units, whose numerator and denominator are the same quantity expressed in different units based on an equation. (Be sure you can define this in a way that is unique and useful to you!)

Dimensional analysis can be broken down into a series of steps as follows:

1. Make a map of the conversions that must take place and determine which equalities will apply.
2. Begin the set-up with a quantity (including the unit(s)) that is given in the original problem.
3. Multiply the starting quantity by one or more conversion factors that are specifically arranged so that unwanted units cancel, leaving behind only the units that are required for the solution.
4. Perform the calculation exactly as it is shown in the set-up.
5. Record the proper numerical value and units as the solution to the problem.
6. Make sure the answer has the appropriate number of significant figures. (See Problem Set #2.)

7. Evaluate the answer to make sure it is logical.

Example Problem:

How many centimeters are equivalent to 3.5 inches?

1. Make a map of the conversions that must take place and determine which equalities will apply. cm → in

2. Begin with the quantity that is given in the problem.

   3.5 in ( )

3. Set up the conversion factors so that unwanted units (inches) cancel, leaving only the units required for the solution (cm).

   $$3.5\ \cancel{\text{in}}\left(\frac{\underline{2.54\ \text{cm}}}{1\ \cancel{\text{in}}}\right) = \text{cm}$$

4. Carry out the required multiplication and/or division on your calculator. This will be obvious once the problem is set up.

   In your calculator, $3.5 \times 2.54 = \underline{8.}89$

5. Record the numerical value and the units as the solution to the problem.

   $$\underline{3.5}\ \text{in}\left(\frac{\underline{2.54\ \text{cm}}}{1\ \text{in}}\right) = \underline{8.8}9\ \text{cm} \approx \mathbf{8.9\ cm}\ (2\ \text{SF})$$

Steps 2 – 5 of the process above constitute showing your work.

Practice Problems red = work you should show, blue = comments

1. How many centimeters are present in 1.00 yard? blue = goal, orange = info given

> 1.00 yd = 3 ft 1 ft = 12 in 1 in = 2.54 cm
>
> Goal: yd → ft → in → cm
>
> Remember, you can convert from an equation to a conversion factor!
>
> $$\underline{1.00}\ \text{yd}\left(\frac{3\ \text{ft}}{1\ \text{yd}}\right)\left(\frac{12\ \text{in}}{1\ \text{ft}}\right)\left(\frac{2.54\ \text{cm}}{1\ \text{in}}\right) = \underline{91.4}4\ \text{cm} \approx \mathbf{91.4\ cm}$$
>
> yd → ft ft → in in → cm

2. Mars' average distance from the sun is 230 million km. What is this distance in miles? Use 1 inch = 2.54 cm as the only Metric/English conversion factor, and 5280 ft = 1 mi.

> 230 million km = 230,000,000 km 1 in = 2.54 cm 1 ft = 12 in 5280 ft = 1 mi
>
> Goal: km → m → cm → in → ft → mi
>
> $$\underline{23}0{,}000{,}000\ \text{km}\left(\frac{10^3\ \text{m}}{1\ \text{km}}\right)\left(\frac{1\ \text{cm}}{10^{-2}\ \text{m}}\right)\left(\frac{1\ \text{in}}{2.54\ \text{cm}}\right)\left(\frac{1\ \text{ft}}{12\ \text{in}}\right)\left(\frac{1\ \text{mi}}{5280\ \text{ft}}\right) = \underline{14}2915374.2\ \text{mi} \approx \mathbf{1.4 \times 10^8\ mi}$$
>
> or **140,000,000 mi**
>
> km→m m→cm cm→in in→ft ft→mi
>
> note that you can also use 100 cm = 1 m

3. Mars' average orbit speed is 24.077 km/s. What is this speed in miles/hour? Use 1 inch = 2.54 cm as the only Metric/English conversion factor.

> 1 in = 2.54 cm   24.077 km/s means 24.077 km = 1 s   60 s = 1 min   60 min = 1 hr
>
> Goal: km → m → cm → in → ft → mi AND s → min → hr
>
> $$\frac{24.077\text{ km}}{1\text{ s}}\left(\frac{10^3\text{ m}}{1\text{ km}}\right)\left(\frac{1\text{ cm}}{10^{-2}\text{ m}}\right)\left(\frac{1\text{ in}}{2.54\text{ cm}}\right)\left(\frac{1\text{ ft}}{12\text{ in}}\right)\left(\frac{1\text{ mi}}{5280\text{ ft}}\right)\left(\frac{60\text{ s}}{1\text{ min}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right)$$
>
> km→m   m→cm   cm→in   in→ft   ft→mi   s→min   min→hr
>
> = 53858.7151 mi/hr ≈ **53859 mi/hr**

4. NASA's *Phoenix* lander arrived on Mars August 25, 2008. The mass of this robotic craft was 350 kg. What is this mass in pounds? 1 lb = 453.59 g

> Goal: kg → g → lb
>
> $$350\text{ kg}\left(\frac{10^3\text{ g}}{1\text{ kg}}\right)\left(\frac{1\text{ lb}}{453.59\text{ g}}\right) = 771.6219493\text{ lb} \approx \mathbf{770\text{ lb}}$$

5. The average density of the surface of Mars is 3.934 g/cm^3. What is this density in pounds/in^3? 1 lb = 453.59 g and 1 inch = 2.54 cm

> Goal: g → lb AND cm^3 → in^3
>
> $$\frac{3.934\text{ g}}{1\text{ cm}^3}\left(\frac{1\text{ lb}}{453.59\text{ g}}\right)\left(\frac{2.54\text{ cm}}{1\text{ in}}\right)^3 = \frac{0.0086730307\text{ lb}}{1\text{ cm}^3}\left(\frac{2.54^3\text{ cm}^3}{1^3\text{ in}^3}\right) = 0.1421255093\text{ lb/in}^3 \approx \mathbf{0.1421\text{ lb/in}^3}$$
>
> remember: $(2.54\text{ cm})^3 = 2.54^3\text{ cm}^3$

6. (a) Earth is 1.0 AU from the sun. Mars is 1.5 AU from the sun. What is the distance between Earth and Mars in km? 1 AU = 149.60 x 10^6 km.

> Assume that Earth is located directly between Mars and the sun.
>
> Distance between Earth and Mars = 1.5 AU – 1.0 AU = 0.5 AU (1 SF)
>
> $$0.5\text{ AU}\left(\frac{149.60\times10^6\text{ km}}{1\text{ AU}}\right) = 74800000\text{ km} \approx \mathbf{70{,}000{,}000\text{ km OR } 7\times10^7\text{ km}}$$
>
> Note that your answer will differ depending on how you positioned Earth and Mars.

(b) The *Concorde SST* could maintain an average air speed of roughly 2400 km/hr. How many days would it take to fly the *Concorde* from Earth to Mars at this speed?

> Since we should end up with units of days, we will need to manipulate 2400 km/hr to get units of time in the numerator: 2400 km/hr → 2400 km = 1 hr → 1 hr / 2400 km Conversion factors can be used as either ratio – the units will determine which conversion factor you need.
>
> Using the answer from (a), $\left(\frac{1\text{ hr}}{2400\text{ km}}\right)\left(\frac{1\text{ day}}{24\text{ hours}}\right) 7\times10^7\text{ km} = 1215.2777778\text{ days} \approx \mathbf{1000\text{ days}}$

Please note: There are no English/Metric conversions for you to memorize in Chem 1251; all English/Metric equalities will be provided for you. The meanings of all of the metric prefixes are specified for you in the Exam Information sheet. It is your responsibility to know how to use these values correctly.