Chemistry Program Review 2007-2008

Program Mission

The Chemistry program provides preparation for professional work in chemistry or forensic science; graduate work in chemistry or forensic science; or pre-professional training in the health sciences or secondary education. Coupling the program with an appropriate minor prepares students to enter related fields such as biochemistry, oceanography, pharmacy, toxicology, and the environmental or atmospheric sciences. Through the study of general, organic, analytical and physical chemistry, students gain an understanding of the world around them.

- Chemistry students develop critical thinking and problem solving skills through hands-on required laboratory courses as well as research and practicum opportunities, and skills for communication within both the scientific and non-scientific communities through departmental writing intensive and seminar courses.
- The chemistry program provides service courses for other majors such as biology, geology, environmental studies, pre-health programs, as well as those interested in obtaining basic chemistry knowledge through the Liberal Arts Core Curriculum.
- The chemistry program fosters partnerships with state, local and federal government by providing both student laboratory interns and teaching opportunities for practicing forensic scientists within the program.

Program Description

The Chemistry program at Western Oregon University offers two different options, the traditional Chemistry option and the Forensic Chemistry option, both leading to a B.S./B.A. degree in Chemistry. Western's integrated Forensic Chemistry option is unique within the state of Oregon. This program melds chemistry, forensic science, and criminal justice courses into a single, integrated curriculum rather than disparate criminal justice and chemistry modules. In addition to the Forensic Chemistry major, the program provides two different Forensic Science minors, one for students pursuing majors within the sciences and one designed for those majoring in Criminal Justice or Law Enforcement.

The Chemistry program seeks to balance both the theoretical and practical aspects of chemistry with a significant laboratory component. Students complete a rigorous series of core courses in analytical, inorganic, organic and physical chemistry. In addition to the core, students choose courses from advanced offerings in biochemistry, inorganic chemistry, and instrumental analysis depending on their career goals. The program strives to provide those practical skills needed by a practicing laboratory chemist. All chemistry graduates leave

the program with the ability to operate a variety of instruments and are computer literate.

We are firmly committed to developing strong communication skills in our graduates. Of the program's 49 core course hours, 22 have been approved as meeting the requirements for designation as writing intensive courses. Oral communication skills are developed through supporting course work and a required technical seminar presentation.

The program is supported by three tenured faculty members, one fixed-term adjunct faculty member, specialty course instructors who are professional scientists at the Oregon State Police crime lab and one full-time lab preparator who holds a B.S. degree in chemistry.

Program Objectives/Outcomes

The program objectives include the following:

- To train students in the basic principles of analytical, inorganic, organic and physical chemistry
- To prepare undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for pre-professional training in the health sciences or secondary education.
- To provide an academic foundation necessary for students in other areas of study whose academic goals require an understanding of chemical principles.
- To gain practical experience via research or internship opportunities
- To have student care about using their chemical knowledge for the "good" of society
- To learn the principles of laboratory safety, quality assurance and quality control

Student outcomes from the program include have the ability to do the following:

- collect and analyze data to solve real world problems using observational, mathematical, computer and critical thinking skills
- carry out a wide range of wet and instrumental laboratory techniques
- make sound decisions based on basic chemical principles
- clearly articulate results of investigations both verbally and in written form
- locate chemical information using the chemical literature
- extrapolate chemical principles to solve different, but related problems
- work both collaboratively and individually
- design chemical investigations

Program Planning

- Obtain a 4th chemist tenure track position
- Continued collaboration with Oregon Crime Labs
- Require 2.0 GPA within the major
- Seek new internship opportunities
- Offer courses at nontraditional times for working students
- Explore distance delivery methods
- More field trips to local industry, labs, etc
- Seek increased science scholarships
- Recruit more diverse students such as Hispanics and Nat. Amer.
- Continued grant writing activities to acquire technology

Role Within the University and Relationship to Other Programs

The Chemistry program is part of the Department of Earth and Physical Sciences Department within the Division of Natural Sciences and Mathematics (NSM). Although Chemistry is not an autonomous department under the current NSM organization, it is treated as such for the purposes of this report.

In addition to the traditional Chemistry major, Forensic Chemistry major and the Chemistry and Forensic Science minors, the program provides a significant portion of the framework for the Chemistry/Physics option of Natural Science major. The program provides support for the Biology and Earth Science majors, and a number of pre-professional programs including pre-medical, pre-dental, pre-veterinary, pre-physical therapy, pre-nursing, and pre-pharmacy. We also provide support for the Environmental Studies minor and offer a general chemistry sequence that can be used to fulfill the laboratory science requirement of Western's Liberal Arts Core Curriculum (LACC). A degree in Chemistry also provides an excellent preparation for students who wish to enter a Master of Arts in Teaching (MAT) program to earn initial licensure to teach chemistry at the high school level.

Chemistry faculty support Western's Environmental Science Institute (ESI) which provides integrated, interdisciplinary field-intensive courses and research opportunities in science. Within the University, we work with the Criminal Justice program to provide training in forensic science.

Outcomes Assessment: Formative and Summative

<u>Formative Assessment</u>

Formative assessment of Chemistry students is accomplished within the course offerings using a number of traditional methods including quizzes and exams taking the form of essays, multiple choice, true/false, and problem solving; group oral presentations and writing assignments. The program has a significant

writing component through which students demonstrate mastery of concepts in both traditional and non-traditional ways. Traditional writing assignments include the laboratory notebook and formal laboratory reports. Less traditional forms include abstracts, annotated bibliographies, letters, reports in business and forensic styles, press releases, research proposals, project summaries, and web pages. Critical thinking skills are tested at different stages of the program by having students solve laboratory unknowns and develop research questions. The results of these investigations are presented in a number of ways including formal reports and poster presentations. The style and level of formative assessment varies with instructor and course content. In some courses, American Chemical Society standardized examinations are administered at the conclusion of a course to assess student knowledge relative to a national scale.

Summative Assessment

Summative assessment is accomplished in a number of ways. Chemistry majors complete two capstone courses. CH 461, 462 is a two term, inquiry-based capstone laboratory course. As a major component of this course, students design and carry out a group research project which requires integration of concepts from all the core areas of chemistry. Throughout this course, students demonstrate their level of proficiency in chemistry and their ability to use theoretical knowledge in practical applications. The second capstone course is Seminar (CH 407). In this course each student chooses a chemical topic of current interest, conducts an in-depth literature search on that topic and presents a formal public seminar on the topic. Each student is afforded a one hour time slot for the Powerpoint presentation. These seminars are evaluated by a panel of judges on the student's ability to present the topic in a clear logical manner, the depth of the student's understanding of the topic, the quality of student's written work (slides, extended abstract and annotated bibliography), and the student's ability to answer questions. Although student seminars traditionally have been presented as part of the NSM seminar program, for the first time in 2006, student seminars will be part of a university-wide, Academic Excellence Showcase event sponsored jointly by the Phi Kappa Phi honor society and the Program for Undergraduate Research Experience. All students must complete both of these capstone course offerings to graduate from the program. In addition to these general requirements, all students in the Forensic Chemistry option must complete an internship in an external laboratory. In conjunction with assessment via capstone courses, an objective assessment tool is being implemented. Use of the Educational Testing Services (ETS) test for chemistry has been given on a trial basis and will be implemented formally for the 2006-2007 academic year.

Overall Changes Since 1997 Report

At the time of the 1997 report, the Chemistry program consisted of only the traditional Chemistry major and minor. Since that report, the Forensic Chemistry

option has been implemented along with two new Forensic Science minors. At the time of the 1997 report, the Chemistry program had 12 declared majors and approximate 20 minors. Presently, the program services 55 declared majors and a similar number of minors. In addition to the increase in the number of students enrolled in our majors and minors, the level of service provided to other programs has increased. At the time of the 1997 report, approximately 60 students enrolled in CH 104-106 (Introductory Chemistry) annually. This course services the LACC, pre-nursing students and is used by those students needing an introductory chemistry course before entering the more intense chemistry offerings. The enrollment in the CH 104-106 sequence has doubled sin 1997. The CH 221-223 sequence (General Chemistry for science majors) has increased from a cap of 72 students in 1997 to its current cap of 96 students annually. CH 334-336 (Organic Chemistry) serves as both a core course in the Chemistry program as well as a service course for the Biology major. This course has increased in size from an enrollment of 30-35 students at the time of the last report to a starting enrollment of 50 in 2005-2006. It was noted in the 1997 report that the large size of General Chemistry courses made student participation and class discussion difficult. This has been exacerbated by the continued growth of these courses. All of these courses are capped at their present levels due to the inability to service more students with the current faculty available to teach in the program. While the size of upper division course offerings has also increased, these courses are still quite intimate having student populations typically in the 8-15 range.

The addition of the Forensic Chemistry option and Forensic Science majors have necessitated the addition of six new courses and forced an increased offering frequency of other courses to the teaching loads of the Chemistry faculty. With the exception increasing the amount of adjunct FTE from approximately 0.5 FTE to 1.25 FTE, there has been no change in the number of faculty FTE allocated to the Chemistry program since 1997.

Three Primary Strengths

- The chemistry program offers close student and faculty interaction through small upper division class sizes and research opportunities
- The chemistry program affords students the opportunity to gain direct hands-on experience using specialized techniques and instrumentation
- a strong collaboration with the Oregon State Police crime lab which provides instructors for Forensic Science courses and internships allowing students to gain professional experience in a working forensic environment

Strengths: Action Plan for Maintenance

- New faculty line in Forensics to adequately cover anticipated increase in enrollments
- Renewed grant-writing activities to purchase forensic-related equipment , e.g. Raman Microscope, updated Gas Chromatograph-Mass Spectrometer
- This new equipment will facilitate continued student-professor research activities, as well as hands-on experience that will enrich their learning environment and improve their prospects for employment
- Continued progress in developing internships for students in local businesses, industry, environmental laboratories, and crime labs.

Three Primary Concerns

Three primary concerns of the Chemistry program remain unchanged since the report of 1997.

- Inadequate Staffing
- Frequency of course offerings
- Equipment holdings

Inadequate Staffing

Although the number of degree options, number of minors and amount of service to other disciplines has increased since the 1997 report, no additional full time faculty positions have been added. This has resulted in capping the enrollment of lower division courses to a level that can be covered by the current level of staffing. In addition, lecture in these courses have been increased to sizes that are not conducive to effective student/faculty interaction in the classroom.

The report of 1997 indicated that an additional permanent faculty member was needed to ensure the future success of the program. This has remained unfulfilled.

Frequency of Course Offerings

Due to an inadequate level of staffing, many chemistry courses are offered on either an alternating year or less regular schedule. The alternating schedule includes not only elective offerings but also courses that are required core courses in the program, capstone courses or courses students select as part of their programs to fulfill the required limited electives. The Ch 440-442 (Physical Chemistry required for the traditional chemistry major), Ch 340 (Elementary Physical Chemistry required for the Forensic major), Ch 420 (Forensic Chemistry required for the Forensic major) and GS 161 (Technical Photography required for the Forensic major) are offered in alternate years. Ch 461, 462 (Experimental

Chemistry) one of our capstone courses required of all majors is also only offered in alternating years. Students are required to choose two courses from a limited list of electives as part of their degree requirement. Ch 411, 412 (Advanced Inorganic Chemistry), Ch 354 (Computational Chemistry) and Ch 471 (Chemical Instrumentation), four of the six courses from which they can choose, are offered on a non-regular schedule often with 3-4 years between being when they are taught. The only limited elective that is offered on an annual basis is Ch 430, 431 (Biochemistry) which is also a core course for the Forensic option and a service course for Biology students. A number of chemistry courses have either never been able to be offered or have been offered on a very limited basis.

The inability to offer courses on either an annual basis or on a regular schedule places a hardship on our students. A significant portion of our student population transfers to the Chemistry program from other institutions. Completing the requirements for the Chemistry program is extremely challenging for these transfer students due to our inability to offer courses on an annual basis. In addition, the alternating year scheduling of the Experimental Chemistry capstone course, requires some students to take that course during their third year of study rather than the fourth year as it is intended.

Equipment Holdings

Although a goal of the Chemistry program is to produce students who are able to operate a variety of instruments, many of our instruments are aging and in need of upgrading. We also do not possess one major instrument routinely used by practicing chemists, the nuclear magnetic resonance spectrometer (NMR). Departmental budgets are insufficient for the purchase of new, modern instrumentation and are stretched to maintain aging instrumentation.

Although the faculty has integrated computer usage into the curriculum, there remains a lack of computer hardware available for use in the general and organic chemistry laboratories. Currently, there are two desktop computers that are shared by the laboratories for those courses. Any data analysis must be done away from the chemistry laboratory in a computer lab. Additional computer resources are needed for data collection and analysis in these laboratories.

Concerns: Action Plan for Improvement

The most pressing concern is the lack of adequate staffing within the Chemistry program. One additional full time tenure-track position in Chemistry needs to be added above the current fulltime and adjunct staffing. The addition of a Chemistry faculty member would improve the frequency of chemistry course offered.

Increasing budgets for capital equipment purchase is necessary. Developing these equipment budgets will require coming up with innovative solutions to fundraising. Several of our current instruments were obtained by funded grants. New grants will need to be written for equipment purchases. The university will need to commit significant funds to match monies obtained via funded grants. Computer holdings could be upgraded by university purchase of a group of laptop computers that would not be tied to a particular laboratory room but could meet the needs of different courses at different times.

Projections for the Future

- Since 90% of our students come from within-state, we assume enrollments will follow projected trend in high school graduations within Oregon.
- Currently we have over 55 declared majors, the majority of whom are taking the Forensics Option to the Chemistry major. We expect this trend to continue.

Value/Competitive Edge

The Chemistry program is competitive within the state system for the following reasons

- Small class size and intimate interaction with dedicated faculty members in upper division classes
- All classes taught by specialists or faculty members holding terminal degrees in their field of expertise.
- A Forensic Chemistry option that integrates traditional chemistry education with specific training in forensic science
- A program of laboratory internships required for Forensic Chemistry students and encouraged for traditional Chemistry students
- A strong communication component of the major that makes our students marketable in the chemical industry

Resources

<u>Faculty and Staff</u>

The three full time permanent faculty members of the Chemistry faculty all hold PhD. degrees in their area of specialization. Of the two males, one holds the rank of Professor and the other Associate Professor. There is one female holding the rank of Professor. Faculty expertise covers organic and organometallic synthesis, analytical techniques including electronics, instrumentation, geochemistry, environmental chemistry and physical chemistry including nuclear chemistry. Adjuncts provide expertise in forensic science areas as well as one full-time adjunct who teaches in lower division courses. The chemical storage room is managed by a chemical preparator who holds a B.S. degree in chemistry. The preparator orders chemicals, prepares reagents for the

teaching laboratories, and manages the Chemical Hygiene Plan. Due to its diversified interests, the faculty is fully capable of offering a variety of courses for its majors and minors.

Other Resources

Chemistry maintains three laboratories. All of the chemical equipment is housed in these laboratory rooms. Two of the rooms can accommodate 24 students at a time and the third which is used for upper division laboratory courses can accommodate approximately 10 students working simultaneously. The two larger rooms share two desktop PC computers, and the smaller room is outfitted with four modern PCs and four antiquated machines of limited utility. Instrumental holdings include a GC-mass spectrometer, Fourier transform infrared spectrophotometer, high pressure liquid chromatograph, atomic absorption spectrometer, bomb calorimeter, polarographic analyzer/stripping voltammeter, uv/visible spectrophotometer and fluorimeter.

Hard copy library resources are limited for Chemistry. However, the availability of electronic library resources and an efficient interlibrary loan allow sufficient access to the chemical literature.

List of Supplemental Materials

Chemistry Majors Graduated in the Last 10 Years

- Amber Faw - Southwest Research Institute, San Antonio, TX
- Britta McBride - unknown
- Aleisha Rosse – Hewlett-Packard, Corvallis, OR
- Carly Sizelove – State Crime Lab, Portland, OR
- Marisa Arnold – Department of Energy Laboratory, Albany, OR
- Robert Smith – currently applying for chemistry positions
- Eder Garcia - unknown
- Megan Wiley - unknown
- Dawn Jarrell - unknown
- Liisa Larson - unknown
- Brooke Belanger - unknown
- Holly Conrad - unknown
- Kristin Glander – USBank, Monmouth, OR
- Dwayne Hawkins - unknown
- Jasa Peterson – unknown (recently left Portland Crime Lab)
- David Morris – Cascade Steel, McMinnville, OR
- Kari Salas – graduate student, Oregon State University (had to withdrawal because of family crisis)
- McKenzie Sexton - unknown
- Peter Williams - unknown
- Jesse Klaetsch - unknown
- Andrew Baltz - unknown
- Rebecca Gaxiola – California Crime Lab, Yreka, CA
- Amanda Norick – Foothill Community College, Los Altos Hills, CA
- Heather Tedisch – AVI Biopharma, Corvallis, OR
- Sharon Clinton – Stockroom Preparator, WOU
- Ilko Deianov - unknown
- Julie Linder - unknown
- Dale Purcell – Portland Crime Lab
- Mike Nelson – LC Resources, McMinnville, OR
- Mary Saba - unknown
- Ben Clark – Hewlett-Packard, Corvallis, OR
- Jason Trigg - Forensic Scientist, Kennewick, WA
- Brian Tuttle - unknown
- Hiroki Yamada - unknown
- Dan Ventura - unknown
- Jason Young – polymer lab, Springfield, OR
- Dawn Reichle - unknown
- Les Wallace – brewery, Spokane, WA
- Kathy Koppenstein – Oregon Metallurgical Wah Chang, Albany, OR

Chemistry Programs

A. Traditional Chemistry Major

This program is designed as a preparation for professional work in chemistry, graduate work in pure or applied chemistry, or as a core for pre-professional training in the health sciences or secondary education. Coupling this program with an appropriate minor allows students to enter related sciences such as biochemistry, oceanography, and the environmental or atmospheric sciences. The chemistry core curriculum consists of coursework in general, organic, analytical and physical chemistry accompanied by a significant laboratory component plus study in either inorganic, biochemistry or instrumentation via limited electives. The remainder of the program consists of career supportive electives. The elective courses offered, and their sequence, depends on resources available and student demand.

The ideal high school preparation for a prospective chemistry major includes chemistry, physics and a minimum of three years of mathematics. To enter the chemistry program, students should test into Mth 111 or higher.

- B.A. Chemistry Degree Requirements:
  - Mathematics (Mth 254)*
  - Information Systems (CS 162)
  - Completion of the third term of the second year of a foreign language course

- B.S. Chemistry Degree Requirements:
  - Mathematics (Mth 252, 254)*
  - Information Systems (CS 162)

  *Mth 253 is not required. Students may enroll in Mth 254 directly after Mth 252.

- B.A. & B.S. Degrees:
  - A total of 6 credits in couses identified in the catalog as addressing multicultural,linguistic or ethnic diversity in a significant way.
  - The writing intensive courses Ch 350, Ch 407, Ch 461, and Ch 462.
  - The sequence Ph 211, 212, 213 is to be completed as the LACC science requirement.

CHEMISTRY MAJOR			
Course Number	**Course Description**	**Credit Hours**	**Offering Frequency**
CHEMISTRY CORE			
Ch 221, 222, 223	General Chemistry	12	twice annually
Ch 312	Quantitative Analysis	4	annually
Ch 313	Instrumental Analysis	4	annually
Ch 334, 335, 336	Organic Chemistry	12	annually
Ch 350	Chemical Literature	1	annually
Ch 407	Seminar	1	annually
Ch 440, 441, 442	Physical Chemistry	9	alternate years
Ch 461, 462, 463	Experimental Chemistry	6	alternate years
Mth 251, 252, 254	Calculus	14	annually
Ch 411, 412	Advanced Inorganic Chemistry	6	alternate years
Ch 450, 451	Biochemistry	6	annually
Ch 354	Computational Chemistry	2	alternate years
Ch 471	Chemical Instrumentation	4	alternate years

B. Forensic Option

Forensic chemistry is the application of chemistry to criminal investigation. This major is recommended for individuals who wish to pursue a career in criminal investigation, in the laboratory analysis of forensic evidence, or pursue graduate study in forensic science. This course of study would also develop the analytical skills required for careers in other areas of civil law such as environmental pollution, accident investigation and product liability. Due to the nature of forensic investigations, the forensic chemist requires a strong background in chemical analysis and must be able to effectively communicate the results of laboratory analyses in reports and in the courtroom. The curriculum is designed so that the major provides a strong theoretical and experimental background in chemistry as well as written and oral communication skills. ***This major may only be taken in conjunction with the Forensics minor designated for chemistry majors.*** The minor provides specialized training in forensics. Students in the program will benefit from experience gained via the required practicum.

B.A. Chemistry Degree Requirements:

- Mathematics (Mth 252)
- Information Systems (CS 121 or 161)
- Completion of the third term of the second year of a foreign language course

B.S. Chemistry Degree Requirements:

- Mathematics (Mth 251, 252)
- Information Systems (CS 121 or 161)

B.A. & B.S. Degrees:

- 6 credits in courses identified in the catalog as addressing multicultural, linguistic or ethnic diversity.
- The writing intensive courses Ch 350, Ch 407, Ch 461, and Ch 462.
- The sequence Ph 201, 202, 203 or 211, 212, 213 is to be completed as the LACC science requirement.

CHEMISTRY MAJOR- - FORENSIC OPTION			
Course Number	**Course Description**	**Credit Hours**	**Offering Frequency**
CHEMISTRY CORE			
Ch 221, 222, 223	General Chemistry	12	twice annually
Ch 312	Quantitative Analysis	4	annually
Ch 313	Instrumental Analysis	4	annually
Ch 334, 335, 336	Organic Chemistry	12	annually
Ch 340	Elementary Physical Chemistry	4	alternate years
Ch 350	Chemical Literature	1	annually
Ch 407	Seminar	1	annually
Ch 409	Practicum	1	annually
Ch 450, 451	Biochemistry	6	annually
Ch 461, 462	Experimental Chemistry	4	alternate years
Mth 243	Introduction to Probability and Statistics	4	annually
Wr 321	Business and Technical Writing	3	annually
Sp 327	Communication in the Legal Field	3	annually
LIMITED ELECTIVES (12 hours from the following list)			
Ch 452	Biochemistry Laboratory	6	
Ch 354	Computational Chemistry	2	alternate years
Ch 471	Chemical Instrumentation	4	alternate years
Bi 101, 102, 103	General Biology	4 each	annually
Bi 211, 212, 213	Principles of Biology	4 each	annually
Bi 321	Systematic Field Biology	4	annually
Bi 331	General Microbiology	4	annually
Bi 341	Genetics	3	annually
Bi 388	Cell Biology	4	annually
Bi 465	Natural History of the Mushroom	3	alternate years
Bi 474	Entomology	4	alternate years
Bi 475	Molecular Biology	4	annually
GS 390	Basic Meteorology	3	annually
G 201, 202	Geology	3	annually
G 351	Elements of Geology	3	annually
Geog 393	Soils Geography	3	alternate years
Sp 321	Influencing Through Argument	3	annually

FORENSICS MINOR (for Chemistry majors ***)			
Course Number	**Course Description**	**Credit Hours**	**Offering Frequency**
Ch 320	Introduction to Forensic Science	3	annually
Ch 420	Forensic Chemistry	4	alternate years
Ch 430, 431, 432	Applications of Forensic Science	6	annually
GS 161	Technical Photography	2	alternate years
CJ 213D	Introduction to Criminal Justice	4	annually
CJ 321	Principles of Forensic Investigation	4	annually
CJ 452	Criminal Procedures	4	annually

***This minor may be taken by majors in other scientific disciplines providing they complete Ch 221-223, Ch 334-336 and Ch 313.

FORENSICS MINOR (for non-Chemistry majors ****)			
Course Number	**Course Description**	**Credit Hours**	**Offering Frequency**
Ch 104, 105, 106	Introductory Chemistry	12	annually
Ch 320	Introduction to Forensic Science	3	annually
Ch 430, 431, 432	Applications of Forensic Science	6	annually
CJ 321	Principles of Forensic Investigation	4	annually
CJ 452	Criminal Procedures	4	annually

****It is suggested that students pursuing this minor take GS 106 and Bi 101 as part of their LACC science requirement. CH 104, 105, 106 may be applied to the LACC. In this case, an additional 12 hours of science elective approved by the minor advisor may be substituted. GS 161 is highly recommended as a general education elective.

Course Descriptions

Ch 221, 222, 223 General Chemistry 4 hrs each term

An introduction to inorganic chemistry covering atomic and molecular structure, chemical reactions, states of matter, equilibrium, and thermodynamics. Three lectures and one three-hour laboratory. Prerequisite: Mth 111 equivalency and high school chemistry/CH104; for CH 222 a passing grade in CH 221 is required; and for CH 223 a passing grade in CH 222 is required

Ch 310 Geochemistry 3 hrs

An application of the principles of chemistry to geological processes such as phase equilibria, isotope fractionation, weathering and supergene enrichment of ore deposits, volcanism, crystal morphology, and chemical processes on the sea floor. Three lectures. Prerequisites: one year of college chemistry, G 351 or equivalent or consent of instructor.

Ch 312 Quantitative Analysis 4 hrs

A study of the fundamental principles of analytical chemistry. Laboratory work consists of standard titrimetric and gravimetric procedures. Two lectures and two laboratory periods. Prerequisite: Ch 223.

Ch 313 Instrumental Analysis 4 hrs

A study of the use of instrumental methods for quantitative determinations of unknown chemical samples. Three lectures and one three-hour laboratory period. Prerequisite: Ch 312, Mth 251, Ph 203 or Ph 213or consent of instructor.

Ch 320 Introduction to Forensic Science 3 hrs

An introduction into the theory and practice of physical evidence analysis. Topics include the recognition, identification, and evaluation of physical evidence such as hairs, fibers, drugs, blood, semen, glass, soil, fingerprints, documents. Three lectures. Prerequisite: one year of college chemistry.

Ch 334, 335, 336 Organic Chemistry 4 hrs each term

A study of the chemistry of carbon compounds including their structure, reactions and syntheses. Three lectures and one laboratory. Prerequisite: Ch 223 or consent of instructor; for CH 335 a passing grade in CH 334 is required; for CH 336 a passing grade in CH 335 is required.

Ch 340 Elementary Physical Chemistry 4 hrs

Fundamental principles of physical chemistry with applications in engineering, biological systems and medicine. This course will not count as credit toward a chemistry major. Prerequisite: Ch 223, Ph 203 or Ph 213, or consent of instructor.

Ch 350 Chemical Literature 1 hr
A study of the methods of searching the chemical literature. One lecture session or field trip per week. Prerequisite or Co-requisite: Ch 335 or consent of instructor.

Ch 354 Computational Chemistry 2 hrs
A study of statistical and graphical methods of data analysis, numerical methods of common importance in chemistry, problem solving, information handling and retrieval, and simulation techniques. Prerequisite: two years of college chemistry or consent of instructor.

Ch 360 Nuclear Chemistry 3 hrs
Emphasis will be placed on the atomic nucleus, nuclear properties, nuclear models, radioactivity, nuclear reactions, fission, nuclear reactors and applications of radioactivity. Prerequisites: Ch 223, Ph 213 or consent of instructor.

Ch 370 Selected Topics in Chemistry 1-3 hrs
An introduction to contemporary topics in chemistry. Prerequisite: consent of instructor.

Ch 371 Environmental Chemistry 3 hrs
A study of current environmental problems such as stratospheric ozone, greenhouse effect, smog, acid rain, pollution, oil spills and pesticides. Prerequisite: Ch 104, 105, 106 or consent of instructor.

Ch 401 Research 1-3 hrs
Terms and hours to be arranged. May be repeated for credit.

Ch 407 Seminar 1 hr
Group study and discussions concerning the frontiers of chemistry, current research problems, and the interaction of chemistry with other disciplines. Students will be required to present a seminar. Prerequisite: Ch 350.

Ch 408 Workshop 1-15 hrs
Terms and hours to be arranged.

Ch 409 Practicum 1-9 hrs
Terms and hours to be arranged.

Ch 411 Advanced Inorganic Chemistry 3 hrs
A study of the basic principles of inorganic chemistry and the main properties and reaction chemistry of inorganic elements and compounds within the framework of the periodic table. Prerequisite: Ch 223, Mth 254, Ph 213, or consent of instructor.

Ch 412 Advanced Inorganic Chemistry 3 hrs
A study of contemporary bonding theory, coordination chemistry, inorganic reaction mechanisms and organometallic complexes. Not sequential with Ch 411. Prerequisite: Ch 223, Mth 254, Ph 213, or consent of instructor.

Ch 420 Forensic Chemistry 4 hrs
The applications of chemistry to the analysis of physical evidence. Included among the topics will be serology, analysis of arson debris, drugs, explosive residues, gunshot residues, papers and inks, paint chips and DNA. Laboratory techniques will include gas chromatography, mass spectroscopy, atomic absorption spectroscopy, electrophoresis, infrared spectroscopy, liquid and thin-layer chromatography. Two lectures and two laboratory periods per week. Prerequisite: Ch 313 or consent of instructor.

Ch 430, 431, 432 Applications of Forensic Science 2hrs each term
An in-depth examination of subjects in modern forensic science as presented by experts in the field. Topics may chosen from the following: fingerprinting, forensic serology, hair and fiber analysis, arson accelerant and explosives residues, glass comparisons, drug analysis, bullet and cartridge analysis, serial number restoration, document examination, voiceprint identification, polygraphy, DNA analysis, forensic botany, forensic meteorology, forensic toxicology, photography, and forensic psychology. These courses will be taught as topic modules incorporating both lecture and laboratory practice as appropriate. Prerequisite: Ch 320 or consent of the instructor.

Ch 440 Physical Chemistry I 3 hrs
A study of the laws of thermodynamics with emphasis on their application to chemical systems. Topics considered include: thermochemistry, equation of states, kinetic-molecular theory, free energy and chemical equilibrium. Prerequisite: Ch 223, Mth 254, Ph 213.

Ch 441 Physical Chemistry II 3 hrs
A study of solutions, heterogeneous equilibria, electrochemistry, chemical kinetics, elementary quantum and statistical mechanics. Prerequisite: Ch 440.

Ch 442 Physical Chemistry III 3 hrs
A study of molecular structure and bonding, electronic structure of atoms and molecules, rotational, vibration and electronic spectra of molecules. Prerequisite: Ch 441.

Ch 450/550 Biochemistry I 3 hrs
A study of the chemistry of the individual subunits used to construct biological macromolecules and the chemical bonding within the macromolecules. Emphasis will be placed on the structures of carbohydrates, nucleic acids and proteins. Prerequisite: Ch 336 or consent of instructor.

Ch 451/551 Biochemistry II 3 hrs
The study of the function of biological macromolecules with emphasis on the mechanisms of protein-ligand binding, metabolic pathways and regulatory enzyme mechanisms. Prerequisite: Ch 450.

Ch 452/552 Biochemistry Lab 3 hrs
An introduction to the basic laboratory techniques used in biochemistry. Topics will include electrophoresis, spectrophotometry, chromatography, centrifugation techniques, and protein purification. One hour lecture and one four hour lab. A research project will be required for graduate credit. Prerequisite: Ch 336, Ch 450, Mth 251 equivalent or consent of instructor.

Ch 461, 462, 463 Experimental Chemistry 2 hrs each term
An advanced laboratory course devoted to experimental techniques of analytical, inorganic and physical chemistry. Prerequisite or Co-requisite: Ch 440 or consent of instructor.

Ch 470 Advanced Topics in Chemistry 1-3 hrs
In-depth coverage of relevant chemical topics in the areas of analytical, biological, inorganic, organic or physical chemistry. Prerequisite: consent of instructor.

Ch 471 Chemical Instrumentation 4 hrs
Theory and operation of instrumentation, including the applications of computer technology, used in modern chemical laboratories. Three lectures and one laboratory. Prerequisite: Ch 313, Ph 203 or Ph 213, Mth 251, 252, or consent of instructor.

Ch 508M Workshop 1-15 hrs
Terms and hours to be arranged.

Ch 570M Selected Topics in Chemistry 1-3 hrs
In-depth coverage of selected current problems in chemistry research: analytical, biological, inorganic, organic or physical chemistry. Prerequisite: consent of instructor.

Alignment of Course Learning Objectives to Program Learning Outcomes

Chemistry Program

Program Mission

The Chemistry program provides preparation for professional work in chemistry or forensic science; graduate work in chemistry or forensic science; or pre-professional training in the health sciences or secondary education. Coupling the program with an appropriate minor prepares students to enter related fields such as biochemistry, oceanography, pharmacy, toxicology, and the environmental or atmospheric sciences. Through the study of general, organic, analytical and physical chemistry, students gain an understanding of the world around them.

- Chemistry students develop critical thinking and problem solving skills through hands-on required laboratory courses as well as research and practicum opportunities, and skills for communication within both the scientific and non-scientific communities through departmental writing intensive and seminar courses.
- The chemistry program provides service courses for other majors such as biology, geology, environmental studies, pre-health programs, as well as those interested in obtaining basic chemistry knowledge through the Liberal Arts Core Curriculum.
- The chemistry program fosters partnerships with state, local and federal government by providing both student laboratory interns and teaching opportunities for practicing forensic scientists within the program.

Program student learning outcomes (major/minor)	**Courses that have minimal contribution to program learning outcome**	**Courses that provide an introductory step toward desired program learning outcome**	**Courses that provide an intermediate step toward desired program learning outcome**	**Courses that have extensive contribution toward expecting mastery of learning outcome**
To train students in the basic principles of analytical, inorganic, organic and physical chemistry		Ch 221, 222, 223 Mth 251, 252 Ph 201, 202, 203 Ph 211, 212, 213	Ch 340 Mth 254 Mth 243	Ch 334, 335,335 Ch 312, Ch 313 Ch 411, 412 Ch 440, 441, 442 Ch 463
To prepare undergraduates for		Ch 221, 222, 223	WR 321	Ch 334, 335,335

Alignment of Course Learning Objectives to Program Learning Outcomes

professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for preprofessional training in the health sciences or secondary education		CJ 213 GS 161	SP 327 CJ 321 CJ 452	Ch 312, Ch 313 Ch 320 Ch 350 Ch 354 Ch 371 Ch 407 Ch 411, 412 Ch 420 Ch 430, 431, 432 Ch 440, 441, 442 Ch 450, 451 Ch 461, 462, 463 Ch 471
To provide an academic foundation necessary for students in other areas of study whose academic goals require an understanding of chemical principles		Ch 104, 105, 106 Ch 221, 222, 223		Ch 310 Ch 320 Ch 360 Ch 371 Ch 420 Ch 430, 431, 432 Ch 450, 451
To gain practical experience via research or internship opportunities				Ch 401 Ch 409
To have students care about using the chemical knowledge for the “good” of society				Ch 320 Ch 360 Ch 370 Ch 371 Ch 461, 462
To learn the principles of laboratory safety, quality assurance and quality control				Ch 461, 462

Alignment of Course Learning Objectives to Program Learning Outcomes

The above table contains your program mission statement and learning outcomes as they appear in the 06-07 catalog. Please list each course offered in your department that services the major/minor; also include courses required by your program that are taught by other departments. Courses may appear in multiple grid locations.

Department of Chemistry 2008 Assessment Document

The Department of Chemistry did not use the learning outcomes/objectives as listed in the WOU catalog in preparing this document. What appears in the catalog is not what was written by this department and is not appropriate for what is done within our program. Rather, we are using the outcomes/objectives and course mapping documents that were developed by this department during the university self-study. Our learning objectives can be distilled to the following bulleted items:

- To train students in the basic principles of analytical, inorganic, organic and physical chemistry preparing undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for pre-professional training in the health sciences or secondary education and to gain practical experience via research projects or internship opportunities
- To provide an academic foundation necessary for students in other areas of study whose academic goals require an understanding of chemical principles.
- To have students care about using their chemical knowledge for the "good" of society

As learning outcomes we expect each student to have the ability to accomplish all of the following:

- collect and analyze data to solve real world problems using observational, mathematical, computer and critical thinking skills
- carry out a wide range of wet and instrumental laboratory techniques
- make sound decisions based on basic chemical principles
- clearly articulate results of investigations both verbally and in written form
- locate chemical information using the chemical literature
- extrapolate chemical principles to solve different, but related problems
- work both collaboratively and individually
- design chemical investigations

The Department currently employs three capstone experiences in addition to the embedded assessment questions, portfolios, essays, national normalized subject exams, etc that are being added to individual courses. The three capstone assessments required of all graduates of our program include taking the Educational Testing Services (ETS) Subject Field Test for Chemistry , the presenting an oral seminar about a chemical or forensic science topic to the university community (Ch 407), and completing of two capstone laboratory courses (Ch 461 & Ch 462).

ETS Chemistry Field Test

The ETS Chemistry Field Test assesses learning objective #1 as it tests the mastery of basic chemical principles. Questions on the exam cover the areas of analytical, biochemical, organic, inorganic, and physical chemistry. There are some difficulties with using the overall scores from this assessment instrument as a single measurement of the general knowledge of our students since the Chemistry Department has two different programmatic options that students pursue depending on their career objectives. The students in the Traditional Chemistry Option take a three-term physical chemistry course which is the level of physical chemistry tested on this exam. Students in the Forensic Chemistry Option are required to complete a one-term basic physical chemistry course which covers those topics that are most important to the area of forensic science. This course cannot cover all the topics of a more comprehensive course. The students in the Forensic Chemistry Option take a two-term sequence in Biochemistry which should adequately prepare them for this section of the ETS exam. Biochemistry is a course that is generally not considered one of the core chemistry courses for chemistry majors in many chemistry programs (the core chemistry courses are general inorganic, organic, physical and analytical). It is an elective in the Traditional Chemistry Option. Some students elect to take advanced courses in inorganic or analytical chemistry rather than biochemistry and will have limited ability to answer the biochemically- related questions. Despite the imperfect fit of this exam, the results can be used as one piece of the assessment puzzle for our program. The exam is given during either the last week or finals week of the spring term. This year the test was administered to the six students who were completing our program. The results of this exam will not be available until later in the summer.

Ch 407 Seminar

The Seminar requirement of our program addresses learning objectives #1 and often #3. Each student chooses a specific chemical or forensic science topic on which to do in depth research. This research includes a comprehensive literature search and may also include actual laboratory research depending on choice of the student. In the development of the seminar, students start with basic chemical principles and apply them to an advanced topic delving into advanced chemical theories not taught in basic courses. This capstone begins the necessary shift the from classroom learning to the self-learning that will be required during a career in chemistry or forensic chemistry.

During the development of the seminar students do database literature searching including a required Chemical Abstracts search, prepare an annotated bibliography, write an abstract for the Academic Excellence Day Proceedings and prepare visual aids including Powerpoint slides. Though out the term, students are required to attend all seminars presented in the Natural Sciences & Mathematics Seminar Series, write a synopsis of each presentation and complete a seminar “grading” form identical to the evaluation form that will be used to assess the quality of their seminar presentations.

This capstone requirement not only assesses chemical knowledge, but also assesses several desired program outcomes namely designing a chemical investigation; exhibiting the ability to collect and analyze real-world data and apply critical thinking skills; locating chemical information using the chemical literature; extrapolating chemical principles to solve different, but related problems; clearly articulating the results of an investigation both verbally and in written form; and working both individually and collaboratively.

The final product of this capstone experience is the presentation of a formal seminar juried panel. This year seven students presented 40 minute seminars. During the week before the formal presentations, each student gave a draft presentation to the members of the seminar class, and the students worked collaboratively to mold the seminars into their final forms. This year's seminars were well attended with 70 or more persons in the audience for most of the presentations. The quality of this year's seminars was excellent as judged by the evaluation panel.

Ch 461, 462 Experimental Chemistry Laboratory

This capstone laboratory experience addresses learning objectives #1 and #3. In this course, students carry out a number of investigations that require them to integrate the chemical principles learned in general/inorganic, analytical/instrumental and organic chemistry. During this course students must demonstrate mastery of basic laboratory techniques and learn more advanced techniques.

During the Fall 2007 term, students were divided into teams on which they worked both individually and collectively on a research investigation in a manner similar to the way a research project would be conducted in a real-world application. During the investigation the students had to collect and analyze data and use their results to make the decisions that moved the project to new directions.

During the Winter 2008 term, students carried out a number of investigations that modeled the solving of real-world problems. Many of these investigations demonstrate how chemical analyses can be used tofor societal good. This course not only requires students to carry out laboratory techniques to solve a problem but also to articulate the results of the investigations in a variety of written forms. The writing assignments require extensive use of the chemical literature and take the form of different reporting types. In this course students learn to write and review research proposals (students also choose one of the proposals to use for a laboratory analysis), articulate the results in the forms of a journal article, press release, memo, letter of transmittal, and client report. Students also prepare formal resumes and write job application letters.

This laboratory sequence allows students to demonstrate most of the desired learning outcomes listed above including collecting and analyzing data to solve real world problems using observational, computer and critical thinking skills: carrying out wet and instrumental laboratory techniques; extrapolating chemical principles to solve different, but related problems; making sound decisions based on basic chemical principles;

articulating results in a variety of written forms; locating chemical information using the chemical literature; and designing chemical investigations.

Other Assessment Tools

The Department is implementing other methods of assessing learning objectives within individual courses which will include embedded assessment questions, portfolios, or national examinations. Currently all students in Ch 334, 335, 336 (Organic Chemistry) are required to take the American Chemical Society (ACS) Organic Chemistry Exam as the spring term final in Ch 336. We are considering administering the ACS General Chemistry Exam at the end of the Ch 221, 222, 223 sequence (General Chemistry). These exams would assess both learning objectives #1 (majors) and #2 (non-majors). We are also looking for an appropriate assessment tool for Ch 104, 105, 106 (Introductory Chemistry) which services our growing pre-nursing audience.

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): Service for science majors & environmental science minor

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: Ch 371 Environmental Chemistry

Faculty name: Arlene Courtney

Date: June 15, 2008

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

#2 and #3 of the learning objectives listed in the Department of Chemistry 2008 Assessment report (inserted below)

- To provide an academic foundation necessary for students in other areas of study whose academic goals require an understanding of chemical principles.
- To have students care about using their chemical knowledge for the "good" of society

B) Check the embedded assessment tool(s) used :

X Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
X Other : Projects

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

The following exam questions assess the students ability to:

- analyze data to solve real world problems using mathematical and critical thinking skills
- articulate results in written form
- extrapolate chemical principles to solve different, but related problems

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Critical Thinking Exam about Population and Energy Production

1. (4 pts) How long will it take for a mice population to double if it is growing at a rate of 5%?

    a. (20 pts) You have been given a job as a resource manager for the State of Oregon, and you need to examine the population base as a function of county within the state. This is your first day on the job, and your boss asks you to answer the following questions using the Oregon Population Statistics provided. What would be the projected population of Polk County in the year 2010?
    b. What is the fastest growing county (in terms of percentage not raw population) in Oregon since 1960?
    c. Where are the regions of fastest and slowest growth in Oregon?
    d. Compare the growth rates from 1970 to 1980 with those from 1980 to 1990 for Polk and Marion Counties. What do you see and do you have an explanation for this result? That is, was the growth rate the same between decades, higher or lower?
    e. Using your knowledge of exponential growth, determine the average growth rates from 1950-1995 for the following counties: Deschutes, Jackson, Lane, Lincoln, Marion and Multnomah. Are these the kind of growth statistics you would have predicted for each of these counties? Why or why not.

Some of the following questions are intended to make you think about how to make choices concerning the production and use of energy.

2. (6 pts) Joe Sixpack lives in the desert with a solar powered beer cooler. On average, 800 watts per square meter of solar energy are present at Joe's location. Over an 8 hour period, Joe requires 2.5 KWH of energy to keep his beer cold. Joe's PV panels are 10% efficient. Approximately how many square meters of panel does Joe require? Is this a good way for Joe to cool his liquid refreshments?

3. (6 pts) About 20% of the electrical energy we consume is used for lighting. A 15 W fluorescent light bulb produces as much light as a 75 W incandescent light bulb. The fluorescent bulb has a life expectancy of 10,000 hours while an incandescent bulb lasts about 1000 hours. The fluorescent bulb costs $20 (why no one buys them) while the incandescent bulb costs about $0.75 (why everyone buys them). Assuming

that electricity costs $0.10 per KWH, compare the cost of using a fluorescent bulb to the cost of the incandescent bulb. Which should you use if you are interested in saving energy and money?

4. (6 pts) Describe in detail how a crystal of silicon, normally a non-conductive material, can be transformed into a material capable of carrying a current.

6. (9 pts) Strontium-90 is a nuclide that is present in the radioactive fallout from nuclear weapon explosions. Sr-90 decays via a beta emission and has a half-life of 28.0 years.

a. Write a balanced equation for the decay process.

b. How long will it take for 94% (15/16) of the Sr-90 atoms in a 1 gram sample to undergo decay?

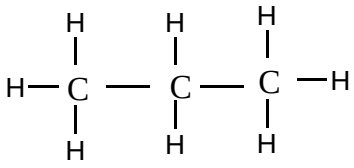
c. Look at strontium's position on the periodic table. Do you think that presence of this isotope in the environment presents a hazard? Why or why not? Does this information influence your views on nuclear weapons?

7. (6 pts) Consider the U-238 decay series scheme attached to this exam. Which of the decay products are likely to be most abundant in a soil rich in uranium? Why? What are the health risks of these isotopes?

8. (4 pts) There are approximately 120 nuclear power reactors in the U.S which account for about 22% of our total domestic electrical production. Over a 30 year lifecycle, each plant requires about 5000 tons of uranium. It is estimated that the U.S. possesses about 2.5 million tons of recoverable uranium. At current usage, how long will U.S. uranium resources last?

9. (10 pts) The major component in natural gas is methane, CH_4 while the bottled gas used in your gas barbecue is propane, C_3H_8. If each of these gases burns completely, compare the amount of energy released by each material in terms of (a) kJ.mole of CO_2 produced and (b)kJ/g of fuel. Do these calculations based on the breaking and forming of bonds during the combustion reaction. You will find the bond energies you need in Table 2.1at the end of this exam. The balanced equations for the two combustions are given below.

$$CH_4 + 2\,O_2 \longrightarrow CO_2 + 2\,H_2O$$



$$+ \quad 5\,O_2 \longrightarrow 3CO_2 + 4\,H_2O$$

10. (6 pts) You are contemplating purchasing a small vehicle for your daily transportation needs. Decide whether it would be economically more practical for you to use a gasoline powered vehicle or an electrically powered one. Assume that electricity costs $0.06 per kWh while gasoline in Monmouth costs $2.00 per gal. Gasoline weighs 5.51 lb/gal and upon combustion releases 19,000 BTU per pound.

    Energy units: 1 calorie = 4.18 j = 1.16×10^{-6} kWh = 3.97×10^{-3} BTU

    a. If an electric engine is 50-80% efficient and a gas engine is 20-25% efficient, which is going to be more economical for you to use based on fuel costs? To answer this you will want to compare the costs per unit for using electricity and gasoline.

    b. How would the fuel source used by your electric utility for producing electricity influence your choice of vehicle? Consider an electric utility that uses geothermal power, one that uses coal and one that uses nuclear fuel. Demonstrate your critical thinking skills here.

11. (8 pts) The amount of energy required to produce disposable consumer goods is an important environmental issue. In this problem you will explore the energy issues surrounding the use of paper versus polystyrene as material for making disposable coffee cups.

    The facts:

    It takes 980 kWh of power to produce a metric ton of paper.
    It takes 300 kWh of power to produce a metric ton of polystyrene.
    A paper cup that holds 8 oz. of coffee weighs 10.1 g.
    A polystyrene cup that holds 8 oz. of coffee weighs 1.5 g.

    a. Compare the amount of energy expended in making a paper cup and a polystyrene cup.
    b. Both types of cups can be incinerated (a combustion reaction like that of fossil fuels) to generate heat energy. A paper cup yields 20 Mj/kg (megajoule per kilogram) and a polystyrene cup 40 Mj/kg. This heat energy can be converted to electricity at a powerplant with an efficiency of about 30%. Compare the amount of electrical power available from incinerating discarded paper and polystyrene cups with the amount of energy needed to produce them. (1 kWh - 3.6×10^6 joules).

c. A fast-food restaurant on a busy street uses 2.5 gross of polystyrene coffee cups per day (1 gross = 12 dozen = 144). Reacting to pressure from an environmental advocacy group, the restaurant switched to using paper cups. What is the effect of this decision in terms of kWh of power per week, if the town has no incinerator? What is the effect if the town sorts and incinerates paper and plastic for electricity production?

d. *Write a paragraph explaining to the proprietors of the restaurant in question (c) what they might do if they want to be as environmentally responsible as possible.

12. (5 pts) You may need to do a bit of research to answer this question. Consider the accident at Three Mile Island and when it occurred. Find out what the movie The China Syndrome was about, and when it was released. Is here a connection between these events, and public perception of nuclear safety?

13. (10 pts) There are several ways in which you can combat the carbon dioxide you produce by driving your car and using electricity.

(a) Purchasing green certificates. Go to http://www.greentagsusa.org/GreenTags/index.cfm to learn about purchasing "Green Tags".

(i) Describe how these green tags work

(ii) How much would you need to spend to offset the carbon dioxide you would produce by driving 12,500 miles a year in a car that gets 15, 20 and 30 miles per gallon.

(b)Go to http://www.treesforlife.org.uk/tfl.global_warming.html to learn about the tree alternative.

(i) Explain how trees offset carbon dioxide production.

(ii) How many trees would you need to plant to off set the carbon dioxide that you estimate you will produce over the next year?

Demonstration of Mastery of Basic Principles and Critical Thinking Exam about The Greenhouse Effect and Ozone Depletion

Part I. Data Collection and Analysis.

Use the link on the Ch 371 syllabus to obtain the data needed for the following questions.

1. (10 pts) For each of the TOMS images depicting the average of total ozone concentration for the month of October for the years 1979 to 1992, measure the ozone

concentration for Tierra del Fuego (Hint: you probably need to find out where this is, and what is there).

(a) Compile your measurements into a data table.
(b) Display your measurements in the form of a bar graph for the ozone concentration versus time in years.
(c) Over this time period, what was the average rate of decline of ozone per year?
(d) If the columns of ozone depicted for the years 1979 and 1992 in your bar graph were compressed until the condition of STP is obtained, how thick (in mm) would the layer be?
(e) Is the decline in the ozone layer above Tierra del Fuego significant? Justify your answer.
(e) From a societal perspective, why would a significant decline in the ozone column above Tierra del Fuego be a concern?

2. (10 pts)
(a) Examine the UV index forecasts for May 17, 2004 for a variety of locations in Australia. Clear weather was forecast for each locality. Explain why the different localities might have differing UV indices.
(b) To what skin type do you belong?
(c) What is the maximum time ***you*** could expect to be exposed to the sun in Darwin, Alice Springs, and Melbourne without burning?
(d) How would this change if you applied sunscreen with an SPF number of 2, 10, and 15 to your skin?

3. (14 pts)
(a) Use the South Pole Ozone Profile for 2003. Make a graph of Total Ozone versus Time for the following dates: 8/6; 8/16; 8/27; 9/11; 9/20; 10/1; 10/11; 10/27; 11/14 and 11/28.
(b) Using the same dates, make a graph of Ozone Partial Pressure versus Time for altitudes of 12, 16, 20, and 24 km.
(c) Examine your graphs from (a) and (b). Explain any trends that you see.
(d) Examine the graph for the vertical profile of ozone over the South Pole when the "ozone hole" becomes well established that is provided on the data links page. What can you infer about the effect of temperature on the depletion of the ozone?
(e) Consider the ozone column versus time for the stratospheric region 12-20 km data for the years 2000-2003. What trend anomaly do you observe?
(f) Use the graphs for PSC formation and vortex area for this time period to develop an explanation of the cause of the anomaly in part (e).

Part II. The section is composed of questions in which you will make calculations and/or provide explanations using concepts developed in lecture or in your reading. In

some cases, the topic of the question was covered in detail in lecture, but in others you will need to decipher the answer from the reading material in the textbook. You will find any mathematical formulas that you need in your text. For any mathematical problems, you must **clearly show any formulas that you used and your work**, or you will not receive any credit for the problem.

1. (6 pts) From the reading "Climate" (Ch 6 Spiro & Stigliani)
   (a) Calculate the long-wave emission by Earth's surface if its mean global temperature is 15 ^{o}C.

   (b) If the Earth's temperature was to increase by 5 ^{o}C, what would be the peak wavelength emitted by the Earth? In what region of the electromagnetic spectrum does this wavelength fall?

2. (6 pts) If the solar irradiance of Earth is 1,368 Wm^{-2} and the amount of solar radiation reflected by the atmosphere is 30%, what would be the temperature of the Earth if there was no greenhouse effect? How would this affect life on Earth?

3. (10 pts)
   (a) Describe the involvement of CFCs in the greenhouse effect.

   (b) Which of the molecules in the table below have the potential to cause a greenhouse effect similar to CFCs? Identify the specific wavelengths that would be involved.

S-C-O (linear)	H-Cl	F-F	H_2S (non-linear)	**Cl_2O**
11,641 nm	**3,465 nm**	**11,211 nm**	**3,830 nm**	14,706 nm
18,975 nm			**7,752 nm**	30,303 nm
4,810 nm			3,726 nm	10,277 nm

4. (8 pts) Parts (b) and (c) will require you to interpret some information (provided with the exam) we did not specifically discuss in lecture.

   (a) Describe how Earth's surface is shielded from harmful radiation by chemical species in the atomosphere. Use chemical equations in your description.
   (b) Beer's Law can be used to calculate how the amount of light transmitted through the ozone layer varies with the height of the ozone column. The table below shows the calculated values of the fractional increase in transmission brought about by a 1% decrease in the thickness of the ozone layer at three different wavelengths.

Wavelength	% Increase in uv Transmission
310 nm	1%
295 nm	6 %

285 nm	19%

As a result of the 1% decrease in ozone concentration, describe what happens to the position of the action spectrum relative to the curve of relative sensitivity to sunburn. Use Table 8.5 on p. 201 of the text to answer this question.

(c) Will the increase in transmission at 285 nm cause more damage to biological tissue than the increase in transmission at 295 nm? Clearly justify your answer.

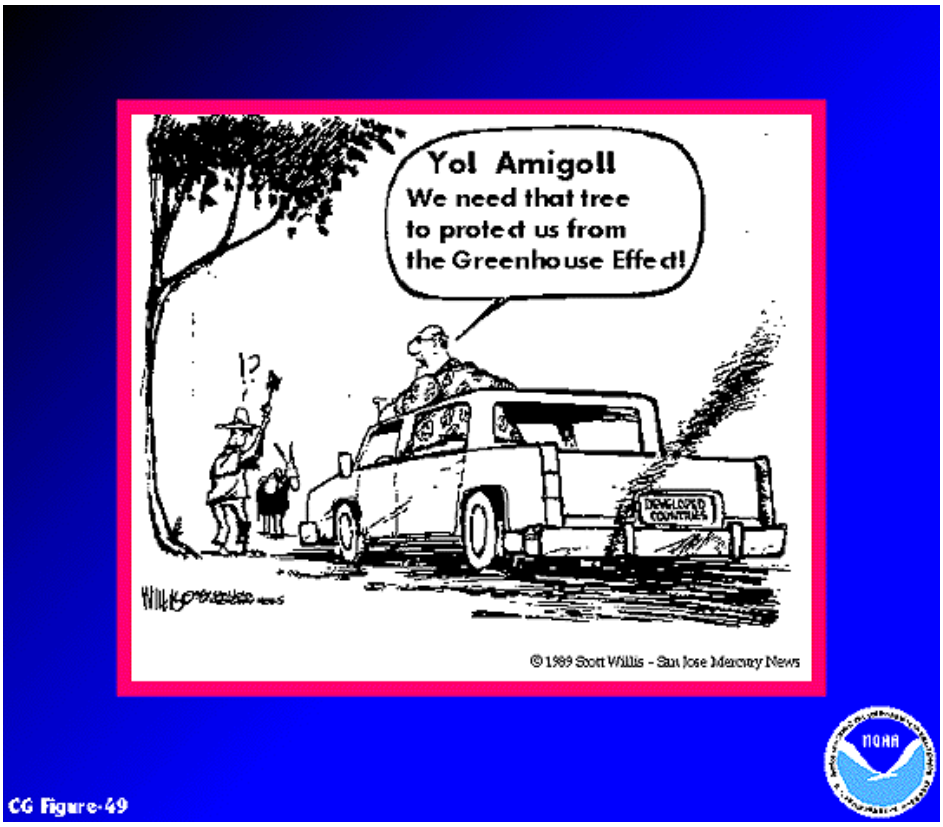
5. (6 pts) Give two reasons why the stratosphere is more susceptible to chemical pollution than the troposphere.

6. (10 pts) Explain in detail the role of CFC's in depletion of stratospheric ozone. Why is the depletion accentuated in the Antarctic?

7. (10 pts) Deforestation has been linked to global warming. At issue is the deforestation of forests in developing countries. Trees are consumers of carbon dioxide. A rapidly growing rain forest can consume between 1-2 Kg carbon/m^2 forest. Cultivated fields consume 0.2-0.4 Kg carbon/m^2. For a very brief overview of the role of forests in the environmental equation, go to:

   http://www.informationsphere.com/html/205.htm

   Obviously the deforestation issue is not a simple one. Economic and environmental concerns must be balanced. Critique the following editorial cartoon. Base your critique on scientific facts not emotion.



8. (10 pts) The Goldilocks Principle describes the human habitability of planets Venus, Mars and Earth. Venus is too hot, Mars is too cold and Earth is just right. The suitability of Earth's surface temperature for sustaining life cannot be explained completely by its position in the solar system.

Study the following facts about these three planets and propose an explanation involving the greenhouse effect for the observed surface temperature phenomena of each planet.

	Venus	Earth	Mars
Atmospheric Pressure	9322 kPa	100 kPa	0.7 kPa
Atmospheric CO_2	96%	0.03%	95%
Atmospheric Water	Trace	0-4%	0.03%
Min. Surface Temp	228 K	185 K	133 K
Mean Surface	737 K	287 K	210 K

Temp			
Max. Surface Temp	773 K	331 K	293 K

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Course Final Questions that require demonstration of knowledge of basic chemical principles, research and critical thinking.

1. (5 pts) In the summers and falls of 1986 and 1987, geographer Lee F. Klinger, who works at the National Center for Atmospheric Research in Boulder, Colorado, discovered extremely acidic rain water in southeast Alaska. This rain had a pH of 3.6 (Normal rain water has a pH of about 5.6). The source of this acidity was not the expected sulfur compounds given off by oceanic organisms, but rather organic acids originating from moss-filled peat lands. How many times more acidic is the southeast Alaskan rain water compared to normal rain water?

2. (5 pts) In almost 20% of the largest cities in the nation, the lead content in drinking water exceeds federal limits. The maximum lead concentration allowed by the federal government is 15 ppb (about equal to 15 raindrops in an Olympic-size swimming pool.) Any large city with a greater level must add chemicals to reduce the lead as it can cause brain damage, high blood pressure, and other illnesses at minimum concentrations. Five-liter water samples were taken and tested for lead from 5 cities. The following is a table indicating the amount of lead found in each sample:

Location	Amt of lead in 5-L water (μg)	Concentration in ppb
Pensacola, Florida	875	
Newton, Massachusetts	815	
Utica, New York	500	
Cedar Rapids, Iowa	400	
Door County, Wisconsin	325	

Hint: find a definition of parts per billion (ppb)

(a) What is the concentration in ppb for each location? Put your answers in the table above.
(b) Which of these cities exceed the federal limit?

3. (6 pts) The morning rush-hour concentrations of NO_x and NMHC (nonmethane hydrocarbon) on an average day in Sydney, Australia are 40 ppbv and 1.0 ppmv, respectively (ppbv is parts per billion per unit of air volume). Using Figure 6.2 in your exam packet:

   (a) Determine what concentration of ozone would be expected.

   (b) On a day with little air movement, the same species have concentrations of 100 ppbv NO_x and 2.0 ppmv NMHC. Under those conditions, what ozone concentration is expected?

   (c) If emissions evolve so that average morning rush-hour concentrations are 100 ppbv NO_x and 0.6 ppmv NMHC, will ozone concentrations be higher or lower than in the first case above? Why?

4. (4 pts) Use the regions of the electromagnetic spectrum named below to answer the questions a-h.

   Infrared (I) Microwaves (M) Ultraviolet (U) Visible (V)

   (a) Which region has the shortest wavelength radiations? _____

   (b) Which region has the radiations of the lowest frequency? _____

   (c) Which radiations are most energetic? _____

   (d) Which region would have radiations that could provide enough energy to move an electron from one energy level in an atom to a higher energy level in the same atom? _____

   (e) Which region would have radiations that could be sufficiently energetic to break bonds in a molecule? _____

(f) Which region would possess radiations that can be absorbed to cause stretching and bending of chemical bonds? _____

(g) In what region of the electromagnetic spectrum is most solar radiation concentrated? _____

(h) Earth radiates most of its energy in which region of the electromagnetic spectrum? _____

5. (2 pts) What is meant by the term "window" as applied to the emission of radiation from the Earth's surface?

6. (2 pts) The atmosphere is approximately 78% nitrogen and 21% oxygen. These gases are transparent to solar radiation. Why do they not absorb terrestrial radiation and contribute to the greenhouse effect?

7. (4 pts) In air pollution, what is meant by a "primary" pollutant and by a "secondary" pollutant? Give examples.

8. (6 pts) In general terms, what is meant by "photochemical smog". What are the initial reactants in the process? Why is sunlight required?

9. (4 pts) Explain why the predominant acid in acid rain differs in eastern and western North America. What is the predominant acid in the east? What is the predominant acid in the west?

10. (4 pts) From July to September 1987, a foreign company deposited radioactive wastes at Koko Village, a small port in Nigeria. It wasn't until one year later that the wastes were discovered. They were found to contain such things as mercury, arsenic, paint and pigment residues and bismuth-205 that emits gamma rays. A study was conducted six months after the discovery to determine if the village outbreak of diarrhea and site workers' complaints of chest pains were caused by radiation injury or the villagers' diet. What fraction of bismuth-205 would be left in the blood of a port worker who had skin contact with the material during the cleanup 183 days before the test? The half-life of bismuth-205 is 15 days.

Part II. Critical Thinking Exercises. (28 pts) You may need to do a bit of internet research to answer some of the following questions. Type your answers and append your pages to this exam copy. **You must answer all questions in this section of the exam.**

1. (10 pts) John Martin, an oceanographer at the Moss Landing Marine Laboratories, once said: "Give me half a tanker of iron, and I will give you an ice age." This proclamation earned him the nickname "Johnny Ironseed." Carry out an internet search to learn about Martin's "iron hypothesis".

   (a) Write an essay describing Martin's idea for reducing atmospheric levels of CO_2, why these levels would be reduced, what experiments have

been done and whether these experiments supported Martin's hypothesis. Attach your ***typed*** essay to this exam sheet.

(b) What are some of the possible negative environmental effects of fertilizing the oceans?

(c) Under what conditions would you be willing to accept these consequences if atmospheric CO_2 concentrations could be reduced?

2. (12 pts) You will need to access air pollution maps on the EPA website (http://www.airnow.gov/index.cfm?action=airnow.archives&RegionID=0) for this question. View the California ozone maps in the map archives for the following dates in 2004: July 30; August 4, 9, 11, 17, 20, 23. Notice on each of these dates that the ozone concentrations are consistently close to the highest in the state in the Kern County (Bakersfield area). You are going to explore the smog problem associated with the greater Bakersfield area.

(a) View the ozone animation map for August 11, 2004. Starting at 6 am, follow the changes in ozone concentration throughout the day. Describe the chemical process that is occurring at different times to give the ozone profiles that you observe.

(b) The EPA has set National Ambient Air Quality Standards (NAAQS) for ozone at 0.12 ppm (1 hr) and 0.08 ppm (8 hr). California has a 0.09 ppm 1-hr standard. On how many of the days listed above was the California 1-hr standard exceeded; the National 1-hr standard? (Note: although these standards were strengthened in March 2008 to 0.075 ppm (8hr), you will use the standards that were in force in 2004).

(c) According to Census figures, Bakersfield had a population of 183,959 in 1990 and a population of 247,057 in 2000.

(i) What was the percent growth over this 10 year period?

(ii) At the current rate of growth, how long will it take for the population to double?

(d) Through June 2, 2004 the San Joaquin Valley Air Basin exceeded the California 1-hr ozone standard 19 times and the National 8-hr standard 15 times. Consider the topography of the Bakersfield area, the population growth statistics along with city growth map located at

http://www.wou.edu/las/physci/ch371/Bakersfield growth map.htm

to explain why Bakersfield has such a frequency of high levels of ozone. What could be done to decrease the production of ozone and improve the air quality?

3. (6 pts) Spanning two decades scientists collected lake and rainwater samples at five year intervals. The table below shows the pH of water samples collected over a 15 year period. Using the Otter Lake Monitoring Project map provided in your packet, interpret and critically analyze the data. Consider possible meteorological and geological factors.

Sample	1980	1985	1990	1995
Otter Lake	7.0	6.0	5.0	4.0
Lily Lake	7.0	7.0	6.0	6.0
Rain Gauge #1	5.5	5.5	5.5	5.5
Rain Gauge #2	5.5	4.0	4.0	4.0
Rain Gauge #3	5.5	3.5	3.5	3.5
Rain Gauge #4	5.5	3.5	3.5	3.5
Rain Gauge #5	5.5	5.5	5.5	5.5

Part III.

1. The Jiffy Coal Company wants to mine in the NW part of Whetpebble on Drypebble Mountain. They have distributed the following ad to the inhabitants of the Whetpebble region.

****

Jiffy Coal Company

We would like to offer Whetpebble the opportunity of a lifetime! By allowing us to strip mine on Drypebble Mountain You can have the life style you always dreamed of. Here's how:

- We will build a power plant next to the mine and provide electricity to everyone in Whetpebble - FREE!!
- Jiffy Coal will hire 200 Whetpebble residents to work in the mine.
- Jiffy Coal will plant 2 new trees for every one cut down to make room for mining.
- We will purchase a school bus for Whetpebble.
- Jiffy Coal will give safety equipment to all workers to prevent injury on the job.
- Jiffy Coal is knowledgeable of all federal and state mining regulations.

****

Here are some facts (see Whetpebble map) to consider:

- All streams in Whetpebble flow into Lake Hopper.
- The wind usually blows from north to south.
- Drypebble Mountain has steep slopes.
- Rain that falls on Drypebble flows into Patterson Run and Mills Creek.
- Drypebble's coal is high in sulfur content.

(a) Place yourself in the life situation of each of the Whetpebble homeowners described (descriptions are in your packet). Each of these homeowners will get a vote in deciding whether Jiffy Coal should be allowed to set up a mining operation. Consider the following questions when deciding how each homeowner should vote:

- What will mining in Whetpebble do to the economy?
- What are the short-term and long-term effects of mining? (Hint: you might need to learn a bit about acid mine drainage as it applies to coal mines; we only looked at metal mines in class). Which are the most important?
- How will your lifestyle be altered if Jiffy Coal Company is allowed to mine? How will your children and future generations be affected?
- Where will emission from the power plant blow? What will they do?
- Where will mine tailings and waste water be stored?
- What other information would be helpful in making a decision? What questions should you have for Jiffy Coal?

Use environmental facts to decide whether each homeowner will be better off with the acceptance of Jiffy Coal's offer or not. Clearly justify each homeowner's yes

or no vote. Remember to place yourself in the shoes of the different residents of Whetpebble in writing your answer – DON'T use your own world perspective.

2. The video entitled "Poison in the Rockies" mentioned the 1872 Mining Law which allows mining on public lands. Read the synopsis of this law and the three legislative reform proposals included in your packet and then answer the following questions:

(a) List the issues you think would be adequately addressed by each legislative proposal. Give reasons for your choices.

(b) List the issues that you think would not be adequately addressed in each proposal. Give reasons.

(c) Calculate the revenues to the government (and indirectly to the taxpayer) for mineral mining on federal lands. Base your calculation on $3 billion worth of minerals being mined in one year.

d) Which reform do you favor? Justify your choice using sound scientific reasoning.

****

Here are some examples of the projects:

Energy Consumption Project:

Requires data analysis, critical thinking skills and articulation skills. The entire module is available at:
http://www.wou.edu/las/physci/GS361/electricity%20generation/HistoricalPerspectives.htm

Investigate how energy consumption relates to standard of living by comparing energy consumption statistics with either Gross National Product (GNP) or Gross Domestic Product (GDP)for the following:

- China
- Russia
- Any two other countries of your choice

You can access a spreadsheet of energy consumption statistics here.
You will need to research the economic data (you may need to look up the difference between GNP and GDP. From your research, write a short essay detailing how energy consumption was related to the economics for each country.

Population Topics:

Requires mathematical data analysis, critical thinking and written articulation. The entire module can be viewed at:

http://www.wou.edu/las/physci//ch371/lecture/popgrowth/popintro.htm

1. There are already places on earth where population densities approach the 1 person/m^2 . A two story building in Delhi, India was found to house 518 individuals (density of 1 person/ 1.5 m^2). Calculate the floor area of the building in Delhi. Compare this to the average floor area of the typical single family home built in the U.S. in 1995 (2095 ft^2).

2. The land area of Brooklyn, NY is 70.5 mi^2 (1990 data). In 1992 the population of Brooklyn was 2,286 million. Calculate the population density of Brooklyn in terms of people per square meter.
($1\ mi^2 = 2.6\ km^2$)

3. If the earth's population growth is 1.36% per year, in what year will the world population reach the same density as Brooklyn's 1992 population density? Is it likely that this density will ever be reached?

Hurricanes pose a great danger to the populations of the southern and eastern U.S. because such storms can, in just a few hours, deposit an amount of rainfall equivalent to several month's normal amount. The Potomac Mills Mall in Prince William County is one of the largest in the U.S. Its building and parking area represent 5,675411 ft^2. In 1972 hurricane Agnes dumped 14 inches of rain on the area over 3 days. The effects of this storm were described as the most costly disaster in the history of the Eastern Seaboard. The Potomac Mills Mall did not in 1972.

1. Suppose Hurricane Sweetie hits Prince William County dumping 14 inches of rain on the region in 72 hours. Assume that the Potomac MIlls Mall was built on pasture and forested land which had a surface geology that would hav absorbed most of the storm's runoff. Calculate the maximum amount of extra runoff Potomac Mills Mall will generate during Hurricane Sweetie. Express your answer in cubic feet then convert it to cubic meters and liters.($1\ ft^3 = 2.83 \times 10^{-2}\ m^3$; $1\ m^3 = 1000$ L).

2. What is the resultant discharge from Potomac Mills Mall in liters per hour? Compare your answer to the typical summer flow of the Potomac River which is 100 million L/hr.
3. Complete the table below by filling in the appropriate spaces to convert county area from acres to hectares and to convert impervious surface area from square feet to square meters. (1 acre = 0.4047 hectare)

Prince William County's Impervious Surface Area						
Year	**Housing Units**	**County area (acres)**	**County area (hectares)**	**Impervious surface area (ft^2)**	**Impervious surface area (m^2)**	**Area of county covered by impervious surface (%) (housing alone)**
1940	3545	222,080		6,696,000		0.07
1950	5755	222,080		10,871,000		0.11
1960	13"07	222,080		24,948,000		0.25
1970	29,885	222,080		56,452,000		0.58
1980	46,490	222,080		87,819,000		0.90
1990	74,759	222,080		141,070,000		1.45
1994	90,759	222,080		163,366,000		1.68

4. Using the table from question 3, plot the following graphs:
    1. housing units versus time
    2. impervious surface area (m^2) versus time

    Interpret your graphs.

5. Calculate average annual growth rates for both housing units and impervious surface area for the period 1940-1994. How do they compare?

6. Using the growth rate for impervious surface area from 1940-1994, and starting at 1994, calculate when 50% of Prince William County will be covered with impervious surface from housing units. Speculate what life will be like in Prince William County when 50% is covered with impervious surface.

Find U.S. Census data on growth for an Oregon county and make calculations similar to those you just did with Prince William County.

- What is the growth rate?
- What are its implications?
- Consider transportation. According to *Statistical Abstract of the U.S.: 1996*, there are approximately 0.6 motor vehicles per person in the U.S. Assuming the number of motor vehicles grows with the population, assess the impact of population growth on road congestion in this county.
    - Is road construction and maintenance an unavoidable cost of pupulation growth?

    - Should people who choose not to own cars pay for these new or expanded roads? Explain your answer by describing your reasoning.
- Examine the county's zoning ordinances (usually can be obtained from the city or town planner's office.) Determine if they are designed to promote or limit growth.

Although it is difficult to determine the exact human carrying capacity for a country as large and diverse as the U.S., an estimate of carrying capacity is essential for those whose jobs involve the development of policies to ensure that the environment is able to support life into the future.

Consider the information in the list below and decide if the item is an indication that humans may have exceeded their carrying capacity in some regions.

Yes	No	Maybe	
			The Los Angeles riots of 1992
			Closure of the Georges Banks fishing grounds
			The 1.9% per capita annual decline of arable land in developing countries during the 1980's
			Closure of Murrells Inset, South Carolina to shell fishing after heavy rains
			The loss of 70,000 km^2 of cropland yearly due to nutrient depletion
			1.7% annual decline in rainforest acreage in Equador during the 1980's
			The existence of 33,000 potential Superfund toxic contamination sites
			Projected exhaustion of fossil fuels by the middle of the next century
			Using groundwater in the U.S. 25% faster than aquifers are recharged
			High unemployment in Flint, Michigan
			Crowded roads and sociopathic driving behavior
			Deteriorating infrastructure (e.g., bridges and roads
			Massacres in Rwanda, one of Africa's most densely populated countries
			Issuance of a fishery management plan by the National Marine Fisheries Service to allow threatened species of sharks to recover

1. Discuss the choices you made with the rest of the class via email. Indicate that your post is for CH 371 in the subject line. Don't be afraid to voice your opinions and to comment on the posts of your classmates. One thing about opinions, everyone has one! Justify yours.
2. Post other evidence that you can think of that supports the claim that the U.S., or any part of the U.S., has exceeded its carrying capacity?

Oil Resources and Reserves:

Requires data collection, mathematical data analysis, critical thinking and written articulation. The entire module can be viewed at :

http://www.wou.edu/las/physci//ch371/lecture/oil_reserves/oil1.htm

Shale oil is often suggested as a viable substitute for oil. Shale oil resources (the total oil in shale, not that which can be economically extracted) in Wyoming, Utah, and Colorado have been estimated to exceed 2000 billion barrels - twice the world's proven oil reserves! Research the geology of oil shale and the limitations to mining oil shale. Consider the following:

- water needs and availability
- waste disposal
- methods proposed for extracting the waxy, almost solid oil from the dense shale rock
- energy required to extract the oil from the shale

Do you believe that shale oil is a viable replacement for oil in conventional rock reservoirs?

Critical Book Review Project:

Requires critical thinking and written articulation. Books were selected from a list of course supportive offerings.

This assignment involves writing a book review not a book report. You probably have written a book report at some point in your academic career. A book report typically contains the biobliographical details of the book, some biographical details about the author and a summary of what the book is about. Basically, a book report is a rehash of what is in the book. A book review, on the other hand, is a critical work combining a brief description of what the book is about, analyzing the themes presented in the book, discussing the significance and relevance of the work, and presenting your reaction to the book. Read more about how to write a book review (up to the section " Some Considerations When Reviewing Specific Genres") here.

Specific Instructions for Your Book Review:

Although book reviews can be very short with only 100-200 words, you will be writing a longer, comprehensive review. Your review should be in the range of 1000-1500 words. You will submit both an electronic version of your review as a Microsoft Word file (if you use a different word processor, you must save the file as a .doc file) and in hard copy. The electronic version is to be submitted as an email attachment to courtna@wou.edu by the due date.

****

Your book review is to be titled…….A Critical Book Review of [title in Italics] by [author] followed by your byline on the next line.

The book review will have the following components. Since it is an essay, the components are not split out by headings. The headings are listed here only as descriptors to guide you.

1. Introduction

An introductory paragraph which includes a statement of the essential bibliographic information including title, author, copyright date, special features (maps, photos, etc if there are any), price and ISBN; the author's background (qualifications and background or lack thereof!); a brief overview of the contents of the book; the intended audience of the book, background information which places the book into context; and a brief introductory statement of your reaction to and evaluation of the book (why should other people read or not read this book?) You might have to do some research using the internet to obtain some of this information.

2. Summary.....What is it about?

A short section summarizing the main points brought out by the book which often quotes or paraphrases key phrases of the author.

3. Your Evaluation

This should be at least one third of the total length of the paper. Describe the purpose of the book (discussed in "How to Write a Book Review" link above) and answer the following questions:

- How well did the book achieve its purpose?
- What viewpoint was used by the author. Was it an objective treatment of the subject or did the author have a particular bias throughout the work?
- How strong was the evidence presented to support the author's conclusions? How persuasive was the evidence?
- What is your judgment of the style, content and historical value of this book?

- Did the book challenge you intellectually by increasing your knowledge or presenting the material in a novel or provocative manner? What, if anything, did the author leave out that should have been included?
- Would you recommend the book? If so, to what audience (general audience or audience of what particular expertise)?

4. Conclusion

End with a paragraph which reviews the main points of your evaluation, whether you thought the book was good or not and whether should anyone read it.

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): BS Chemistry/ Service for other science majors

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: Ch 334, 335, 336 Organic Chemistry

Faculty name: Arlene Courtney

Date: June 15, 2008

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

#1 and #2 of the learning objectives listed in the Department of Chemistry 2008 Assessment report (inserted below)

- To train students in the basic principles of analytical, inorganic, organic and physical chemistry preparing undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for pre-professional training in the health sciences or secondary education and to gain practical experience via research projects or internship opportunities
- To provide an academic foundation necessary for students in other areas of study whose academic goals require an understanding of chemical principles.

B) Check the embedded assessment tool(s) used :

☐ Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
X☐ Other : National normed examination (ACS Organic Chemistry Exam)

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of examination may not be attached for ACS security requirements

Please submit a copy of this action report to the LAS dean’s office.

LAS
Embedded Assessment Action Report
For
Program Review

Degree Program(s): BA/BS Chemistry (Traditional and Forensic Options)
(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: Ch161: Photography

Faculty name: Pete Poston

Date: June 9, 2008

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

- To prepare undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for preprofessional training in the health sciences or secondary education

B) Check the embedded assessment tool(s) used :

☐ Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
X Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other _____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Please submit a copy of this action report to the LAS dean's office.

Ch61 - Technical Photography
Special Project Guidelines (F '07)

You will develop a portfolio of images based on your selected topic. For example, maybe you have selected an insect collection as your subject, and you want to obtain closeup images to be published in a scientific journal. Here are some other possible subjects -

Luminol and bloodstains
Fingerprints
Casts of tire tracks and shoe impressions
Domestic violence photography (simulated, of course, with make-up)
Atmospheric optical effects - rainbow, diffraction halos, etc
Nighttime photography - star tracks, car traffic downtown, fireworks, the moon, etc
Closeups - insects, leaves, etc
Wildlife
City architecture
Fossil collection

1. Your choice of special project must first be approved by the instructor. **The special project subject must be approved by Wednesday, Oct 31st.**

2. Discuss with the instructor the photographic details of your project, e.g. film speed, aperture, tripods, lenses, etc.

3. The portfolio may consist partially of color digital images that have been printed out in color, but you also must submit black & white images developed by yourself as explained below.

4. At the very least, each portfolio must contain the following:

   (a) A record of each picture↴s f-stop, shutter speed, etc
   (b) A short description of each photo and what it is meant to convey.
   (c) At least four 8x10 B&W pictures that you developed yourself in the darkroom
   (d) At least five 4x6 color pictures developed in a lab or printed out in color from a digital image
   (e) There must be at least one B&W close-up in your portfolio. I chose B&W because that would be the most likely type of photo published in a journal and it↴s cheap.

5. The portfolio will be graded based on the technical details of the photographs, not the content, artistic quality, or esthetics. All photos need to be in focus, possess the right amount of contrast, and be properly exposed. A more subjective grading criterion will be whether or not your photos convey the desired qualities. For example, if you are photographing an athlete and your intention is to blur the photos to convey a sense of motion, power, grace, etc, then if those qualities don↴t come through then I will count off.

6. I expect that your portfolio will develop as you work on it. Please consult with me regularly on your progress. Do not wait until the last minute to start work on your portfolio! So I am going to ask for a partial preview before you hand in the final version. **The preview is due on Wednesday, Nov 14th.**

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): BA/BS Chemistry (Traditional and Forensic Options)

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: Ch221-223: General Chemistry

Faculty name: Pete Poston

Date: June 9, 2008

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

- To train students in the basic principles of analytical, inorganic, organic and physical chemistry

- To prepare undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for preprofessional training in the health sciences or secondary education

- To provide an academic foundation necessary for students in other areas of study whose academic goals require an understanding of chemical principles

B) Check the embedded assessment tool(s) used :

☐ Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
X Other Standardized ACS Exam

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

LAS
Embedded Assessment Action Report
For
Program Review

Degree Program(s): __BA/BS Chemistry (Traditional and Forensic Options)_____
(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch312: Quantitative Analysis_____

Faculty name: __Pete Poston_____

Date: _____June 9, 2008_____

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

- To train students in the basic principles of analytical, inorganic, organic and physical chemistry

- To prepare undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for preprofessional training in the health sciences or secondary education

B) Check the embedded assessment tool(s) used :

☐ Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
X Other __Standardized ACS Exam_____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Please submit a copy of this action report to the LAS dean's office.

LAS
Embedded Assessment Action Report
For
Program Review

Degree Program(s): __BA/BS Chemistry (Traditional and Forensic Options)_____
(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch313: Instrumental Methods_____

Faculty name: __Pete Poston_____

Date: _____June 9, 2008_____

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

- To train students in the basic principles of analytical, inorganic, organic and physical chemistry

- To prepare undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for preprofessional training in the health sciences or secondary education

B) Check the embedded assessment tool(s) used :

X Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other _____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Please submit a copy of this action report to the LAS dean's office.

The following question will be given in the Final Exam at the end of the course. The questions are designed to see if students are able to apply what they've learned to "real-world" situations. Enough hints are given that the students should be able to recognize under what conditions a given instrumental technique is applicable.

"REAL WORLD" APPLICATIONS (24 pts)

Explain how you would handle each of the following situations. Include a discussion of sampling procedures, what instrument you would use, and what detection limits you would expect.

1. (8 pts) You're working on sequencing a gene for a bio-tech company, and you have the mixture that remains after applying restriction enzymes to the gene (fragments of DNA of unknown composition and molecular weight). How would you identify the composition and masses of the fragments?

2. (8 pts) A factory which manufactures metal alloys is accused of illegally dumping metal waste which then percolates downward below the water table and into the groundwater. How could you prove the company dumped the waste?

3. (8 pts) You work for a pharmaceutical company and have just synthesized a new drug. You need to verify the structure of your new compound. Your sample is the complicated mixture that remains after the reaction.

LAS
Embedded Assessment Action Report
For
Program Review

Degree Program(s): BA/BS Chemistry (Traditional and Forensic Options)
(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: Ch354: Computational Chemistry

Faculty name: Pete Poston

Date: June 9, 2008

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

- To prepare undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for preprofessional training in the health sciences or secondary education

B) Check the embedded assessment tool(s) used :

☐ Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
X Other Special Project

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Special Project Description:

Worth 18% of the course grade. Students select a topic in Computational Chemistry that requires application of the computer-based techniques covered in lecture using the scientific calculation program MatLab®.

LAS
Embedded Assessment Action Report
For
Program Review

Degree Program(s): BA/BS Chemistry (Traditional and Forensic Options)
(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: Ch420: Forensic Chemistry

Faculty name: Pete Poston

Date: June 9, 2008

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

- To prepare undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for preprofessional training in the health sciences or secondary education

- To provide an academic foundation necessary for students in other areas of study whose academic goals require an understanding of chemical principles

B) Check the embedded assessment tool(s) used :

- ☐ Exam question
- ☐ Essay
- ☐ Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ Capstone paper / project
- ☐ Other _____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Please submit a copy of this action report to the LAS dean's office.

LAS
Embedded Assessment Action Report
For
Program Review

Degree Program(s): BA/BS Chemistry (Traditional and Forensic Options)
(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: Ch461: Experimental Chemistry

Faculty name: Pete Poston

Date: June 9, 2008

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

- To prepare undergraduates for professional work in chemistry or forensic science, graduate work in pure or applied chemistry, or as a core for preprofessional training in the health sciences or secondary education
- To have students care about using the chemical knowledge for the "good" of society
- To learn the principles of laboratory safety, quality assurance and quality control

B) Check the embedded assessment tool(s) used :

X Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other _____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Please submit a copy of this action report to the LAS dean's office.

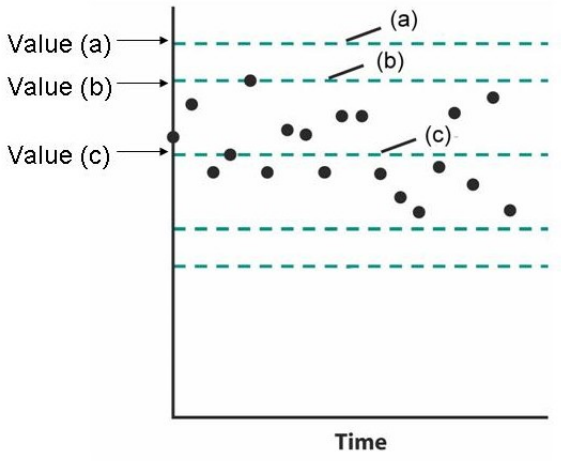
Results of stated **program learning outcome** or **general education goal**: See attached quiz

- To learn the principles of laboratory safety, quality assurance and quality control

  This goal was evaluated with the attached Quiz #4, and the student results were:
  22, 24, 25, 25, 23, 23 for an average of 23.7 out of 25 pts.

Quiz #4 **F '07** **Ch 461** **Name**_____

1. (10 pts) Matching. Only one best answer each.



1. line (a) _____
2. line (b) _____
3. line (c) _____

(a) target value
(b) action line
(c) alert line
(d) warning line
(e) alert value

****

4. value (a) _____
5. value (b) _____
6. value (c) _____

(a) μ
(b) $\mu \frac{2\sigma}{\sqrt{N}}$
(c) $\mu + \frac{2\sigma}{\sqrt{N}}$
(d) $\mu \frac{3\sigma}{\sqrt{N}}$
(e) $\mu + \frac{3\sigma}{\sqrt{N}}$

****

7. _____ Standard Reference Materials
8. _____ Method blank
9. _____ 21 CFR Part 11 compliant
10. _____ Quality Control

(a) steps taken to ensure under control/properly monitored
(b) steps taken to ensure under statistical control
(c) digital audit trail
(d) certified levels of analyte in realistic materials
(e) reference books, journals, etc
(f) guarantees accuracy and precision
(g) contains everything but analyte

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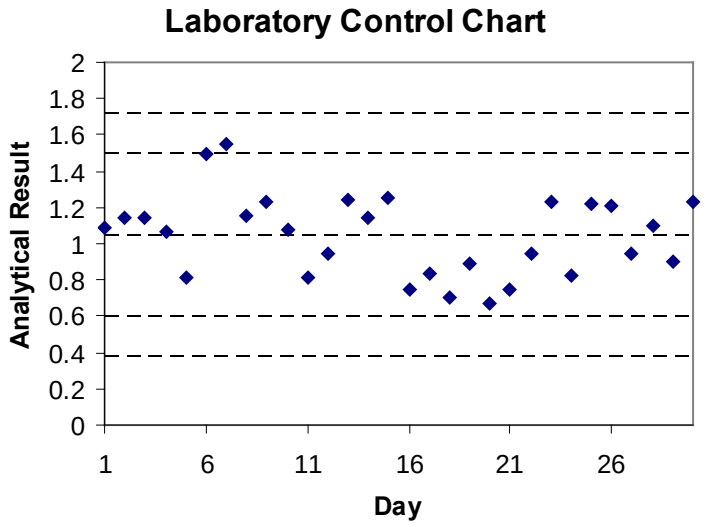
2. (5 pts) What is meant by a "blind" sample?

MORE QUESTIONS ON BACK.

3. The following control chart was generated in an analytical laboratory.



(a) (5 pts) Explain the purpose of a control chart using basic statistical terminology and the meanings of the dashed lines in the chart above.

(b) (5 pts) Is there any particular day or days where there is cause for concern, and if so, briefly explain why based on the statistical criteria presented in lecture.