

Chemistry Department Policy
Assessment: Undergraduate Programs

1. MISSION STATEMENT

The Chemistry Department offers academic programs which provide students with a liberal arts background and the theoretical knowledge and experimental skills to prepare for entry-level careers in the public and private sectors involving chemistry, to enter a graduate school in chemistry or to qualify for the credential program. The curriculum is organized into two primary degree programs: Bachelor of Arts and Bachelor of Science. The Bachelor of Arts degree has three concentrations: General, Biochemistry and Forensics. Each degree program has a core set of lower division and upper division courses that provide fundamental knowledge and experimental training; upper division elective courses expand upon the fundamental information learned in the core courses. Students are encouraged to participate in the life of the University and department and to work with a faculty member in a scholarly project.

2. SUMMER ADVISEMENT AND ORIENTATION PERIODS FOR NEWLY ADMITTED FRESHMEN AND TRANSFER STUDENTS

- A. The student will take appropriate diagnostic placement exams in English and Mathematics administered by the University
- B. Chemistry faculty advisors will meet with students to assess appropriate placement in Chemistry courses.
- C. Students planning to take Chemistry 1A are required to pass a diagnostic placement examination. If a passing score is not achieved, students are advised to enroll in Chemistry 4.

3. FRESHMEN THROUGH SENIOR YEARS

- A. Students not taking the Chemistry 1A diagnostic test before classes start will take it in the first laboratory period.
- B. Students must take the appropriate sequence of English, Mathematics and Physics courses in order to succeed as a chemistry major. Progress in these areas will be monitored by Chemistry faculty advisors and appropriate recommendations will be given to students based on their performance in the prerequisite courses.
- C. Students are expected to begin taking required English and Mathematics courses in General Education in the first semester of attendance or have completed them if they are transferring.
- D. Students are expected to develop their competence in eight skill areas. Five of these are transferable skills taken from general education courses and three [the last three] are more specifically aimed at students majoring in Chemistry.

- Effective Writing
- Effective Oral Communication
- Critical Thinking (logic and rhetoric)
- Problem Solving and Critical Thinking
- Quantitative Analysis
- Library and Scientific Information Literacy
- Computer literacy
- Laboratory Skills

E. A capstone project is required of students in Chemistry 125, 141 or 164 to assess students' ability to transfer many of the skills listed above to a selected laboratory project. The projects

will require the use of chemical literature, doing a laboratory project, preparing a paper, and presenting the project in a poster presentation format to students, faculty and others. Students will be expected to be able to answer questions orally. Faculty will make a holistic judgment of students= ability to transfer liberal arts skills to the field of chemistry. Also, students will be assigned a grade.

4. BEYOND GRADUATION

A. Recent Alumni will be surveyed every three years to determine their satisfaction regarding the quality of their undergraduate education and their preparedness for graduate school and/or their entry level position in industry. They will also be asked to suggest changes for improvements in the curriculum.

B. All Alumni will be able to inform the Chemistry Department of their successes and concerns in an alumni questionnaire that will be included in any Chemistry Department newsletter.

5. BS CHEMISTRY CURRICULUM*

	FRESHMAN	SOPHOMORE	JUNIOR	SENIOR
CRITICAL THINKING	GE:AREA A3 CHEM 1A, 1B	CHEM 24, 31, 124	CHEM 140A, 140B, 141	CHEM 110, 133, 198
EFFECTIVE WRITING	E: AREA A2 CHEM 1A, 1B	CHEM 25	CHEM 125, 141	CHEM 110L, 198
EFFECTIVE ORAL COMMUNICATION	GE:AREA A1		CHEM 125	CHEM 110L, 198
PROBLEM SOLVING AND CREATIVE THINKING	GE: AREA B4 CHEM 1A, 1B	GE: AREA B CHEM 24, 25, 31, 124	CHEM 125, 140A, 140B, 141	CHEM 110L, 198
QUANTITATIVE ANALYSIS	GE: AREA B4 CHEM 1A, 1B	GE: AREA B CHEM 31	CHEM 125, 140A, 140B, 141	CHEM 110L, 133, 198
LIBRARY AND INFORMATION LITERACY			CHEM 125, 141	CHEM 110L, 198
COMPUTER LITERACY	CHEM: 1B		CHEM 125, 141	CHEM 110L
LABORATORY SKILLS	GE: AREA B CHEM 1A, 1B	CHEM 25, 31	CHEM 125, 141	CHEM 110L, 133, 198

Note: Six units of elective courses are required and these also will fit into the above matrix.

*Core and required upper division courses are typically listed. Elective courses will add breadth to the assessment areas.

BA, GENERAL CHEMISTRY, CURRICULUM

	FRESHMAN	SOPHOMORE	JUNIOR	SENIOR
CRITICAL THINKING	GE:AREA A3 CHEM 1A, 1B	CHEM 24, 31, 124	CHEM 140A, 140B, 141	
EFFECTIVE WRITING	GE: AREA A2 CHEM 1A, 1B	CHEM 25	CHEM 141	TWO ELECTIVE COURSES
EFFECTIVE ORAL COMMUNICATION	GE:AREA A1			
PROBLEM SOLVING AND CREATIVE THINKING	GE: AREA B4 CHEM 1A, 1B	GE: AREA B CHEM 24, 25, 31, 124	CHEM 140A, 140B	TWO ELECTIVE COURSES
QUANTITATIVE ANALYSIS	GE: AREA B4 CHEM 1A, 1B	GE: AREA B CHEM 31	CHEM 140A, 140B, 141	TWO ELECTIVE COURSES
LIBRARY AND INFORMATION LITERACY			CHEM 141	
COMPUTER LITERACY	CHEM: 1B		CHEM 141	
LABORATORY SKILLS	GE: AREA B CHEM 1A, 1B	CHEM 25, 31	CHEM 141	TWO ELECTIVE COURSES

Note: 12 units of upper division chemistry elective courses, including two courses containing a laboratory, will also fit into the above matrix

BA, BIOCHEMISTRY, CURRICULUM

	FRESHMAN	SOPHOMORE	JUNIOR	SENIOR
CRITICAL THINKING	GE:AREA A3 CHEM 1A, 1B	CHEM 24, 31, 124	CHEM 142, 160A/B,164	

EFFECTIVE WRITING	GE: AREA A2 CHEM 1A, 1B	CHEM 25	CHEM 162	CHEM 164
EFFECTIVE ORAL COMMUNICATION	GE:AREA A1			CHEM 164
PROBLEM SOLVING AND CREATIVE THINKING	GE: AREA B4 CHEM 1A, 1B	GE: AREA B CHEM 24, 25, 31, 124	CHEM 142	CHEM 160A, 160B
QUANTITATIVE ANALYSIS	GE: AREA B4 CHEM 1A, 1B	GE: AREA B CHEM 31	CHEM 142,162	CHEM 164
LIBRARY AND INFORMATION LITERACY			CHEM 160B	CHEM 164
COMPUTER LITERACY	CHEM: 1B		CHEM 160A,162	CHEM 164
LABORATORY SKILLS	GE: AREA B CHEM 1A, 1B	CHEM 25, 31	CHEM 141	CHEM 162, 164

Note: Two upper division courses must also be chosen from a prescribed list of courses in the Biological Sciences Department. These will also fit into the above matrix.

BA, FORENSIC CHEMISTRY, CURRICULUM

	FRESHMAN	SOPHOMORE	JUNIOR	SENIOR
CRITICAL THINKING	GE:AREA A3 CHEM 1A, 1B	CHEM 24, 31, 124	CHEM 140A, 140B OR 142	Chem 110* Chem 164*
EFFECTIVE WRITING	GE: AREA A2 CHEM 1A, 1B	CHEM 25	CHEM 141*	Chem 110L* Chem 164*
EFFECTIVE ORAL COMMUNICATION	GE:AREA A1			Chem 110L* Chem 164*
PROBLEM SOLVING AND CREATIVE THINKING	GE: AREA B4 CHEM 1A, 1B	GE: AREA B CHEM 24, 25, 31, 124	CHEM 140A, 140B OR 142, 141*	

QUANTITATIVE ANALYSIS	GE: AREA B4 CHEM 1A, 1B	GE: AREA B CHEM 31	CHEM 142, 141*	
LIBRARY AND INFORMATION LITERACY				CHEM 110*, CHEM 110L*
COMPUTER LITERACY	CHEM: 1B		CHEM 141*	CHEM 110*, CHEM 164*
LABORATORY SKILLS	GE: AREA B CHEM 1A, 1B	CHEM 25, 31	CHEM 141*, CHEM 125	CHEM 162, CHEM 110L*

* Elective Option

6. ASSESSMENT GOALS

Assessment Goals

Laboratory Knowledge and Skills

Students obtaining a baccalaureate chemistry degree should have upon graduation

1. the basic analytical and technical skills to work effectively in the various fields of chemistry.
2. the ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.
3. the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.
4. the ability to use information technology tools such as the Internet and computer-based literature searches as well as printed literature resources to locate and retrieve scientific information needed for laboratory or theoretical work.
5. the ability to present scientific and technical information resulting from laboratory experimentation in both written and oral formats.
6. knowledge and understanding of the issues of safety regulations in the use of chemicals in their laboratory work.

Assessment Goals

Computer, Library and Information Skills

Students obtaining a baccalaureate chemistry degree should have upon graduation

1. the ability to make effective use of the library and other information resources in chemistry, including
 - a. finding chemical information utilizing the primary literature.
 - b. critically evaluating chemical information.
 - c. finding and evaluating chemical information utilizing secondary sources such as the Internet.

2. the ability to make effective use of computers in chemistry applications, including
 - a. using a computer as a tool in writing, drawing chemical structures and data analysis to communicate scientific information.
 - b. having a familiarity with the applications of computers in the modeling and simulation of chemical phenomena.
 - c. having an appreciation of the applications of computers in data acquisition and processing.
 - d. retrieval of information using library or internet resources.

Assessment Goals
Oral and Written Communication Skills in Chemistry

Students obtaining a baccalaureate chemistry degree should have upon graduation

1. adequate skills in technical writing and oral presentations. [Students must be given the opportunity to practice effective writing and oral communication throughout the chemistry curriculum.]
2. the ability to communicate scientific information in oral and written formats to both scientists and nonscientists.

Assessment Goals
Quantitative Reasoning Skills

Students obtaining a baccalaureate chemistry degree should have upon graduation

1. sufficient quantitative reasoning skills to successfully pursue their career objectives, a related career or further professional training.
2. developed their
 - a. proficiency in unit algebra skills.
 - b. ability to accurately collect and interpret numerical data.
 - c. ability to solve problems competently using extrapolation, approximation, precision, accuracy, rational estimation and statistical validity.
 - d. ability to relate theories involving numbers and the practice of the theory.
 - e. proficiency in the scientific method (formulating hypotheses and arriving at appropriate answers and conclusions)

Assessment Goals
Knowledge of Chemical Principles and Facts

Students obtaining a baccalaureate chemistry degree should have upon graduation

1. developed a mastery of critical thinking skills, problem-solving skills and data analysis skills leading to the ability to

- a. collect and analyze data.
 - b. apply fundamental chemical principles to gather and explain data.
 - c. design experiments or model systems to test hypotheses.
 - d. assess the relative validity of several possible solutions to a problem.
2. a working knowledge of chemical principles appropriate to a chemistry degree program to include thermodynamics, equilibrium, kinetics, quantum mechanics, structures of materials, and synthesis.
3. a mastery of a broad set of factual chemical knowledge concerning the properties of substances, molecules and atoms.

The set of preceding assessment goals were developed and approved by CSU chemistry faculty at a May 5, 1999, statewide conference of Assessment of Chemistry Degree programs.

7. CAPSTONE PROJECTS & SENIOR RESEARCH:

Capstone projects and senior research consist of the following components in the chemistry major:

A. Preparation: Students

- 1) Explore a specific topic suitable for undergraduate student research or capstone laboratory project in a subdiscipline of chemistry in collaboration with one or more faculty members in the department;
- 2) Review safety literature and MSDS sheets of chemicals to be used in project.

B. Execution of Research or Capstone Laboratory Project

As a result of these preparative activities, the student, in collaboration with the faculty member in whose laboratory or class the student:

- 1) Describes the goals to be achieved in the project
- 2) Describes and evaluates the experimental design to be used in achieving the project goals;
- 3) Delineates the protocol to be followed; describes and evaluates experimental controls;
- 4) Identifies, describes and evaluates specific techniques and instrumentation to be used; gains competence in techniques and/or instrumentation with which he/she is not familiar;
- 5) Executes prescribed protocol;
- 6) Records data generated from the experimental protocols; provides charts, tables or graphs which summarize and/or illustrate major results; completes any descriptive and/or inferential statistical treatment of the data in order to assess the certainty associated with the results;
- 7) Articulates and evaluates interpretations made from the data/results;
- 8) Articulates and evaluates major conclusions of the experiment or study;
- 9) Addresses any problems encountered with achieving the project goals;
- 10) Proposes future experiments to improve upon or extend the present work.

C. Preparation of a Poster

(**Note:** Capstone courses will require a Poster. An Oral Presentation and/or written report may be required.)

The student:

- 1) Constructs a poster using the style and format given in the individual course guidelines. In general, the poster should closely follow the Formal Written Report.
- 2) Writes with clear, accurate sentence structure using appropriate terminology, spelling, grammar and punctuation.
- 3) Successfully communicates the research in the Poster to an audience, using the Poster as a visual aid.

D. Preparation of a Written Report

- 1) A written report shall conform to the appropriate research journal in the field. For example, the appropriate journal for a project in organic chemistry is *Journal of Organic Chemistry*. The instructor of the capstone course will identify the appropriate journal.
- 2) Generally, the report will have a title, abstract, introduction, experimental section, results, discussion and references. The format of each section is described in the respective research journal.

The student:

- 3) Utilizes an approved word processing program to produce hard copies of text for revision, proofreading and final copy.
- 4) Reviews the paper for a.) logical train of thought, b.) continuity and clarity of transitions between elements of the topic, c.) consistency of style and approach, and d.) balance between elements of the topic consistent with objective of the paper.
- 5) Writes with clear, accurate sentence structure using appropriate and conventional words, grammar, and punctuation; uses correct verb tense, symbols and abbreviations; avoids jargon, wordiness and repetition.

E. Preparation of an Oral Presentation

The student:

- 1) Utilizes a format in which the written report serves as the basis for the oral presentation and the Introduction, Materials and Methods, Results and Discussion sections comprise the major portion of the presentation;
- 2) Uses the appropriate audio-visual aids to illustrate the presentation in a clear and concise manner. Uses supplementary handouts during the presentation where appropriate;
- 3) Avoids reading the presentation; presents from a list of notes consisting of the main concepts and points to be emphasized;
- 4) Speaks slowly and clearly, maintaining eye contact with the entire audience; uses appropriate gestures;
- 5) Repeats difficult or confusing material using different wording and invites questions at points in the presentation which may be confusing;
- 6) Ends the presentation at the designated time limit which includes a review and emphasis of major points and conclusions of the research;

ASSESSMENT CRITERIA FOR FORMAL LAB REPORTS

Format – The report contains the required sections as per syllabus: Title, Abstract, Introduction, Results, Discussion, and References.

Content – Each section of the report contains the appropriate type and amount of information.

Data analysis and presentation – The data are properly analyzed as well as clearly and neatly presented.

Conclusions – The conclusions drawn from the data are consistent with the data presented. The results of the report are thoroughly discussed in the context of the present experiment with extensive reference to the existing primary literature. Errors in experimental measurements or design are thoroughly analyzed.

Writing

Grammar – The report contains good grammar, including accurate spelling, good sentence construction, appropriate use of punctuation, and proper word usage.

Organization – The writing in each section of the report is organized, with a logical flow of ideas between and within paragraphs.

Style – Each section of the report is written in the appropriate style and in passive voice.

Presentation – The report is presented well and has an overall appearance that leaves a favorable impression upon the reader

"A" papers are those that flawlessly fulfill all of the above criteria.

"B" papers are those that generally fulfill the criteria but may be less than excellent in one or more areas. For example, a paper that has very good data presentation but a somewhat choppy or clunky writing style is more likely to be a "B" rather than an "A" paper.

"C" papers are those only fulfill some of the criteria and/or contain serious flaws such as poor sentence structure, poor paragraph organization, or shoddy data presentation.

"D" papers are those that contain major flaws in several areas.

"F" papers are those that contain major flaws in several areas and are missing critical information (such as the abstract or a reference list).

ASSESSMENT CRITERIA FOR POSTER PRESENTATIONS

Format – The poster is properly constructed in the format stated in the course guidelines and contains a Title and the required sections such as Abstract, Materials and Methods, Results, Conclusion, References.

Content – The poster successfully reports the results of the project by focusing on the essential features of the project while avoiding excessive wordiness.

Writing – The writing is smooth, concise, well-organized, with good logical flow of ideas. The writing contains good grammar with proper spelling, punctuation, sentence structure and word usage.

Results – The poster shows that the student understands the experimental procedures and experimental outcomes. The student demonstrates an understanding of the quality of the work.

Data Analysis and Presentation – The data are carefully analyzed and presented in a clean, readable format. Plots and tables are organized and clearly labeled so that the reader can grasp the essential features of the data at a glance.

Conclusions – The conclusions are clearly and simply laid out. The reader should be able to easily grasp the overall results of the study from this section alone.

Presentation – The poster presentation is clean, neat, uncongested, and easy to follow.

"A" posters are those that flawlessly fulfill all of the above criteria.

"B" posters fulfill most of the criteria. A "B" poster may contain major flaws in only one area or minor flaws in no more than two areas.

"C" posters contain major flaws in two areas or minor flaws in three areas.

"D" posters contain major flaws in three areas or minor flaws in most areas.

"F" posters contain major flaws in three areas and are missing sections or other critical information.

PRIMARY ASSESSMENT ACTIVITIES FOR THE NEXT FIVE YEARS

Alumni Survey

The first survey conducted by the department encompassed the entire alumni population. The next alumni survey is being conducted by Institutional Studies in the year 2000. A future survey of alumni will focus on alumni who graduated after the second survey was administered. The questions will focus on concerns and issues of faculty based on a review of the results of the first and second alumni survey. This survey will occur in the three years after the second survey is completed.

Writing in the Major

A random selection of laboratory/poster reports will be collected in chemistry 141 and 164 in the spring semester. A committee composed of the instructors in the two courses and two other faculty will review the reports to determine how effectively students are meeting two criteria:

Organization

Technical writing skills

The committee will prepare a report to the department that discusses how effectively students performed in the two criteria areas. Recommendations for improving, if necessary, the performance of students will also be submitted. The faculty of the department will discuss the recommendations and adopt appropriate recommendations and action pathways.

American Chemical Society Exams

The department will initiate a study of the feasibility of using American Chemical Society examinations in the following courses

Chemistry 124

Chemistry 140B

Chemistry 160B

The first step is a study of each ACS examination by a group of faculty who teach these courses. Each study will consider: The content covered in the exams compared to the content covered in the course, the level of difficulty of the examination, how the entire exam might be administered, and security of exam issues. At the conclusion of each study, the faculty group will prepare a written report to the faculty regarding the potential for administering each exam at least once per academic year.

The purpose of administering an ACS exam is to compare the chemical knowledge competency of chemistry degree students compared to a national norm.

After receiving the reports, the faculty will determine whether to administer all or any of the ACS examinations. For those ACS examinations approved for administration, a committee of the instructors of the identified courses will meet annually and review the results. A report will be developed and submitted to the department for its review. At the end of the trial period, the department will determine if continuation of the exams is justified.

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