Chemistry

Overview

A series of chemistry courses designed to meet transfer requirements for chemical, physical and biological science majors. A series of courses intended for students majoring in fields other than chemistry, biology, or physical science. A course designed specifically for students who require preparation or review of the more basic chemical concepts. All chemistry courses at CRC include a practical component where students conduct hands-on chemical experimentation in a modern, well-equipped laboratory.

Program Maps


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Associate Degrees

A.S. in Chemistry

The Chemistry Program at CRC consists of: a series of courses designed to meet transfer requirements for chemical, physical and biological science majors; a series of courses intended for students majoring in fields other than chemistry, biology, or physical science; and a course designed specifically for students who require preparation or review of the more basic chemical concepts.

All chemistry courses at CRC include a practical component where students conduct hands-on chemical experimentation in a modern, well-equipped laboratory.

HIGHLIGHTS
* An outstanding chemistry faculty striving to maintain an excellent and well-respected chemistry program
* Ample contact with the instructor and the relaxed atmosphere that only a limited class size can offer
* A Mathematics, Engineering and Science Achievement (MESA) program

This degree is designed to meet common lower division requirements for a major in chemistry.

Catalog Date: January 1, 2021

Degree Requirements

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<tr>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>UNITS</th>
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<tbody>
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<td>CHEM 401</td>
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<td>Organic Chemistry I</td>
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<td>PHYS 431</td>
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<td>Total Units:</td>
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</table>

The Chemistry Associate in Science (A.S.) degree may be obtained by completion of the required program, plus general education requirements, plus sufficient electives to meet a 60-unit total. See CRC graduation requirements.

Career Information

Biochemist; Chemist; Pharmacist; Chemical Engineer; Chemical Technology; Physician; Dentist; Veterinarian; Allied Health Professional; Biologist; Physicist; Geologist; Geochemist; Oceanographer. Some career options require more than two years of college study. Classes beyond the associate degree may be required to fully prepare students for transfer to a university program.
# A.S. in General Science

Areas of Study include:

- Physical Anthropology
- Astronomy
- Biology
- Chemistry
- Engineering
- Physical Geography
- Geology
- Physics

Eighteen (18) units of transfer level course work in science is required. Two laboratory courses must be included: one in the physical sciences and one in the biological sciences. Courses may be selected from astronomy, biology, chemistry, geology, physical geography, physical anthropology, and physics. The student, in consultation with a counselor, should choose science courses to meet his or her program, transfer, or general education requirements.

Students interested in transferring to a four-year university with a science major are encouraged to complete a science AS or AS-T degree such as Anthropology, Biology, Chemistry, Engineering, Geography, Geology, or Physics. This General Science degree may not include the majors-level transfer courses needed for many science majors. Students are strongly recommended to see a counselor for guidance.

**Catalog Date:** January 1, 2021

## Degree Requirements

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<tr>
<th>COURSE CODE</th>
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<td>and ANTH 301</td>
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<td>BIOL 307</td>
<td>Biology of Organisms (4)</td>
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<td>BIOL 310</td>
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<tr>
<td>CHEM 306</td>
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<td>CHEM 309</td>
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<td>Physical Geography: Exploring Earth's Environmental Systems (3)</td>
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**Total Units:** 18

1 Courses used in A or B above will not count towards C, except units exceeding the 4 or 3 unit minimum in A and B. For example, a student completing the 5 unit CHEM 309 under B could apply 2 of those units towards C. A total of 18 science units is required.

The General Science Associate in Science (A.S.) degree may be obtained by completion of the required program, plus general education requirements, plus sufficient electives to meet a 60-unit total. See CRC graduation requirements.

**Student Learning Outcomes**

Upon completion of this program, the student will be able to:

- explain the core perspectives of the scientific method and apply it to at least one scientific discipline. (SLO 1)
- solve introductory problems of a conceptual and/or numerical nature of at least one scientific discipline. (SLO 2)
- accurately apply the basic vocabulary and concepts of at least one scientific discipline verbally and in writing. (SLO 3)
- recognize the use and misuse of scientific concepts in society including politics and the media. (SLO 4)
**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- **SLO #1: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES**
  - recognize types of matter, and explain macroscopic observations in terms of the basic properties and theories of matter
  - distinguish the three states of matter
  - apply the basic terminology and nomenclature of inorganic chemistry
  - relate the properties of the elements to their relative positions on the periodic table
  - develop a general knowledge of the atom with an understanding of electrons, protons, neutrons, and atomic orbitals, and how they relate to chemical bonding and structure
  - develop a basic knowledge of the concepts of chemical bonding and chemical reactivity
  - predict the geometric shape and structure of basic inorganic compounds
  - demonstrate an understanding of basic chemical equilibria, and use LeChatelier's Principle
  - predict solubility of ionic compounds, distinguish between soluble and insoluble compounds, and illustrate the effects of both solvent and solute properties on solubility
  - describe the colligative properties of solutions, qualitatively predicting their changes in freezing point, boiling point, vapor pressure, and osmotic pressure
  - recognize acids and bases and list their properties

- **SLO #2: SOLVE CHEMISTRY PROBLEMS AT AN APPROPRIATE LEVEL BY ANALYZING THE GIVEN DATA FOR ITS SIGNIFICANCE, BY FORMULATING A SOLUTION STRATEGY, AND BY EXPRESSING THE RESULTS IN PROPER FORMAT**
  - use calculators, tables of reference values, and mathematical manipulation to solve chemical problems, and express answers in both regular decimal formats and scientific notation
  - solve problems by dimensional analysis
  - write balanced chemical equations and perform stoichiometric calculations
  - apply chemical principles such as percent yield to predict expected outcomes of chemical reactions, including acid/base reactions, redox reactions, and precipitation reactions. Discuss actual versus expected yields, distinguishing potential sources of differences in percent yields
  - calculate the percent composition and determine the empirical and molecular formulas of compounds
  - solve chemical calculation problems that involve solids, solutions, or gases, clearly and logically; for example, calculate pressure or volume of a gas, solubility, solution concentrations, and results of titration
  - solve chemical calculation problems that involve solids, solutions, or gases, clearly and logically; for example, calculate pressure or volume of a gas, solubility, solution concentrations, and results of titration
  - organize large quantities of information in logical patterns
  - **SLO #3: COMMUNICATE EFFECTIVELY, BOTH ORALLY AND IN WRITING**
  - write a logical, complete setup for each chemical calculation, that details the method used
  - demonstrate proper collection and recording of scientific measurements, with the correct units and number of significant figures (i.e. measuring mass, volume, temperature, length, and pressure)
  - demonstrate the recording and evaluation of observations (physical and chemical changes and properties)
  - **SLO #4: WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES**
  - observe basic chemistry laboratory safety practices
  - apply both chemical deduction and scientific method to the solving of problems in a laboratory environment
  - demonstrate basic laboratory techniques, including following written directions from a laboratory manual, measuring, pipetting, graphing, titration, synthesis, writing observations of physical changes, writing observations of chemical changes, filtration, neutralization, qualitative analysis, calorimetry
  - apply an understanding of the importance of significant figures and appropriate measurement units to all chemical calculations based on laboratory-obtained data
  - calculate non-measured information based on that data, such as the concentration of an unknown solution, or the specific heat capacity of an unknown metal
  - draw sound conclusions from collected data and observations
  - analyze sources of experimental error
  - analyze individual and group data as well as scientific literature to determine the validity, precision and accuracy of results obtained from experimental data. Calculate percent error and perform statistical analyses including standard deviation
  - conclude laboratory experiments after receiving both written and verbal instructions, in a safe manner within time lines established by the instructor
  - **SLO #5: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY**
  - welcome constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate
  - acknowledge past and present contributors to the field of chemistry and credit another's idea and data with appropriate reference
CHEM 305 Introduction to Chemistry

Units: 5
Hours: 72 hours LEC; 54 hours LAB
Prerequisite: MATH 100 or 102 with a grade of "C" or better
Transferable: CSU; UC (1) CHEM 305, 306, 400, and 401 combined: maximum transfer credit is one series; 2) No transfer credit for CHEM 305 if taken after CHEM 400
General Education: AAAS Area IV; CSU Area B1; CSU Area B3; IGETC Area 5A; IGETC Area 5C
C-ID: CHEM 101
Catalog Date: January 1, 2021

This is a general chemistry course intended for students majoring in the allied health fields, such as nursing, physical therapy, dental hygiene, veterinary technology, and environmental technology. This course emphasizes the fundamental principles of chemistry: types of matter, physical and chemical processes, atomic and molecular structure, stoichiometry, properties and theories of gases, properties of solutions, acids and bases, equilibria, oxidation-reduction and an introduction to organic functional groups as they pertain to medicine or biological systems.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- **SLO #1: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES**
  - recognize types of matter, and explain macroscopic observations in terms of the basic properties and theories of matter
  - distinguish the three states of matter
  - apply the basic terminology and nomenclature of inorganic chemistry
  - recognize some basic functional groups in organic chemistry and write simple formulae
  - relate the properties of the elements to their relative positions on the periodic table
  - develop a general knowledge of the atom with an understanding of electrons, protons, neutrons, and atomic orbitals, and how they relate to chemical bonding and structure
  - develop a basic knowledge of the concepts of chemical bonding and chemical reactivity
  - predict the geometric shape and structure of basic inorganic and organic compounds
  - demonstrate an understanding of basic kinetics, and some elements of thermochemistry and equilibria
  - predict solubility of ionic compounds, distinguish between soluble and insoluble compounds, and illustrate the effects of both solvent and solute properties on solubility
  - describe the colligative properties of solutions, qualitatively predicting their changes in freezing point, boiling point, vapor pressure, and osmotic pressure
  - recognize acids and bases and list their properties
  - develop a basic understanding of nuclear chemistry and its applications in medicine
  - assess the importance and application of chemistry in Life Sciences and Allied Health

- **SLO #2: SOLVE CHEMISTRY PROBLEMS AT AN APPROPRIATE LEVEL BY ANALYZING THE GIVEN DATA FOR ITS SIGNIFICANCE, BY FORMULATING A SOLUTION STRATEGY, AND BY EXPRESSING THE RESULTS IN PROPER FORMAT**
  - solve problems by dimensional analysis
  - write balanced chemical equations and perform stoichiometric calculations
  - apply chemical principles such as percent yield to predict expected outcomes of chemical reactions, including acid/base reactions, redox reactions, and precipitation reactions. Discuss actual versus expected yields, distinguishing potential sources of differences in percent yields
  - solve chemical calculation problems that involve solids, solutions, or gases, clearly and logically; for example, calculate pressure or volume of a gas, solubility, solution concentrations, and results of titration
  - perform basic calculations involving heat energy transfers in physical changes or chemical reactions; for example, determine the calories transferred or specific heat capacity
  - organize large quantities of information in logical patterns
  - **SLO #3: COMMUNICATE EFFECTIVELY, BOTH ORALLY AND IN WRITING**
    - write a logical, complete setup for each chemical calculation, that details the method used
    - demonstrate proper collection and recording of scientific measurements, with the correct units and number of significant figures (i.e. measuring mass, volume, temperature, length, and pressure)
    - demonstrate the recording and evaluation of observations (physical and chemical changes and properties)
    - complete laboratory manual pages documenting work completed, evaluating data obtained, calculating further information based on that data, and deriving conclusions from that data
  - **SLO #4: WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.**
    - observe basic chemistry laboratory safety practices
    - apply both chemical deduction and scientific method to the solving of problems in a laboratory environment
    - demonstrate basic laboratory techniques, including following written directions, measuring, pipetting, titration, synthesis, writing observations of physical changes, writing observations of chemical changes, filtration, neutralization, qualitative analysis, calorimetry
    - apply an understanding of the importance of significant figures and appropriate measurement units to all chemical calculations based on laboratory-obtained data
    - calculate non-measured information based on that data, such as the concentration of an unknown solution, or the specific heat capacity of an unknown metal
    - draw sound conclusions from collected data and observations
    - analyze sources of experimental error
    - analyze individual and group data as well as scientific literature to determine the validity, precision and accuracy of results obtained from experimental data
    - conclude laboratory experiments after receiving both written and verbal instructions, in a safe manner within time lines established by the instructor
  - **SLO #5: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY**
    - welcome constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate
    - acknowledge past and present contributors to the field of chemistry and credit another's idea and data with appropriate reference
The organic chemistry portion of this course emphasizes the major classes of organic compounds: their structure, physical and chemical properties related to biological systems, and nomenclature. Some clinical and pharmacological aspects are also discussed. The biochemistry portion of this course emphasizes the structure and function of carbohydrates, proteins, and lipids in biological systems. Special topics include enzymes and enzyme regulation, drugs their bioavailability and metabolism.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- **SLO #1: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES OF ORGANIC MOLECULES.**
  - identify, name, draw and build structures of organic compounds including hydrocarbons, alcohols, organic acids, esters, amines, and amides
  - defend predicted physical properties of hydrocarbons, alcohols, organic acids, esters, amines, and amides based on their chemical structure
  - classify reactions involving hydrocarbons, alcohols, organic acids, esters, amines, and amides
  - predict products from reactions involving hydrocarbons, alcohols, organic acids, esters, amines, and amides

- **SLO #2: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL BIOCHEMICAL PRINCIPLES AND PROCESSES**
  - distinguish important carbohydrates, amino acids, lipids and nucleic acids by name and structure.
  - compare the structure, function, and uses of important carbohydrates, lipids, proteins, and nucleic acids.
  - describe the process of digestion and metabolism of proteins, carbohydrates, and lipids.
  - describe the process by which energy is generated from carbohydrates, proteins, and lipids.
  - explain the role of enzymes in biochemical processes, and describe how they perform those roles.

- **SLO #3 - APPLY BASIC CONCEPTS OF MODERN ORGANIC CHEMISTRY TO EXPLAIN BIOCHEMICAL PROCESSES AND MECHANISMS.**
  - apply concepts learned in the organic chemistry portion of the course to proteins, carbohydrates, lipids, and nucleic acids.
  - predict physical properties of biochemical molecules based on their functional groups and intermolecular attractions
  - explain the role of group functionality in enzyme function and regulation.
  - describe how functional groups and solubility affect drug bioavailability and metabolism
  - compare the physical and chemical properties of carbohydrates, lipids, proteins, enzymes, and nucleic acids
  - describe how functional groups and solubility affect drug bioavailability and metabolism

- **SLO #4: WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.**
  - conduct and follow the laboratory safety protocols and practice chemical safety based on MSDS.
  - demonstrate proper laboratory techniques
  - synthesize classes of organic compounds
  - determine physical and chemical properties of classes of organic compounds
  - determine physical and chemical properties of proteins and amino acids
  - SLO #5: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY
  - process constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate.
  - recognize and acknowledge past and present contributors to the field of chemistry.
  - reference others on their original ideas with proper credit in student's submitted work.

CHEM 309 Integrated General, Organic, and Biological Chemistry

This course is an intensive survey of general, organic, and biological chemistry specifically designed for nursing majors and other health-related fields. Topics include general chemistry, organic chemistry, and biological chemistry. This course satisfies the requirements of those health-career programs that require one semester of chemistry. Students who had chemistry in high school and retained some of it are advised to take CHEM 309. Students who have not taken a chemistry course recently or have never taken a chemistry course are advised to take the CHEM 305 and CHEM 306 sequence.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- **SLO #1: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES**
  - analyze the fundamental features of chemistry including measurement of physical properties such as mass, volume, density, pressure, temperature, and solutions
  - differentiate between functional groups when they appear in biological molecules and relate their functional groups to the physical and chemical properties of the biological molecules
  - differentiate between physical and chemical properties of matter
  - name and write chemical formulæ of cations, anions, inorganic compounds, and organic compounds

- **SLO #2: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL BIOCHEMICAL PRINCIPLES AND PROCESSES**
  - describe the structure, function, and uses of important carbohydrates, lipids, proteins, and nucleic acids
  - compare the physical and chemical properties of carbohydrates, lipids, proteins, enzymes, and nucleic acids
  - describe how functional groups and solubility affect drug bioavailability and metabolism

- **SLO #3 - APPLY BASIC CONCEPTS OF MODERN ORGANIC CHEMISTRY TO EXPLAIN BIOCHEMICAL PROCESSES AND MECHANISMS.**
  - apply concepts learned in the organic chemistry portion of the course to proteins, carbohydrates, lipids, and nucleic acids.
  - predict physical properties of biochemical molecules based on their functional groups and intermolecular attractions
  - explain the role of group functionality in enzyme function and regulation.
  - describe how functional groups and solubility affect drug bioavailability and metabolism
  - compare the physical and chemical properties of carbohydrates, lipids, proteins, enzymes, and nucleic acids
  - describe how functional groups and solubility affect drug bioavailability and metabolism

- **SLO #4: WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.**
  - conduct and follow the laboratory safety protocols and practice chemical safety based on MSDS.
  - demonstrate proper laboratory techniques
  - synthesize classes of organic compounds
  - determine physical and chemical properties of classes of organic compounds
  - determine physical and chemical properties of proteins and amino acids
  - SLO #5: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY
  - process constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate.
  - recognize and acknowledge past and present contributors to the field of chemistry.
  - reference others on their original ideas with proper credit in student's submitted work.
● differentiate typical acid and base formulae and compare the behaviors associated with acids and bases
● SLO #2: SOLVE CHEMISTRY PROBLEMS AT AN APPROPRIATE LEVEL BY ANALYZING THE GIVEN DATA FOR ITS SIGNIFICANCE, BY FORMULATING A SOLUTION STRATEGY, AND BY EXPRESSING THE RESULTS IN PROPER FORMAT
● apply the concept of unit analysis towards concentration, dilution, and medical dosage calculation
● describe intermolecular forces and apply them to the understanding of basic principles of biochemistry and physical characteristics of organic compounds
● apply LeChatelier's equilibrium principles to the understanding of blood buffers
● distinguish among various functions of four major classes of biomolecules in living cells
● compare the processes of DNA replication, transcription, and translation
● compare major biochemical components in catabolic pathways for carbohydrates, triglycerides, and proteins and compare the output from those processes.
● SLO #3: COMMUNICATE EFFECTIVELY, BOTH ORALLY AND IN WRITING
● write a logical, complete setup for each chemical calculation, that details the method used demonstrate proper collection and recording of scientific measurements with the correct units (i.e. measuring mass, volume, temperature, length, and pressure)
● complete laboratory manual pages documenting work completed, evaluating data obtained, calculating further information based on that data, and deriving conclusions from that data
● demonstrate the recording and evaluation of observations (physical and chemical changes and properties)
● SLO #4: WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.
● observe basic chemistry laboratory safety practices based on MSDS
● demonstrate proper laboratory techniques: apply both chemical deduction and scientific method to the solving of problems in a laboratory environment including following written directions, measuring, synthesizing, writing observations and appropriate measurement units to all chemical calculations based on laboratory-obtained data
● calculate non-measured information based on that data, such as the concentration of an unknown solution draw sound conclusions from collected data and observations analyze sources of experimental error
● analyze individual and group data as well as scientific literature to determine the validity, precision and accuracy of results obtained from experimental data
● SLO #5: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY.
● welcome constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate
● acknowledge past and present contributors to the field of chemistry and credit another's idea and data with appropriate reference

CHEM 321 Environmental Chemistry

Units: 3
Hours: 54 hours LEC
Prerequisite: None.
Transferable: CSU; UC
General Education: AA/AS Area IV; CSU Area B1; IGETC Area 5A
Catalog Date: January 1, 2021

This course explores the interrelationship of human beings and the surrounding environment with regard to the chemical substances that are encountered in everyday life. The role of chemistry in both creating environmental problems as well as providing solutions to environmental problems will be examined. Students will learn how chemicals released to the environment can have adverse effects on ecosystems and human health. Chemical and physical methods of controlling and remediating air, water, and soil pollutants will be covered. The role of environmental regulations in preventing and mitigating environmental degradation will also be covered. By the completion of this course, students will have acquired skills and techniques that can be utilized to examine environmental problems and their proposed solutions.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

● SLO #1: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES
● describe the structure of the atom and how electrons, protons, and neutrons relate to chemical binding and structure.
● demonstrate the ability to recognize acids and bases and their properties.
● evaluate environmental processes from the perspective of basic chemical principles of matter and energy.
● analyze how chemical and physical properties affect pollutant behavior in the environment.
● SLO #2: SOLVE CHEMISTRY PROBLEMS AT AN APPROPRIATE LEVEL BY ANALYZING THE GIVEN DATA FOR ITS SIGNIFICANCE, BY FORMULATING A SOLUTION STRATEGY, AND BY EXPRESSING THE RESULTS IN PROPER FORMAT.
● write balanced chemical equations and perform stoichiometric calculations
● identify the sources of air, water, and soil pollution.
● apply basic chemical principles in the interpretation and analysis of a Material Safety Data Sheet, Department of Transportation Guidebooks, and basic toxicological reference materials.
● design pollution control and remediation systems based on chemical and physical principles.
● describe the function of environmental laws and regulations in protecting and cleaning up the environment.
● SLO #3: COMMUNICATE EFFECTIVELY, BOTH ORALLY AND IN WRITING
● write a concise report on an effective solution to an air, water or soil pollution issue
● prepare and present an oral presentation on a remediation process
● SLO #4: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY
● process constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate.
● acknowledge past and present contributors to the field of chemistry and credit other's idea and data with appropriate reference.

CHEM 322 Environmental Chemistry Laboratory

Units: 1
This course provides "hands-on" opportunities for students to collect and analyze data about chemicals found in the environment. Students will learn how to collect and analyze soil, water and air samples for environmental quality parameters and the presence of pollutants. Analysis of samples will involve the use of readily available field test equipment. Field trips for sample collection will take place during laboratory periods or at arranged times. There may also be field trips to environmental analytical laboratories.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- **SLO #1:** SOLVE CHEMISTRY PROBLEMS AT AN APPROPRIATE LEVEL BY ANALYZING THE GIVEN DATA FOR ITS SIGNIFICANCE, BY FORMULATING A SOLUTION STRATEGY, AND BY EXPRESSING THE RESULTS IN PROPER FORMAT.
- **SLO #2:** WORK SAFELY IN A LABORATORY OR FIELD ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.
- **SLO #3:** COMMUNICATE EFFECTIVELY, BOTH ORALLY AND IN WRITING
- **SLO #4:** CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES
- **SLO #5:** WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.

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**CHEM 400 General Chemistry I**

This is a general college chemistry course intended for students majoring in the scientific disciplines including chemistry, biology, physics, geology and engineering. This course emphasizes the fundamental principles of chemistry. Topics include chemical measurement, physical and chemical processes, nomenclature, atomic structure, quantum theory, stoichiometry, molecular structure, bonding theory, physical properties of gases, thermochemistry, modern materials, and properties of solutions.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- **SLO #1:** CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES
- **SLO #2:** SOLVE CHEMISTRY PROBLEMS AT AN APPROPRIATE LEVEL BY ANALYZING THE GIVEN DATA FOR ITS SIGNIFICANCE, BY FORMULATING A SOLUTION STRATEGY, AND BY EXPRESSING THE RESULTS IN PROPER FORMAT.
- **SLO #3:** COMMUNICATE EFFECTIVELY, BOTH ORALLY AND IN WRITING
- **SLO #4:** WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.

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**EXPERIMENTAL OUTCOMES.**

**SLO #4:** WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.
• demonstrate basic chemistry laboratory techniques and safety practices
• synthesize data into computer generated graphical outputs, and make predictions by interpolation, using linear and non-linear regression analyses.
• evaluate errors related to experimental procedures, and assess their effects on experimental results.
• demonstrate understanding of the importance of significant figures, use of correct units of measurement, and proper application of basic calculations of stoichiometry and thermochemistry as they apply to laboratory experiments.
• successfully analyze individual and group data as well as scientific literature to determine the validity, precision and accuracy of results obtained from experimental data.
• successfully conclude laboratory experiments after receiving both written and verbal instructions, in a safe manner within time lines established by the instructor.
• design experimental procedures, execute the designed experiments, assess the data obtained, formulate hypotheses to categorize and correlate data obtained, and identify critical factors affecting results obtained from the experimental work.
• SLO #5: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY
  - process constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate.
  - recognize and acknowledge past and present contributors the field of chemistry and credit other’s ideas and data with appropriate reference.

CHEM 401 General Chemistry II

Upon completion of this course, the student will be able to:

- SLO #1: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES.
- SLO #2: SOLVE CHEMISTRY PROBLEMS AT AN APPROPRIATE LEVEL BY ANALYZING THE GIVEN DATA FOR ITS SIGNIFICANCE, BY FORMULATING A SOLUTION STRATEGY, AND BY EXPRESSING THE RESULTS IN PROPER FORMAT.
- SLO #3: COMMUNICATE EFFECTIVELY, BOTH ORALLY AND IN WRITING
  - demonstrate the proper collection and recording of scientific measurements in tables with the correct units and number of significant figures (i.e. measuring mass, volume, temperature, length, and pressure), and the recording and evaluation of observations (physical and chemical changes and properties).
  - prepare a written lab notebook documenting work completed, evaluating data obtained, and analyzing conclusions derived from that data, by means of calculated results, data tables and both hand generated and computer generated graphs.
  - SLO #4: WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.
  - demonstrate basic chemistry laboratory techniques and safety practices
  - synthesize data into computer generated graphical outputs, and make predictions by interpolation, using linear and non-linear regression analyses.
  - evaluate errors related to experimental procedures, and assess their effects on experimental results.
  - demonstrate understanding of the importance of significant figures, use of correct units of measurement, and proper application of basic calculations of kinetics, equilibrium, thermochemistry, and electrochemistry as they apply to laboratory experiments.
  - justify the identity of unknown cations and anions using experimental evidence from qualitative analysis, the scientific method, and chemical reasoning.
  - analyze individual and group data as well as scientific literature successfully to determine the validity, precision and accuracy of results obtained from experimental data.
  - conduct and successfully conclude laboratory experiments after receiving both written and verbal instructions, in a safe manner within time lines established by the instructor.
  - design experimental procedures, execute the designed experiments, assess the data obtained, formulate hypotheses to categorize and correlate data obtained, and identify critical factors affecting results obtained from the experimental work.
  - SLO #5: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY
  - process constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate.
  - recognize and acknowledge past and present contributors the field of chemistry and credit other’s ideas and data with appropriate reference.

CHEM 420 Organic Chemistry I

This course surveys the principles of organic chemistry intended for chemistry and biological science majors or those students interested in the medical and related professions. Units covered include chemistry of alkanes/cycloalkanes, alkenes, alkyl halides, alcohols with emphasis on physical and chemical properties, nomenclature, stereochemistry, reaction mechanisms (SN1, SN2, E1, and E2) and spectroscopy (FT-IR and MS). Laboratory work includes characterization of organic molecules using analytical instrumentation such as FTIR, GC, and
GC/MS. Modern separation and purification techniques are also introduced such as HPLC, Packed-column GC, and Capillary GC, as well as traditional techniques such as distillation, liquid-liquid extraction, recrystallization, column chromatography, and thin-layer chromatography.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- **SLO #1**: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES OF ORGANIC MOLECULES.
  - name saturated and unsaturated hydrocarbons, alkyl halides and alcohols.
  - analyze the relationship between the molecular structure of an organic molecule and its physical properties and chemical reactivity.
  - classify 3-D structures of organic molecules in their chiralitys, optical activity and correct isomeric classifications.
  - explain the fundamental concepts of polar covalent bond, resonance structure, steric effect, electronegativity, and inductive effect.

- **SLO #2**: APPLY BASIC CONCEPTS OF THE MODERN ORGANIC CHEMISTRY AND SPECTROSCOPY TO EXPLAIN ORGANIC REACTIONS AND MECHANISMS.
  - analyze reaction mechanisms to predict products of organic chemistry reactions.
  - propose reaction mechanisms for common organic chemistry reactions including SN1, SN2, E1, E2, and electrophilic addition reactions.
  - propose a chemical structure based on given chemical and spectroscopic information: molecular formula, IR spectrum, and mass spectrum.
  - provide reasons for favored products based on kinetic and thermodynamic preference.

- **SLO #3**: SOLVE CHEMISTRY PROBLEMS AT AN APPROPRIATE LEVEL BY ANALYZING THE GIVEN DATA FOR ITS SIGNIFICANCE, BY FORMULATING A SOLUTION STRATEGY, AND BY EXPRESSING THE RESULTS IN PROPER FORMAT.
  - design single and multi-step organic synthesis.
  - analyze organic reactions via retro-synthesis.
  - identify oxidative and reductive reactions.
  - propose plausible reaction mechanisms with major and minor products for given reactants and reaction conditions.
  - identify necessary reagents for regioselective synthesis.

- **SLO #4**: WORK SAFELY IN A LABORATORY ENVIRONMENT, APPLY AND EVALUATE SCIENTIFIC METHODS FOR ASSEMBLING EXPERIMENTS, COLLECTING DATA, AND INTERPRETING EXPERIMENTAL OUTCOMES.
  - conduct and follow the laboratory safety protocols and practice chemical safety based on MSDS.
  - perform laboratory techniques such as liquid extraction and partition, synthesis, purification using both macro- and micro-scale procedures.
  - prepare a structured laboratory notebook.
  - perform basic spectral data collection (FT-IR and MS).
  - perform basic sample analysis using Column Chromatography, TLC, GC, GC/MS and HPLC.
  - analyze and interpret experimental data and apply statistics to express results.
  - prepare and present formal oral report on an experiment.
  - prepare written laboratory report and cite relevant literature reference.

- **SLO #5**: APPLY PRINCIPLES OF SCIENTIFIC ETHICS AND ACADEMIC INTEGRITY.
  - process constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate.
  - recognize and acknowledge past and present contributors to the field of chemistry.
  - reference others on their original ideas with proper credit in student's submitted work.

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**CHEM 421 Organic Chemistry II**

**Units:** 5  
**Hours:** 54 hours LEC; 108 hours LAB  
**Prerequisites:** CHEM 420 with a grade of “C” or better  
**Transferable:** CSU, UC  
**General Education:** CSU Area B1; CSU Area B3; IGETC Area 5A; IGETC Area 5C  
**C-ID:** Part of C-ID CHEM 160S  
**Catalog Date:** January 1, 2021

This course is a continuation of CHEM 420. Units covered include an in-depth study of the physical and chemical properties of aromatic compounds, aldehydes, ketones, amines, carboxylic acids and its derivatives. A special emphasis is placed on structural analysis/elucidation of these compounds by the various spectroscopic techniques. In addition, an introduction to pericyclic reactions and biomolecules is presented.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- **SLO #1**: CONCEPTUALIZE, MODEL, AND EXPLAIN FUNDAMENTAL CHEMICAL PRINCIPLES AND PROCESSES OF ORGANIC MOLECULES.
  - recognize and identify nomenclatures of aromatics, aldehydes, ketones, amines, carboxylic acids and their derivatives.
  - analyze the relationship between the molecular structure of an organic molecule and its physical properties and chemical reactivity.
  - explain the fundamental concepts of conjugated alkenes, aromaticity, carbonyl groups involving nucleophilic addition and nucleophilic acyl substitution.

- **SLO #2**: APPLY BASIC CONCEPTS OF THE MODERN ORGANIC CHEMISTRY AND SPECTROSCOPY TO EXPLAIN ORGANIC REACTIONS AND MECHANISMS.
  - analyze reaction mechanisms to predict major products of organic chemistry reactions.
  - propose reactions mechanisms for common organic chemistry reactions including electrophilic aromatic substitution, nucleophilic addition to carbonyl groups, and nucleophilic acyl substitution.
  - propose a chemical structure based on given chemical and spectroscopic information: molecular formula, IR spectrum, mass spectrum, UV-Vis spectrum and 1H and 13C – NMR spectrum.
  - Describe reasons for favored products based on kinetic and thermodynamic preference.
- SLO #3: Solve chemistry problems at an appropriate level by analyzing the given data for its significance, by formulating a solution strategy, and by expressing the results in proper format.
  - Design multi-step organic synthesis.
  - Analyze organic reactions via retro-synthesis.
  - Propose plausible reaction mechanisms with major and minor products for given reactants and reaction conditions.
- SLO #4: Work safely in a laboratory environment, apply and evaluate scientific methods for assembling experiments, collecting data, and interpreting experimental outcomes.
  - Demonstrate basic chemistry laboratory techniques and safety practices.
  - Perform laboratory techniques such as liquid extraction and partition, synthesis, purification using both macro- and micro-scale procedures.
  - Prepare a structured laboratory notebook.
  - Perform basic spectral data collection (FT-IR and NMR).
  - Perform basic sample analysis using column chromatography, TLC, GC, GC/MS and HPLC.
  - Analyze and interpret experimental data and apply statistics to express results.
  - Apply statistics to express experimental results.
  - Prepare and present formal oral report on an experiment.
  - Prepare written laboratory report and cite relevant literature reference.
- SLO #5: Apply principles of scientific ethics and academic integrity.
  - Evaluate constructive criticism of submitted work and offer the same to other individuals in a manner that fosters mutual respect amid objective scientific debate.
  - Acknowledge past and present contributors to the field of chemistry.
  - Cite others on their original ideas with proper credit in student's submitted work.

CHEM 495 Independent Studies in Chemistry

**Units:** 1 - 3  
**Hours:** 54 - 162 hours LAB  
**Prerequisite:** None.  
**Transferable:** CSU  
**Catalog Date:** January 1, 2021

An independent studies project involves an individual student or small group of students in study, research, or activities beyond the scope of regularly offered courses. See the current catalog section of "Special Studies" for full details of Independent Studies.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- **SLO #1:** Actively engage in intellectual inquiry beyond that required in order to pass a course of study (College Wide Learning Outcome – Area 4).
  - Discuss and outline a proposal of study (that can be accomplished within one semester term) with a supervising instructor qualified within the discipline.
  - Design an independent study (to be completed individually or by collaboration of a small group) to foster special knowledge, skills, and experience that are not available in any one regularly scheduled course.
  - Use information resources to gather discipline-specific information.

- **SLO #2:** Utilize modes of analysis and critical thinking to apply theoretical perspectives and/or concepts in the major discipline of study to significant problems and/or educational activities (College Wide Learning Outcome – Area 3).
  - Analyze and apply the knowledge, skills and experience that are involved in the independent study to theoretical perspectives and/or concepts in the major discipline of study.
  - Explain the importance of the major discipline of study in the broader picture of society.

- **SLO #3:** Communicate a complex understanding of the major discipline of study (College Wide Outcome – Area 3).
  - Demonstrate competence in the skills essential to mastery of the major discipline of study that are necessary to accomplish the independent study.
  - Identify personal goals and pursue these goals effectively (College Wide Outcome – Area 4).
  - Utilize skills from the "academic tool kit" including time management, study skills, etc., to accomplish the independent study within one semester term.

CHEM 498 Work Experience in Chemistry

**Units:** 1 - 4  
**Hours:** 60 - 300 hours LAB  
**Prerequisite:** None.  
**Transferable:** CSU  
**General Education:** AAAS Area III(b)  
**Catalog Date:** January 1, 2021

This course provides students with opportunities to develop marketable skills in preparation for employment in their major field of study or advancement within their career. It is designed for students interested in work experience and/or internships in transfer level degree occupational programs. Course content includes understanding the application of education to the workforce; completion of required forms which document the student's progress and hours spent at the work site; and developing workplace skills and competencies. Appropriate level learning objectives are established by the student and employer. During the semester, the student is required to participate in a weekly orientation and 75 hours of related paid work experience, or 60 hours of unpaid work experience for one unit. An additional 75 or 60 hours of related work experience is required for each additional unit. Work Experience may be taken for a total of 16 units when there are new or expanded learning objectives. Only one Work Experience course may be taken per semester.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- SLO #1: Actively engage in intellectual inquiry beyond that required in order to pass a course of study (College Wide Learning Outcome – Area 4).
  - Discuss and outline a proposal of study (that can be accomplished within one semester term) with a supervising instructor qualified within the discipline.
  - Design an independent study (to be completed individually or by collaboration of a small group) to foster special knowledge, skills, and experience that are not available in any one regularly scheduled course.
  - Use information resources to gather discipline-specific information.

- SLO #2: Utilize modes of analysis and critical thinking to apply theoretical perspectives and/or concepts in the major discipline of study to significant problems and/or educational activities (College Wide Learning Outcome – Area 3).
  - Analyze and apply the knowledge, skills and experience that are involved in the independent study to theoretical perspectives and/or concepts in the major discipline of study.
  - Explain the importance of the major discipline of study in the broader picture of society.

- SLO #3: Communicate a complex understanding of the major discipline of study (College Wide Outcome – Area 3).
  - Demonstrate competence in the skills essential to mastery of the major discipline of study that are necessary to accomplish the independent study.
  - Identify personal goals and pursue these goals effectively (College Wide Outcome – Area 4).
  - Utilize skills from the "academic tool kit" including time management, study skills, etc., to accomplish the independent study within one semester term.
DEMONSTRATE AN UNDERSTANDING AND APPLICATION OF PROFESSIONAL WORKPLACE BEHAVIOR IN A FIELD OF STUDY RELATED TO ONE'S CAREER (SLO 1)
- Understand the effects time, stress, and organizational management have on performance.
- Demonstrate an understanding of consistently practicing ethics and confidentiality in a workplace.
- Examine the career/life planning process and relate its relevancy to the student.
- Demonstrate an understanding of basic communication tools and their appropriate use.
- Demonstrate an understanding of workplace etiquette.
- DESCRIBE THE CAREER/LIFE PLANNING PROCESS AND RELATE ITS RELEVANCY TO ONE'S CAREER (SLO 2)
- Link personal goals to long term achievement.
- Display an understanding of creating a professional first impression.
- Understand how networking is a powerful job search tool.
- Understand necessary elements of a résumé.
- Understand the importance of interview preparation.
- Identify how continual learning increases career success.
- DEMONSTRATE APPLICATION OF INDUSTRY KNOWLEDGE AND THEORETICAL CONCEPTS AS WRITTEN IN LEARNING OBJECTIVES IN PARTNERSHIP WITH THE EMPLOYER WORK SITE SUPERVISOR (SLO 3)

CHEM 499 Experimental Offering in Chemistry

**Units:** 0.5 - 4  
**Prerequisite:** None.  
**Transferable:** CSU  
**Catalog Date:** January 1, 2021

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