CHEM 12CL: ORGANIC CHEMISTRY LABORATORY

Foothill College Course Outline of Record

Heading	Value
Units:	2
Hours:	6 laboratory per week (72 total per quarter)
Prerequisite:	CHEM 12BL or 13BH.
Corequisite:	Completion of or concurrent enrollment in CHEM 12C.
Advisory:	Not open to students with credit in CHEM 13CH.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade Only
Repeatability:	Not Repeatable

Student Learning Outcomes

- Interpret experimental data through application of theoretical models
- Safely handle Organic Chemicals
- Gain skill with common synthetic chemistry techniques

Description

Laboratory course to accompany CHEM 12C. Intended to strengthen skill in application of laboratory techniques, and to encourage independent work. Emphasis is on chemical reactions relevant to CHEM 12C, multi-step syntheses, and identification of unknowns.

Course Objectives

The student will be able to:
A. Safely handle and dispose of hazardous organic chemicals
B. Acquire skill in laboratory techniques common to experimental organic chemistry
C. Acquire and interpret spectroscopic data, including NMR, IR, and GC-MS
D. Provide a rationale for each step in an experimental design
E. Analyze data to discern the validity of a hypothesis
F. Communicate clearly using the language of organic chemistry
G. Work constructively and collaboratively in groups

Course Content

A. Safely handle and dispose of hazardous organic chemicals
1. Research the Material Safety Data Sheets of chemicals
2. Categorize chemicals according to their compatibility
B. Acquire skill in laboratory techniques common to experimental organic chemistry. Representative projects may include the following or an alternative of equal complexity:
1. α,β-unsaturated ketones via aldol condensation using unknown aldehydes and ketones
2. Ester synthesis via Fischer esterification of unknown alcohols
3. Amine synthesis via selective reduction of 4-nitroacetophenone
4. Multi-step synthesis: formation of hydrobenzoin acetonide from benzaldehyde
5. Qualitative analysis of unknowns by chemical diagnostic testing
C. Acquire and interpret spectroscopic data, including NMR, IR, and GC-MS
1. Routine acquisition of 1H NMR and IR spectra following isolation of organic products
2. Analysis of 1H NMR data. Applications may include but are not limited to:
a. Acquisition of 13C NMR of organic unknowns
b. Utilizing 1H NMR spectra to determine equilibrium constants between acetate esters and their associated alcohols
c. Analyze GC-MS data of a general organic unknown to confirm its identity
D. Provide a rationale for each step in an experimental design
1. Independent strategic planning of experimental procedures
2. Evaluate procedural steps to identify consequences of errors and to propose alternative approaches
E. Analyze data to discern the validity of a hypothesis
1. Determine the stereoselectivity of a reaction through NMR analysis following derivative formation as in borohydride reduction of hydrobenzoin under conditions of kinetic control
2. Formulate a strategy to deduce the identity of an unknown organic compound based on its properties and chemical reactivity alone
F. Communicate clearly using the language of organic chemistry
1. Maintain complete and accurate records of experimental data and observations
2. Prepare written laboratory reports
3. Research and present chemical safety and handling precautions (SDS reports)

Lab Content

A. Safely handle and dispose of hazardous organic chemicals
1. Research the Material Safety Data Sheets of chemicals
2. Categorize chemicals according to their compatibility
B. Acquire skill in laboratory techniques common to experimental organic chemistry. Representative projects may include the following or an alternative of equal complexity:
1. α,β-unsaturated ketones via aldol condensation using unknown aldehydes and ketones
2. Ester synthesis via Fischer esterification of unknown alcohols
3. Amine synthesis via selective reduction of 4-nitroacetophenone
4. Multi-step synthesis: formation of hydrobenzoin acetonide from benzaldehyde
5. Qualitative analysis of unknowns by chemical diagnostic testing
C. Acquire and interpret spectroscopic data, including NMR, IR, and GC-MS
1. Routine acquisition of 1H NMR and IR spectra following isolation of organic products
2. Analysis of 1H NMR data. Applications may include but are not limited to:
a. Acquisition of 13C NMR of organic unknowns
b. Utilizing 1H NMR spectra to determine equilibrium constants between acetate esters and their associated alcohols
c. Analyze GC-MS data of a general organic unknown to confirm its identity
D. Provide a rationale for each step in an experimental design
1. Independent strategic planning of experimental procedures
2. Evaluate procedural steps to identify consequences of errors and to propose alternative approaches
E. Analyze data to discern the validity of a hypothesis

1. Determine the stereoselectivity of a reaction through NMR analysis following derivative formation as in borohydride reduction of hydrobenzoin under conditions of kinetic control
2. Formulate a strategy to deduce the identity of an unknown organic compound based on its properties and chemical reactivity alone
F. Communicate clearly using the language of organic chemistry
1. Maintain complete and accurate records of experimental data and observations
2. Prepare written laboratory reports
3. Research and present chemical safety and handling precautions (SDS reports)

Special Facilities and/or Equipment

A. Chemistry laboratory with adequate chemicals and equipment for conducting the prescribed course.
B. Each student is issued a laboratory bench locker containing specialized glassware and equipment for both mini and microscale organic synthesis.
C. Instrumentation maintained for shared routine use includes analytic balances, melting point apparatus, polarimeters, gas chromatographs, UV-Visible spectrophotometers, FTIR spectrophotometers, and 1H/Multinuclear 60 MHz FT-NMR, and a gas chromatograph-mass spectrometer (GC-MS).

Method(s) of Evaluation

The student will demonstrate proficiency by:
A. Writing laboratory reports
B. Demonstrating skill in safe handling of organic chemicals
C. Written examination on course content
D. Presenting research into chemical hazards
E. Presenting solutions to problems

Method(s) of Instruction

During periods of instruction the student will be:
A. Actively participating in lecture/discussion
B. Collaborating with peers in group work

Representative Text(s) and Other Materials

Mohrig, Jerry R. Laboratory Techniques in Organic Chemistry: Supporting Inquiry-driven Experiments. New York, NY: W.H. Freeman, 2014.

Pavia, D., G. Kriz, and G. Lampman. A Microscale Approach to Organic Laboratory Techniques. Boston, MA: Cengage Learning, 2018.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

A. Written preliminary analysis of experimental procedure

B. Data analysis to draw conclusions about a chemical reaction

C. Laboratory reports: A logical, concise discussion of data that is analyzed to draw a conclusion about the purpose of the experiment

Discipline(s)

Chemistry