CHEM161

Organic Chemistry I

3 Credits

Instructor: Dr. Raymond Anana
Phone: 780 871 5765
Original Developer: Kingsley Donkor
Current Developer: Dr. Raymond Anana
Reviewer: Dr. Robert Cuny

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2602 - 59 Avenue, Lloydminster, Alberta, Canada T9V 3N7. Ph: 780 871 5700
5707 College Drive, Vermilion, Alberta, Canada T9X 1K5. Ph: 780 853 8400
Toll-free in Canada: 1 800 661 6490

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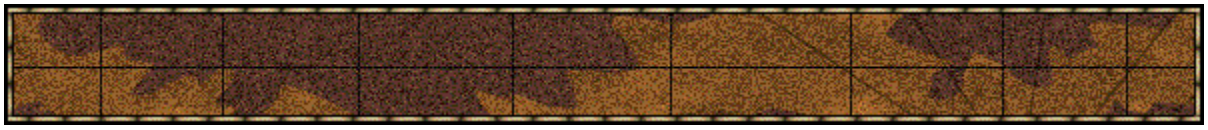

Organic Chemistry I

Calendar Description

The study of basic molecular structure and reactivity of organic compounds based on their functional groups. Introduction to nomenclature, three dimensional structure, physical properties, and reactivity of compounds of carbon. Functional groups covered will emphasize alkanes, alkenes, alkynes, alkyl halides, alcohols, and some aromatics. Examples will include hydrocarbons (petroleum products), halogenated organic compounds (e.g. pesticides), and polymers of industrial importance which may be found in everyday life.

Rationale

Organic chemistry is the study of the compounds of carbon. The compounds of carbon constitute the central chemicals of all living things on this planet. Essentially all chemical reactions that take place in living systems, including our own bodies, are organic reactions because the molecules of life - proteins, enzymes, vitamins, lipids, carbohydrates, and nucleic acids - all contain carbon. Together with the air we breathe, carbon-containing compounds in our diets furnish the energy that sustains life.

Chemistry 161 provides the fundamentals of organic chemistry required by students intending to pursue careers in pure science, in the health professions, in agriculture, in environmental sciences, and in pharmacy. Even for those who do not plan a career in any of the sciences, a study of organic chemistry is important. We live in an age of technology that is made possible in large part by applications of organic chemistry to industries as diverse as plastics, textiles, pharmaceuticals, communications, transportation, and agriculture.

Prerequisites

Chemistry 30 or equivalent

Co-Requisites

None

Course Learning Outcomes

Upon successful completion of this course, students will be able to

1. describe chemical behaviours of different functional groups in carbon-containing compounds.
2. outline the essential steps in a possible laboratory synthesis of an organic compound from an available starting material.
3. predict the type of chemical reaction between two compounds.
4. demonstrate the skills necessary for doing experiments in an organic laboratory.
5. determine the stereochemistry or absolute configuration of organic compounds.

Resource Materials

Required Text:

McMurry, J. (2015). *Organic Chemistry* (9th ed.). Pacific Grove, CA: Brooks/Cole.

McMurry, S. (2015). *Study guide and solution manual for organic chemistry* (9th ed.). Pacific Grove, CA: Brooks/Cole.

Williamson, K. L., Masters, K. M. (2017). *Macroscale and Microscale Organic Experiments* (7th ed.). Belmont, CA: Brooks/Cole.

Reference Text:

None

Conduct of Course

This is a 3 credit course with 3 hours of lecture and 3 hours of lab per week. (3-0-3).

Chemistry 161 students will attend lectures, participate in discussion and run experiments in the laboratory. The class meets for a total of 3 hours (lecture/discussion) per week. If necessary, an additional hour may be scheduled for discussion. The class also meets once a week for a three hour laboratory.

Students will be asked to do assignments and end-of-chapter problems as homework. The aim is to give students more practice to enhance their skills in problem solving, that is so essential to doing well in this course. The results will contribute to the final grade. In this regard, the Solutions Manual can also be of real benefit. It provides detailed solutions to all the end-of-chapter problems using the strategies emphasized in the textbook. It is highly recommended that students purchase their own copies of the Solutions Manual from the College Bookstore.

Laboratory

The laboratory sessions are once a week (3 hours). Students are required to study the theoretical as well as the experimental procedures of every experiment before coming to the lab. Occasionally a quiz will be given at the start of the lab. The Lab report (including end-of chapter problems) must be written and handed in to the instructor within two days of completion of the experiment. For example, a lab that is done on Monday must be handed in by Wednesday before 4:30 pm.

In order to eliminate accidents in the laboratory, students are required to read and obey the rules of safety as contained in the hand-out on laboratory safety and the Macroscale and Microscale Organic Experiments by Williamson. The chemistry laboratory is a potentially dangerous place if students fail to observe safety precautions. Every student must wear a pair of safety glasses (provided during lab sessions) and Lab coats (that can be purchased from the College Bookstore). Contact lenses are not a substitute for safety glasses and are particularly dangerous if a chemical gets in the eye. Prescription glasses are acceptable if used with side guards.

Federal and provincial legislation (WHMIS) recognizes the workers "right" to know about hazardous materials in the workplace. Students carrying out experiments in a lab are considered workers, and the lab will be their workplace. Therefore, they need to identify dangerous chemicals in the lab and be able to protect themselves. The required information is provided in Material Safety Data Sheets (MSDS). Students are requested to consult the MSDS before running an experiment. Materials Safety Data Sheets (MSDS) of all chemicals used in the Lloydminster campus chemistry lab can be found in two locations:

1. One set is available in the library. Students can find them in the reference books section or ask the librarian for help.

2. The other set is in the Hazard Information Center in Room 1008 (chemistry lab).

Students are required to hand in the written lab reports one week after every experiment. A general plan and a sample report is provided below.

General Plan for Laboratory Report

Number and Title of Experiment

Reference: Page number in the laboratory manual and any other reference

Equation: As appropriate

Procedure: Write in the third person past tense. The section should be very brief and should record what you did. It should not be a copy of the procedure from this manual.

Observations: All color changes, formation of precipitates, appearance of crystals, etc. should be described.

Results: These must be recorded clearly and systematically as follows:
melting point or boiling point
literature melting point or boiling point with reference
yield
theoretical yield
percentage yield

Discussion: This section should be very brief and should include conclusions where necessary or an explanation of low melting or boiling points or a poor yield.

See "Appendix A" for a specific example of a laboratory report.

Evaluation Procedures

The final grade is an aggregate of the following components:

Assignments	10%
First Midterm Exam	15%
Second Midterm Exam	15%
Final Exam	35%
Laboratory	25%
Total	100%

The breakdown of the laboratory mark of 25% is as follows:

Lab Report/End-of-chapter problems	20%
Lab Exam	5%
Total	25%

No supplemental assignments or examination re-writes are permitted in this course.

Grade Equivalents and Course Pass Requirements

A minimum grade of D (50%) (1.00) is required to pass this course.

Letter	F	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Percent Range	0-49	50-52	53-56	57-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100
Points	0.00	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.00

Students must maintain a cumulative grade of C (GPA - Grade Point Average of 2.00) in order to qualify to graduate.

Attendance

Students are expected to attend all lectures and laboratories. If more than four lectures are missed then, except for extenuating circumstances, the student will not be allowed to write the final examination. Missing even one lab without legitimate excuse will result in a failing grade in the course regardless of exam marks. Missing three or more labs will definitely result in a failing grade and no excuse will be acceptable. Attending a lab session but not handing in the lab report within the accepted time period (as stated under Conduct of Course) will be regarded as having missed that particular lab.

Course Units/Topics

Session	Topics
	I. Structure and Bonding
1	Introduction The Structure of Atoms, Chemical Bonding Theory, Chemical Bonding: Ionic and Covalent Bonds
2	Atomic Orbitals Molecule Orbital Theory
3	Hybridization of Orbitals
	II. Bonding and Molecular Properties
4	Polar Covalent Bonds: Electronegativity and Dipole Moment Formal Charges, Resonance
5	Acids and Bases: Bronsted-Lowry Definition, Lewis Definition, Acid-Base Reactions from pKa values
	III. Alkanes and Cycloalkanes
6	Functional groups, structure determination - infrared spectroscopy. Alkyl groups, IUPAC Nomenclature of Alkanes and Cycloalkanes
7	Properties and Reactions of Alkanes and Cycloalkanes
	IV. Conformations of Molecules
8	Conformations of Alkanes: Ethane, Propane, Butane
9	Stability of Cycloalkanes: The Baeyer Strain Theory

10	Conformations of Cycloalkanes
11	**First Midterm Exam**
V. Alkyl Halides	
12	Nomenclature, Structure, and Synthesis of Alkyl Halides
13	S_N1 and S_N2 Reactions Factors affecting the Rates of S_N1 and S_N2 Reactions Elimination reactions
VI. Alkenes	
14	Structure, Properties, and IUPAC Nomenclature
15	Synthesis and Addition Reactions of Alkenes
16	Cis-Trans Isomerism of Alkenes The E, Z Sequence Rules
VII. Alkynes	
17	Properties and Nomenclature
18	Synthesis and Addition Reactions
19	**Second Midterm Exam**
VIII. Stereochemistry	
20	Chiralty and Enantiomers Properties of Enantiomers Optical Activity
21	Sequence Rules for Specification of Configuration Racemic Mixtures Nomenclature of Enantiomers: The R, S system Drawing Enantiomers: Fischer Projections
22	Diastereomers Molecules with More than Two Stereogenic Centers Meso Compounds
IX. Alcohols	
23	Structure, nomenclature and physical properties of alcohols
24	Preparation and reactions of alcohols

X. Ethers	
25	Structure, nomenclature and physical properties of ethers
26	Preparation and reactions of ethers; Epoxides
27	**Final Examination**

Laboratory Schedule

1. Crystallization
2. Melting Points and Boiling Points
3. Extraction: Isolation of caffeine from tea
4. Thin Layer Chromatography
5. Gas Chromatography: Analysis of Mixtures (see handouts)
6. Distillation and Fractional Distillation
7. Alkene from Alcohols: Cyclohexene from Cyclohexanol
8. The S_N2 Reaction: 1-Bromobutane
9. Purification of Cholesterol

Appendix A

Specific Example of a Laboratory Report

Reference: Organic Chemistry Experiments, page 35

Procedure: Benzoic acid (3.1 g) was dissolved in boiling water (55 ml) and decolorizing charcoal (2 spatulafuls) added. The charcoal was removed by gravity filtration; the solution was allowed to cool for about 20 minutes, then placed in an ice-water bath. The crystals were collected by vacuum filtration, washed with ice-cold water and air-dried.

Observations: Crude benzoic acid was a dirty yellow color. Black particles remained after the benzoic acid was dissolved in the boiling water. A yellow solution formed. The filtrate after removal of the charcoal was colorless and the solid resembled snowflakes.

Results:

Melting point of crude benzoic acid 115 - 118^{o}C

Melting point of purified benzoic acid 120 - 121^{o}C

Literature melting point (lab manual, page 206) 122^{o}C

Yield of benzoic acid 1.8 g

Theoretical yield 3.1 g

Percentage yield

Discussion: The low yield of purified benzoic acid resulted when the hot aqueous solution was spilled during filtration of the charcoal.

There are questions related to every experiment at the end of each chapter. Students will be asked to answer some elected questions in the lab report.

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Toll-free in Canada: 1 800 661 6490 E-mail: admissions@lakelandcollege.ca