

**CAMOSUN COLLEGE**  
**DEPT. OF CHEMISTRY & GEOSCIENCE**  
**CHEMISTRY 230-ORGANIC CHEMISTRY 1**  
**FALL 2004**

**Instructor:** Dr. Nasr Khalifa, Fisher 348C, Phone: 370-3201, E-mail: khalifa@camosun.bc.ca

**Texts:** "Organic Chemistry" Sixth Edition, by John McMurry  
"Organic Chemistry Experiments for Chemistry 230 and 231" by R. Raap and N. Khalifa  
\*\*\*\*\*Both texts are REQUIRED\*\*\*\*\*

**Course Description:**

This course provides a general introduction to the theory and practice of organic chemistry. Topics include alkanes, stereochemistry, alkyl halides, substitution and elimination reactions, free radical reactions, alcohols, ethers, spectroscopy, alkenes, and alkynes. The laboratory experiments are designed to expose students to a wide range of organic laboratory techniques.

**Credits: 4**

**Mode and Hours of Delivery: 3 hour of lectures and 3 hours of labs. Duration: 15 weeks, Estimated out-of-class: at least 6 hours.**

**Pre-requisites: Chem120 (or Chem112 with a B and permission of the Chair)**

**Pre/Co-requisite: Chem121**

**Prior Learning Assessment Available: Yes**

**Intended Learning Outcomes:**

At the end of this course, students will possess an enhanced ability to:

- Utilize the specialized vocabulary and nomenclature based on the IUPAC system for organic compounds including alkanes, cycloalkanes, alkenes, alkynes, alcohols, ethers, epoxides, and alkyl halides according to their structures and functional groups present.
- Describe the general physical properties such as stability, acidity and basicity, density, melting and boiling point, and water solubility of the above compounds.
- Describe the chemical properties of the above classes of organic compounds, and explain any differences and similarities.
- Draw a synthetic scheme outlining the preparation of some of the compounds above and their subsequent reactions, including details such as stereochemistry of some typical reactions and mechanisms, stability of transition states, intermediates, products, and factors affecting the outcome.
- Utilize the concepts of functional group transformations and reaction mechanisms to explain organic reactions.
- Demonstrate an ability to apply the method of retrosynthetic analysis based on the knowledge of some general organic reactions of the above compounds.

- Identify the fundamental differences among the three types of isomerism: structural, geometric, and stereo.
- Recognize and draw Newman, Fischer, and Haworth projections.
- Communicate an understanding of the Cahn-Prelog-Ingold sequence rules and to recognize basic differences between enantiomeric and diastereomeric compounds.
- Communicate an understanding of the phenomena of infrared, ultra violet-visible, and mass spectroscopy and to interpret and predict the spectroscopic data for the classes of organic compounds listed above.

### **Detailed Course Outline:**

#### **1. Review and Preview:**

**Chemical Bonding (Chapters 1, 2); Acid and Base Theory As It Relates To Organic Chemistry (Chapter 2); Alkanes and Cycloalkanes (Chapter 3); An overview of Organic Reactions (Chapter 5)**

**\* lectures are scheduled to cover topics that were not covered in Chem121, a review problem set will be given)**

- Structural theory of organic chemistry, Lewis structures, Exceptions to the octet rule, formal charges, Atomic orbitals, molecular orbitals, Resonance, hybridization, Molecular geometry, polar and nonpolar molecules, Carbon-carbon covalent bonds, Aromaticity, Functional groups; classification of organic compounds into families, Organic reactions and mechanisms.
- Acid and base reactions, Homolysis and heterolysis of bonds to carbon, Use of curved arrows in reaction mechanisms, Carbocations and carboanions, The strength of acids and bases,  $K_a$  and  $pK_a$
- Relationship between structure and acidity, Effect of the solvent on acidity, protic and aprotic solvents, Acids and bases in nonaqueous solutions
- IUPAC nomenclature, Physical properties of alkanes and cycloalkanes, Bicyclic and polycyclic alkanes, Synthesis of alkanes and cycloalkanes, Reactions of alkanes

#### **2. Stereochemistry and Chirality: (Chapter 4, 6.6, 9.1 – 9.11, 9.15 )**

- Conformational analysis of ethane, propane, and butane
- Ring strain in cycloalkanes
- Conformations of cyclohexanes
- Isomerism: constitutional isomers and stereoisomers
- Enantiomers and chiral molecules
- Nomenclature of enantiomers, the R-S system
- Optical activity
- Diastereomers, Fischer projection formulas
- The E,Z designation in alkenes
- Separation of enantiomers; resolution
- Compounds with stereocenters other than carbon

### 3. Nucleophilic Substitution and Elimination Reactions: (Chapters 10.1 – 10.2, 11, omit 11.13)

- Organic halides, physical properties
- Nucleophilic substitution reactions, nucleophiles, leaving groups
- Thermodynamic and kinetic control of reactions
- Transition state theory, energy diagrams
- Mechanism for  $S_N1$  and  $S_N2$  reactions, stereochemistry
- Factors affecting the rates of  $S_N1$  and  $S_N2$  reactions, solvent effects
- Elimination reactions of alkyl halides, the E2 and the E1 reactions
- Substitution versus elimination
- Functional group transformations using the  $S_N2$  reaction

### 4. Spectroscopy: (Chapters 12, 14.8 – 14.11)

- The electromagnetic spectrum
- Absorption spectra, transitions between electronic energy levels
- Ultraviolet spectroscopy, relationship between structure and  $\lambda_{max}$
- Infrared spectroscopy, molecular vibrations and absorption frequencies,
- IR spectra of alcohols, aldehydes, ketones, carboxylic acids, esters, aromatic compounds
- Mass spectroscopy, molecular ions, fragmentation patterns, isotopes
- Use of UV/VIS, IR, and MS spectra to elucidate structures of organic compounds

### 5. Free Radical Reactions: (Chapter 10.2 – 10.6)

- Homolytic bond dissociation energies
- Reactions of alkanes with halogens
- Chlorination of methane, mechanism
- Halogenation of higher alkanes,
- Geometry of alkyl radicals, stereochemistry of the reactions
- Selectivity in radical substitution reactions
- Radical polymerization

### 6. Alkenes and Alkynes: (Chapters 6, 7, 8)

- Structure and nomenclature
- Physical properties: stability, boiling point, solubility
- Preparation of alkenes and alkynes
- Polar additions to the carbon-carbon multiple bond: ionic addition, carbocations, addition of halogens,
  - Markovnikov's Rule, Anti-Markovnikov addition of HBr
  - hydration using mercuric acetate, hydroboration, addition of carbenes
- Catalytic hydrogenation: the catalyst, stereochemistry
- Oxidation of alkenes: conversion to diols, cleavage of the double bond
- Alkynes as acids, hydration of alkynes, reduction of alkynes
- Conjugated dienes: 1,2- and 1,4-additions, thermodynamic versus kinetic control (**Chapter 14.3-14.4**)
- The Diels-Alder reaction, stereochemistry (**Chapter 14.5-14.6**)
- Synthetic methodology and applications

**7. Alcohols: (Chapter 17, omit phenols; their chemistry will be covered later)**

- Classification and nomenclature
- Physical properties: boiling points, solubility in water
- Preparation of alcohols: hydration of alkenes, oxymercuration and demercuration, hydroboration of alkenes, nucleophilic substitution reactions
- Acidity and basicity of alcohols
- Reactions of alkoxide ions
- Mesylates and tosylates
- Concept of protecting groups, use in synthesis
- Substitution reactions of alcohols: reactivity of alcohols toward hydrogen halides,  $S_N1$  vs  $S_N2$
- Other reagents to convert alcohols to alkyl halides
- Elimination reactions of alcohols
- Oxidation reactions of alcohols, chromium (VI) reagents, potassium permanganate, selective oxidation

**8. Ethers and Epoxides: (Chapter 18.1 – 18.9)**

- Nomenclature of ethers and epoxides
- Physical properties of ethers and crown ethers
- Preparation of ethers: preparation of diethyl ether, Williamson ether synthesis, acid-catalysed Markovnikov addition to alkenes, cyclic ethers
- Preparation of epoxides
- Substitution reactions of ethers
- Substitution reactions of epoxides: mechanism of base-catalysed and acid-catalysed cleavage, anti-hydroxylation of alkenes via epoxides
- Synthetic applications

**LEARNING SUPPORT AND SERVICES FOR STUDENTS**

There are a variety of services available for students to assist them throughout their learning. This information is available in the College Calendar, Registrar's Office or the College web site at <http://www.camosun.bc.ca>

**ACADEMIC CONDUCT POLICY**

There is an Academic Conduct Policy. It is the student's responsibility to become familiar with the content of this policy. The policy is available in each School Administration Office, Registration, and on the College web site in the Policy Section.

[www.camosun.bc.ca/divisions/pres/policy/2-education/2-5.html](http://www.camosun.bc.ca/divisions/pres/policy/2-education/2-5.html)

**Chem. 230 Lab Schedule (Fall 2004)**  
**(subject to change)**

week of Sept. 7-10	no labs
week of Sept. 13-17	review problem set/conformations
week of Sept. 20-24	exp. 8, stereochemistry and models (week 1)
week of Sept. 27-Oct. 1	no labs. <b>Test # 1</b>
week of Oct. 4-8	exp. 1, melting point determination
week of Oct. 12-15	exp. 8, stereochemistry and models (week 2)
week of Oct. 18-22	spectroscopy I
week of Oct. 25-29	no labs. <b>Test # 2</b>
week of Nov. 1-5	spectroscopy II (problem set worth 2 lab reports)
week of Nov. 8-12	no Labs (Thanksgiving holiday)
week of Nov. 15-19	exp. 3, recrystallization and sublimation ( <b>spec. problem set due</b> )
week of Nov. 22-26	no labs. <b>Test # 3</b>
week of Nov. 29-Dec. 3	exp. 4, separation of a mixture
week of Dec. 6-10	exp. 7, isolation of natural products

**Grades:**

A+ = 95-100%	B- = 70- 74
A = 90- 94	C+ = 65- 69
A- = 85- 89	C = 60- 64
B+ = 80- 84	D = 50- 59
B = 75- 79	F = < 50

<b>Lab experiments</b>	<b>30%</b>
<b>Test 1 Wed. Sept. 29 or Thurs. Sept. 30 (2.5 hrs)</b>	<b>10%</b>
<b>Test 2 Wed. Oct. 27 or Thurs. Oct. 28 (2.5 hrs)</b>	<b>10%</b>
<b>Test 3 Wed. Nov. 24 or Thurs. Nov. 25 (2.5 hrs)</b>	<b>10%</b>
<b>Final Examination (Dec., 3 hrs)</b>	<b>40%</b>
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	<b>100%</b>

\*Final exam at the end of the course will cover **all** course material

\*At least a passing grade on lab marks must be achieved in order to write the final exam.

\*You must pass both the lecture portion and the lab portion in order to pass the course.

\*You must provide your own **safety glasses**. Prescription glasses are OK, but sunglasses are NOT. You must wear these safety glasses at all times while you are in the lab. You will not be allowed to carry out any experiments without safety glasses.

\*Office hours are posted on the door. You can, however, drop by the office any time.

You will not be wasting my time if you come for help. I'm here to help you learn.

## Organization Of The Lab Report

**Title of the experiment:** State the title of the experiment you have just carried out.

**Date:** Write the date on which you did the experiment.

**Name:** Your name and lab partner's name (if applicable)

**Objective:** State what you want to achieve by doing the experiment in one or two sentences. Be very brief and to the point.

**Procedures:** You can write the following: Please refer to Chem. 230/231 lab manual, 2004 Edition. pp. xx-xx. Record any changes to the given procedures.

**Data:** Organize any data, whether numerical or descriptive, in a **neat table** (or tables if applicable). Report such things as **unknown numbers**, **concentrations** of solutions, **masses** of reactants and products. Any relevant data recorded on a rough data sheet should be copied here. Do not forget to write **chemical equations** here.

**Discussion and Calculations:** In this part of the report, you will make sense out of the data you have obtained. If you obtain a product, calculate the **percentage yield**. (yield, m.pt. are worth one mark each). Provide a physical description of your product. Show **all** the calculations you do, but there is no need to be repetitive. For example, if you perform 3 or 4 titrations using the same two solutions, then you only need to show the calculation for one trial. In cases where you have not obtained the results you were hoping for, provide a very brief explanation.

**Conclusion:** In no more than two sentences, state what you have achieved by doing the experiment.

**Answers To Questions:** In cases where questions are asked during or at end of experimental procedures, provide the answers here.

\* Lab reports should be written in **ink, including all calculations**. The report does not have to be typed. If you are not using a computer to graph data, use graph paper. If your report does not follow the format given above, it may be deemed unacceptable and you may have to resubmit it. The new report will be considered late if it is not submitted on the same due date (see below).

\* Lab reports are normally due one week after the assigned date for the experiment. You will be informed in advance if there are any changes to the due date.

\* The report is marked out of 10. For every day the report is late, you lose 1 (one) mark.

\* Make sure to **staple** the pages of your report together, including any **rough data sheets**. You lose 1 (one) mark if the pages of your report are not stapled together.