

CHEM 331, ORGANIC CHEMISTRY I

Western Illinois University, Fall 2014

Course Description: A study of nomenclature, preparations, reactions, and reaction mechanisms of the functional groups of aliphatic and aromatic compounds. Prerequisite: CHEM 202 (C grade or better, **strictly enforced**). 4 hrs. lect.; 3 hrs. lab.

Course Objectives:

- To know and understand the bonding, structure and reactivity of organic compounds
- To appreciate the dependence of molecular properties on bonding and structure
- To know the reactions and to understand the mechanisms by which those reactions take place
- To obtain the ability to carry out simple reactions and learn the process of chemical synthesis
- To learn spectroscopic and related techniques to determine the structure of organic molecules
- To gain practical laboratory experience in a modern organic chemistry laboratory setting

Course Instructor: Dr. Jin Jin
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Currens Hall 430-A
298-2261

My expectation is that **you will attend all classes**, read the text, do the assigned work, and complete all quizzes and exams. Study of organic chemistry is very “cumulative” in nature; *i.e.*, each topic (in fact, each lecture) builds upon the material discussed and mastered during the previous class. Students who repeatedly miss lectures do it at the risk of failing the course. Attendance for the laboratory sections is required.

Required Texts & Materials:

Organic Chemistry (11th Edition) by Solomons & Fryhle

Introduction to Organic Laboratory Techniques: A Microscale Approach (5th Edition)

by Pavia, Lampman, Kriz, and Engel

Laboratory Notebook (Carbonless Copy Sheets, Required)

Personal protective eye wear is required. The student must purchase safety goggles (and any lab notebooks if required). Students enrolled in this course are levied a non-refundable laboratory usage fee of \$35 to cover the cost of consumable supplies utilized during the semester.

Meeting Times: Lecture: 8:00 - 8:50 am; M,T,W,F in Currens 203.
Laboratory: T (9 am, 2 pm), W (3 pm) or Th (8 am) in Currens 423.

Office Hours: Monday, Wednesday, Friday 9:00 AM-10:30 AM, **or by appointment**

Quizzes & Exams: Ten in-class quizzes (25 pts each) and four lecture exams (100 pts each) will be administered during semester; the lowest score of the lecture exams will be dropped when assigning the final grade for the course. Lecture exams will consist of multiple choice questions as well as those requiring short paragraph answers. **Under no circumstance will a student be allowed to make-up a missed quiz or**

exam without a doctor's note indicating your inability to attend class on the day of the quiz or exam.

Grading:

Quizzes (10)	250 Points
Exams (3)	300 Points
Laboratory	250 Points
<u>Final Exam Comprehensive</u>	<u>200 Points</u>
Total	1000 Points

Course Grading Scale:

The tentative letter grade breakdown for the course is given in the table below. Please note that you will need a minimum grade of C or higher for this course to enroll in other courses that require CHEM 331 as a prerequisite.

930-1000	A	740-769	C
900-929	A-	700-739	C-
870-899	B+	650-699	D+
840-869	B	600-649	D
800-839	B-	500-599	D-
770-799	C+	0 - 499	F

Course Outline

Week	Title of Chapter	Concepts Covered
1 8/25-8/29	Chapter 1: The Basics	Bonding, hybridization, shapes of molecules, bond angle, bond lengths, resonance, structural formula, common functional groups.
2 9/1-9/5	Chapter 2: Carbon Compounds	Alkanes, alkenes, alkynes, alkyl groups, common functional groups, electromagnetic spectrum, infra-red spectroscopy, recording and analyzing IR spectra, correlation table, molecular structure and physical property.
3 9/8-9/12	Chapter 3: Acids and Bases	Acids and bases, pK _a value, structure and acidity, Lewis acids and bases, predicting the outcome of an acid-base reaction.
4 9/15-9/19	Chapter 3: Acids and Bases cont	Homolytic and heterolytic bond breaking, acid-base reactions, theories, strength of acids, pK _a values, predicting the outcome of acid-base reactions; Relationship between acidity and molecular structure, revisit resonance, organic compounds as acids and bases, mechanism of organic reactions, curved arrow symbolism.
5 9/22-9/26	Chapter 4: Alkanes and Cycloalkanes	Introduction to alkanes and cycloalkanes, systematic nomenclature, conformations of alkanes and cycloalkanes, Introduction to mass spectrometry, normal alkanes versus branched alkanes.
6 9/29-10/3	Chapter 4: Alkanes and Cycloalkanes	Conformations of cycloalkanes, chair and boat conformations of cyclohexane, energy profile diagrams, relative stabilities of cycloalkanes, angle strain, hydrogenation reaction, bicyclic alkanes and nomenclature.
7 10/6-10/10	Chapter 5: Stereochemistry	Cis-trans isomers, diastereomers, chirality, enantiomers, optical activity, biology and chirality, naming enantiomers, R/S nomenclature; Racemic mixture, meso compound, enantiomeric excess and enantiomeric composition, chiral resolution, chiral synthesis, Fischer projection formulas.
8 10/13-10/17	Chapter 6: Ionic Reactions	Substitution at sp ³ carbons, substrate, nucleophile, leaving group, S _N 1 and S _N 2 mechanisms, kinetics of S _N 1 and S _N 2 reactions,

		Stereochemistry of substitution reactions, Factors effecting the rates substitution reactions.
9 10/20-10/24	Chapter 6: Ionic Reactions	Substitution reactions in organic synthesis, alkynide anions as nucleophiles, selective reduction of alkynes, basicity and nucleophilicity, E1 and E2 reactions, Zaitsev rule, stereochemical requirements for E2 elimination, E2 elimination reaction on substituted cyclohexane substrates, predicting whether substitution or elimination is preferred.
10 10/27-10/31	Chapter 7: Alkenes and Alkynes I	Systematic nomenclature of alkenes and alkynes, E-Z nomenclature, organic reactions revisited, reaction profile diagrams, reactions of alkenes, addition reactions, mechanism and stereochemistry of addition across double bonds.
11 11/3-11/7	Chapter 8: Alkenes and Alkynes II	Reactions of alkenes, electrophilic additions(addition of HX, H ₂ O, Br ₂ etc), Markovnikov rule, anti-Markovnikov addition of HBr and HOH across double bonds, carbocation stability order, molecular rearrangements during hydration, oxymercuration-demercuration, stereochemistry of addition reactions, stereospecific reactions.
12 11/10-11/14	Chapter 9: NMR spectroscopy	NMR phenomenon, magnetically active nuclei, nuclear spin, interaction of 'molecular' magnets with lab magnet, NMR signal, deshielding-shielding, chemical shift, spin-spin splitting, n+1 rule
13 11/17-11/21	Chapter 9: NMR spectroscopy	Analysis of ¹ H NMR spectra, ¹³ C NMR, broadband decoupled spectra, chemical shift ranges.
14 11/24-11/28	Thanksgiving break	
15 12/1-12/5	Chapter 10: Radical Reactions	Introduction to radicals, chain reactions, stability of radicals, bromine selectivity, polymerization, reactions of alkanes with halogens.
16 12/8-12/12	Review	
17 12/15-12/19	Finals Week	12/15, Mon, 8-9:50 am

Tentative Schedule of Exams and Quizzes: CHEM 331

Assessment	Week
Quiz 1 (chpt 1)	2
Quiz 2 (chpt 2)	3
Quiz 3 (chpt 3)	4
Exam 1 (chpt 1-3)	5
Quiz 4 (chpt 4)	7
Quiz 5 (chpt 5)	8
Quiz 6 (chpt 6)	9
Exam 2 (chpt 4-6)	10
Quiz 7 (chpt 7)	11
Quiz 8 (chpt 8)	12
Quiz 9 (chpt 9)	13
Exam 3 (chpt 7-9)	13
Quiz 10 (chpt 10)	15
Exam 4	16

Useful Resources: <http://sdo.wiu.edu/facultyStaff/absencepolicy.asp> (absence policy)
<http://www.wiu.edu/policies/acintegrity.php> (academic integrity policy)
<http://sjp.wiu.edu/CodeOfConduct/index.asp> (Disorderly conduct)

Emergency

Preparedness: WIU Office of Risk Management and Emergency Preparedness provides resources on how to respond to emergency situations. Please view the video resources at www.wiu.edu/rmep/ (Click “Resources” on the right side of the page)

WIU Policies:

It is the policy of Western Illinois University to accommodate individuals with disabilities pursuant to federal law and the University's commitment to equal educational opportunities. It is the responsibility of the student to inform the instructor of any necessary accommodations at the beginning of the course. Any student with a disability requiring accommodations should contact the Office of Disability Support Services.

In accordance with University policy and the Americans with Disabilities Act (ADA), academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. For the instructor to provide the proper accommodation(s), you must obtain documentation of the need for an accommodation through Disability Resource Center and provide it to the instructor. It is imperative that you take the initiative to bring such needs to the instructor's attention, as he/she is not legally permitted to inquire about such particular needs of students. Students who may require special assistance in emergency evacuations (i.e. fire, tornado, etc.) should contact the instructor as to the most appropriate procedures to follow in such an emergency. Contact Disability Resource Center at 298-2512 or disability@wiu.edu for additional services.

CHEM 331 Lab
Western Illinois University, Fall 2014

Laboratory meeting time and place

Sec 21	9:00 - 11:50 am	Tu	Cu 423	Jin, J
Sec 22	2:00-4:50 pm	Tu	Cu 423	Kola, K
Sec 23	8:00-10:50	Th	Cu 423	Vedula, S. K.
Sec 24	3:00-5:50 pm	W	Cu 423	Kola, K

Lab manual and required materials

1. Introduction to Organic Laboratory Techniques: A Microscale Approach 5th Edition by Pavia, Lampman, Kriz, and Engel
2. Laboratory Notebook (with Copy Sheets)

Laboratory safety rules

- Wear safety goggles (eye protection) at all times when in the laboratory. This is a departmental and state regulation.
- Do not eat or drink in the laboratory.
- Know the location and use of the nearest fire extinguisher, nearest First Aid kit, nearest eye wash station, nearest safety shower, and nearest exit designated for evacuation. You will be advised of the locations on the first day of the lab.
- Know the location of the [Material Safety Data Sheets \(MSDS\)](#) and know that you have access to them. You are protected by the right to know law.
- Know the NFPA ([National Fire Protection Association](#)) [Hazardous Material Classification Codes](#).
- Report all accidents, even minor injuries, to the instructor at once.
- In case of an organic chemical spilled on your person, flush with water, wash with soap, rinse with water, rinse with ethyl alcohol, wash with soap, and rinse with water. Pat dry.
- Never taste chemicals or solutions. Minimize the inhalation of organic vapors by using the smallest amounts of materials and utilizing the hood as much as possible. Check the MSDS if you have questions.
- Dispose of all wastes properly. Read labels on bottles! Keep bench and floor clean.
- Before leaving the laboratory, be sure that the water, steam, heaters, and gas cocks are shut off.

Grading: The instructors will collaborate so as to grade each lab section in a uniform manner. Overall, the lab will count as 250 points and it will be added to your lecture portion points to tabulate a final grade for this course. Failure to complete the lab with at least 60% (>150 points out of 250 lab grade) will result in failure for the Lab. Since the laboratory experience is integral to the overall course, failure to earn a passing grade in the lab will result in an automatic failure for the course.

Grading Scheme

Pre-lab	Recorded Observation & Data	Result Discussion Conclusion	Post-lab questions	Organization Lab technique Product	Subtotal	Lab final exam	Total
4	4	4	4	4	20x11=220	30	250

Laboratory Information

Hands-on experience is a vital factor in learning chemistry. For the first semester of this organic sequence, the emphasis of the laboratory exercises will be on microscale methods and techniques. The laboratory grade will be based upon your completion of the experiments, lab reports (pre-lab and post-lab), and technique evaluation. *Since the laboratory experience is integral to the overall course, failure to earn a passing grade in the lab will result in automatic failure for the course.* Notebooks will be checked to verify that they contain the information necessary for the day's experiment. If a student comes to the lab with an incomplete pre-lab report or does not seem to be prepared to do the work, that student will not be allowed to continue in that day's lab until the lab instructor is convinced of the student's preparedness for the experiment.

Cleaning up. When you have finished your lab work, clean up your personal workspace by putting away your equipment, wiping or sweeping up spilled materials, disposing of waste chemicals in the proper containers in the waste hood, etc. Community areas (especially the instrument areas) are to be cleaned up immediately after you have used them. This would include the balances, the mp apparatus and used capillaries, the infrared cells, and the IR sample prep area.

Lab Reports: At the beginning of the next lab section, you must submit a lab report for the previous lab comprised of the copy sheets from your notebook and any other forms/papers, includes pre-lab, observation (in-lab), post-lab, copies of any graphs, print-outs, and spectra obtained during the experiment. Record all information in **ink!** (Since we are using carbonless-copy pages, make sure you use the cardboard backer sheet between copy sheets, and that you write firmly and legibly so the lab instructor may read and grade your reports!) Pre-lab and observation are to be handwritten; post-lab can be handwritten or typewritten. They should be stapled together and handed in. **Sample of the lab report can be found on the course website.**

For each experiment, the notebook/report should contain:

Prelab Report will contain	Postlab Report will contain
Title and Date	Title and Date
Purpose	Observations; Results
A brief procedure in your own words with safety issues, if any, noted	Discussion of results with explanations provided for low yields, unexpected result/observations etc.
Reagents and chemicals used with quantities (preferably in a tabular form)	Conclusions
	Answers to all assigned post lab questions (in complete sentences)
	Spectra and other recordings must be attached

Tentative Laboratory Schedule

Week	Expt # (PLKE)	Title of the experiment	Lab concepts to be covered
1		<i>No Lab</i>	
2		Laboratory Check-in	Laboratory Safety rules
3	#4D	Use of extraction to isolate a neutral compound from a mixture containing an acid	Extraction, extraction coefficient, acid-base chemistry, use of drying agent, recrystallization, mp determination
4	#9	Preparation of Aspirin	% yield calculation, MP determination, IR
5	#12	TLC analysis of analgesic drugs	Identification of drugs, analysis of commercial analgesics, thin-layer chromatography
6	#54A	Isolation of Essential Oils by Steam Distillation	Stream distillation, IR spectroscopy
7		Stereochemistry dry lab	Stereochemistry, chirality
8	#17	Isolation of Chlorophyll and Carotenoid pigments from spinach	Chromatography, column chromatography, thin-layer chromatography, R _f values
9	#14	Isopentyl acetate (banana oil)	% yield calculation, MP determination, IR, and GC-MS
10	#31	Reduction of camphor to isoborneol	Use of hydride reagents, % yield calculation use of ¹ H NMR for estimation of product ratios, IR
11	#21	Reactivities of some alkyl halides	S _N 1 and S _N 2 reaction mechanisms
12	#24	Preparation of 4-methylcyclohexene	Reflux, elimination reaction, % yield, IR
13		NMR dry lab	¹ H & ¹³ C NMR, structure analysis by NMR spectra
14		<i>Thanksgiving Break</i>	
15		<i>Make-up Lab period</i>	
16		<i>Laboratory Exam and Check-out</i>	