

Boston University Dresden Science Program
ORGANIC CHEMISTRY CAS CH 203 Lecture

Instructor: Professor Wolf D. Habicher, Professor Claus Rüger

Meeting Times

Lectures: twice a week at 90 minutes each

Discussions: once a week at 60 minutes

Note well: The lectures and the discussions **are not repeated.**

Lecture Textbooks and Other Course Material.: Organic Chemistry, Boston University, Custom 7e by William H. Brown et. al., Cengage Learning 2013, Solutions Manual, 6th Edition, Cengage Learning 2012, and Pushing Electrons, by Daniel Weeks (Saunders) - this book is recommended but not required. Molecular Models especially those that have "space filling" hydrogen atoms are useful.

Examinations: (There are no "make-up" exams) There will be three (3) 'in class' examinations during the semester and a final examination. The examination rooms will be announced prior to the examinations. **You may drop one of the "in class" examinations for any reason** but you may not drop the final examination. Each examination (including the final examination) is worth 100 points.

Grading guidelines and criteria

Final Grades: The final grades for those students taking both the lecture and laboratory portions of the course (CH203) will be based on 400 points (300 points for examinations and 100 points for the laboratory). The total credits for the course are 4 points.

Taking into account the differences between Academic Cultures the following grading scale will apply.

Grade Breakdown based on 400 points

Total Points ^a	Honor points	Description	Letter Grade
>360	4.0	Excellent	A
340<360	3.7		A-
320<340	3.3		B+
300<320	3.0	Good	B
280<300	2.7		B-
260<280	2.3		C+
240<260	2.0	Satisfactory	C
220<240	1.7		C-
200<220	1.0	Sufficient	D
<200	0.0	Failed	F

^aTotal points after medium grade has been adjusted to 75%.

Incompletes or "I" grades are not permitted to be issued by faculty, because of the obvious difficulty in making up missed work once the student has left country.

All work must be completed on time.

The grades reflect the quality of the work.

Grade Changes: A course grade cannot be changed after six months.

Workload: You must plan to spend 4-5 hours per lecture hour (**12-15 hours per week**) studying organic chemistry and working on the homework problems. (To encourage you do as many homework problems as possible, the material on the quizzes and examinations will be taken occasionally from the questions in the text.) This is in addition to work associated with the laboratory.

If you need extra help: If you need extra help in organic chemistry it is suggested that you ask questions before, after or during lectures, attend discussion and ask lots of questions, attend Professor Habicher's or Professor Rueger's office hours.

Rules for Taking Examinations, Cheating and Academic Misconduct. We attempt to conduct our examinations in a manner that discourages cheating. Cheating is self destructive, disrespectful to your faculty and terribly unfair to your classmates. Accordingly, we have rules that govern the administration of our examinations.

You are permitted to bring to the examination

- 1) Molecular Models as long as they are contained in a **colorless and transparent** plastic bag. No paper is permitted in the bag. Nothing can be etched on the models.
- 2) Beverages in a colorless and transparent bottle.

You are not permitted to bring to the examination

- 1) Any notes or other resources
- 2) Calculators or any other electronic or optical device.
- 3) No wrapped food

During the examination, you must be seated orderly in every other row.

All personal possessions are to be placed at the front of the room.

Hats with visors are to be turned backwards.

There is no talking to other students or sharing of any materials such as molecular models.

If you need to go to the restroom **you must be accompanied by a teaching fellow.**

You may not start the exam late if a student has turned in his/her examination and left the exam room. If you are late you will not be given additional time to take the test.

All other common rules of exam taking are enforced.

Any infraction is **immediately** reported to University officials who then take further action.

Helpful Hints:

- 1) Keep up with the material.
- 2) Review and rewrite your lecture notes after every lecture.
- 3) Form study groups (maximum of four students).
- 4) Find problems at the end of the chapter that correspond to the lecture material.
- 5) Don't cram for exams
- 6) Use the practice exams to see if you are prepared for the real exam.

CH203 (Fall 2015) Reading Assignments – Brown et. al

Do the appropriate 'in text' problems as you read the text. We have assigned a number of 'end of chapter' problems.

The Bonding: Chapter 1: 1.1; 1.3; 1.4; 1.6 Most of this material is a review of general chemistry. Some of the material will be dealt with in the first tutorial session. Do problems in **Chapter 1 (20-23, 51-63)**;

Solve the Handout problems too.

- 1) Electronic Structure of Atoms
- 2) Lewis Structure and Formal Charge
- 3) Polarity of Covalent Bonds
- 4) Hybridization and bonding
- 5) Valence Bond Theory

Nomenclature: Appendix 9 Use the nomenclature system that we present in class. Much of this material is scattered through the chapters of the textbook.

Solve the Handout problems too.

- 1) Priority and non priority groups
- 2) Generic and trivial names
- 3) Hydrocarbyl substituents and the IUPAC naming of alkanes. Use of Bond line representations.
- 4) Cycloalkanes
- 5) Alkene and Benzene
- 6) Alkynes
- 7) Other non-priority groups (halides, nitro compounds, nitroso compounds, ethers, thioethers, azides, sulfoxides, sulfones).
- 8) Priority groups (sulfonic acids, carboxylic acids, esters, amides, nitriles, aldehydes, ketones, alcohols, thiols and amines)

Electronic Structure / Polar Covalent Bonds:

Chapter 1: 1.2; 1.5; 1.7B, 1.7C; 1.8; 1.9A; 1.10. Chapter 21: 21.1, 21.2; class notes. Do the following problems: **Chapter 1:** 25-30, 32-36, 38, 41, 49, 52, 54; 55, 66, 69, 70, 74, 75; **Chapter 21:** 12-18

- 1) Electronegativity and chemical bonds
- 2) Inductive effects
- 3) Delocalization of pi electrons
- 4) Resonance and resonance structures
- 5) Aromaticity

Weeks - Read chapter on drawing resonance structures.

Acids and Bases:

Chapter 4; Chapter 7: 7.4; Chapter 10: 10.3; Chapter 21.4B and class notes. Do the following problems in **Chapter 4:** 9, 10, 12, 14, 15, 16, 17, 30, 32, 33, 34, 36, 41, 45, 48, 49, 54 ; **Chapter 10:** 25 -28; **Chapter 21:** 35-40

Factors that influence acidity (bond energies, electronegativity and inductive effects, resonance effects and aromaticity, steric inhibition of resonance, solvation and hydrogen bonding.

- 1) Bronsted-Lowry acids and bases
- 2) Acid dissociation constants and relative strength of acids and bases
- 3) Molecular structure and acidity

4) Lewis acids and bases

Mechanisms of Organic Reactions, Thermodynamics, Kinetics:

Chapter 4:4.5; Chapter 6: 6.2; Primer I; Do the following problems in **Chapter 4:** 20, 21, 22, and handout problems

- 1) Kind of Organic Reactions
- 2) The concept of mechanism.
- 3) Factors that control the rate of reaction.
- 4) The reaction coordinate diagram; Intermediates
- 5) Transition states and the Hammond postulate
- 6) Multistep reactions and the rate limiting step.
- 7) Rates equations and thermodynamic considerations

Stereochemistry:

Chapters 2 and 3. Do problems in **Chapter 2** (19-25, 32-39, 40-52) Chapter 3 (11-13, 14-19, 20-24, 25-39).

Solve the Handout problems too.

- 1) Types of isomers
- 2) Cis/trans isomerism in cycloalkanes and alkenes
- 3) Cahn Ingold Prelog rules
- 4) Angle strain, torsional and steric strain
- 5) Conformational analysis of ethane, propane, butane, and cyclohexane
- 6) Symmetry
- 7) R/S convention
- 8) enantiomers and diastereomers
- 9) meso compounds
- 10) optical rotation/optical purity
- 11) Fischer projections
- 12) resolution
- 13) enantiotopic diastereotopic/homotopic hydrogens
- 14) N, P, S stereogenic centers
- 15) Conformational isomers

Haloalkanes, and Radical Reactions:

Chapter 8: 8.1 to 8.8; Chapter 15: 15.1 to 15.3

Do problems in **Chapter 8:** 10, 12, 13, 14, 20, 23, 24, 25, 26 30a,b,d,e; 31, 32, 33 and in **Chapter 15:** 7, 8, 9, 10, 12a, (17, 18, 20 final).

- 1) Structure of organohalides
- 2) Preparing alkyl halides from alkanes; radical halogenation
- 3) Preparing alkyl halides from alkenes; allylic bromination
- 4) Stability of allyl radicals
- 5) Reaction of alkyl halides; Grignard reagents, Gilman reagent, Simmons-Smith reagent
- 6) Organo metallic coupling reactions

Nucleophilic Substitution Reactions and β -Eliminations:

Chapter 9

Do problems in **Chapter 9:** 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 22, 25, 28, 29, 30, 34, 37, 38, 43, 44, 45, 47, 51, 55, 56

- 1) The S_N2 Reaction (mechanism, stereochemistry, characteristics of the S_N2 reaction, influences of the substrate (steric effects), of the nucleophile, the leaving group, and the solvent)
- 2) The S_N1 reaction (mechanism, stereochemistry, characteristics of the S_N1 reaction, influences of the substrate, the leaving group, the **nucleophile**, and the solvent)
- 3) Elimination reactions of alkyl halides: Zaitsev's Rule, mechanisms
- 4) The E2 reaction (mechanism, deuterium isotope effect, stereochemistry, E2 reaction and cyclohexane conformation)
- 5) The E1 and E1cb reaction (mechanism, deuterium isotope effect, stereochemistry)

Alcohols, Ethers, Epoxides and Sulfides

Chapter 10: 10.4, 10.5, 10.6, 10.7, 10.8, 10.9; Chapter 11: 11.4, 11.5, 11.6., 11.7, 11.8-11.10

Do problems in **Chapter 10:** 14, 16, 25-28, 29, 30 a, b, c, d, e; 31a, b, c, d, h; 34, 35a, b, 37-38 (final), 51, 55 and in **Chapter 11:** 15, 19-22, 25, 27, 31, 34, 36, 37, 39, 44-46 (final).

- 1) Conversion of alcohols to sulfonates and halides;
- 2) Dehydration of alcohols;
- 3) Oxidation of alcohols
- 4) Protection of alcohols
- 5) Epoxidation and nucleophilic opening of epoxides

Spectroscopical Methods

Mass Spectroscopy

Brown - Chapter 14

- 1) Brief introduction to mass spectroscopy
- 2) Interpretation of mass spectra
- 3) Mass spectrometry of functional groups

Solve the Problems 4-38.

Do the problems in the Handout too.

Infrared Spectroscopy

Brown - Chapter 12

- 1) Infrared spectroscopy, schematic of the IR spectrometer, vibration energy levels, number of normal modes of vibration, different types of vibrations, IR active vibrations, Hooks law, reduced mass, bond energies
- 2) Interpreting infrared spectra

Solve the examples

Do the following problems at the end of the chapter 12: 5-11.

Do the Handout problems too.

Nuclear Magnetic Resonance Spectroscopy

Brown - Chapter 13

- 1) Magnetic energy states
- 2) Chemical shifts
- 3) Number of signal and integrations of signals
- 4) Spin-spin splitting and coupling constants - Karplus curve
- 5) Time dependence, equilibrating structure, hydrogen bonding.
- 6) Deuterium
- 7) Generation of NMR spectra
- 8) Interpreting NMR spectra.
- 9) Degree of unsaturation
- 10) Stereochemistry and Topicity

Do the following problems at the end of the chapter 13: 10-28.

Do the Handout problems too.

Alkenes: Properties and Reactions:

Chapters 5: 5.1, 5.3, 5.4; Chapter 6: 6.1 to 6.7

Do problems in **Chapter 5:** 9, 11, 12, 13, 15, 18, 23; **Chapter 6:** 3, 5, 6, 7, 9, 10, 13, 15, 16, 17, 18, 19, 20, 22, 23, 26, 27, 29, 30, 31, 32, 33, 34, 36, 37, 39, 40, 44, 45, 48, 50, 53; **Chapter 8:** 30; **Chapter 10:** 31 b, c, d, h, 35 a, b, 37, 38, 40, 45; **Chapter 15:** 12, 20;

- 1) Electrophilic addition reactions (carbocation stability, regiochemistry, stereochemistry, Markovnikov's rule,)
- 2) Carbocation rearrangement, hydride shift, methyl shift, ring expansion
- 3) Addition of halogens and pseudo-halides
- 4) Addition of HX
- 5) Hydration
- 6) Addition of carbocations
- 7) Oxymercuration
- 8) Epoxidation, osmylation, dihydroxylation
- 9) Addition of HOX - Halohydrin formation,
- 10) 1,4 versus 1,2 -addition to conjugated dienes
- 11) Thermodynamic and Kinetic Control
- 12) Other reactions: Hydrogenation, hydroboration, cyclopropanation, hydroxylation, epoxidation.
- 13) Carbon-carbon double bond cleaving reactions - ozonolysis

Alkynes: Properties and Reactions

Chapters 7: 7.1, 7.3 to 7.8

Do problems in **Chapter 7:** 8, 10, 11, 12, 13, 14, 16, 17, 18, 20, 21, 23, 24, 30; **Chapter 8:** 29

- 1) Electrophilic addition reactions
- 2) Addition of HX and X₂
- 3) Hydration / keto-enol tautomerism
- 4) Hydroboration/ oxidation
- 5) Reduction / catalytic hydrogenation
- 6) Oxidativ cleavage