

## ORGANIC CHEMISTRY

**CHEM 241** instructor: Jean-Claude Bradley [bradlejc@drexel.edu](mailto:bradlejc@drexel.edu)

**Course goals and objectives:** This is an introductory course to organic chemistry. Particular attention will be given to the correlation of molecular properties with the physical properties of materials. Detailed mechanisms of several reactions will be covered. This course will provide the needed background for the more advanced Organic Chemistry courses [CHEM 242](#) and [CHEM 243](#).

**Resources: Textbook:** Solutions to problem sets from Wade (Organic Chemistry, Ed. 5) are available only to students registered in the class via [WebCT](#).

**Grading:** 2 1.5-hour exams 2 x 100

final 200

total 400

**Course Information:** An FAQ for the class is maintained on this blog and is updated periodically. E-mail the instructor if your question is not addressed in the FAQ.

**Make-up test policy:** Tests, quizzes and exam will be available on WebCT. Location and times of testing are specified in the [FAQ](#). Quizzes will be available for each chapter but will not count towards the final grade. Make-up tests will be available on WebCT but will consist of additional questions without additional time. The **better score** between the test and make-up will be used.

**Lecture archives:** The theory in lecture format for this class are already available on the [class blog](#). The problem solutions are in [WebCT](#). The class archives are made available by screencasting as streaming audio/video as well as podcast by audio with pdfs to follow along.

**Grading Policy:** A: 90-100% B: 80-89% C: 65-79% D: 50-64% F: 0-50% (borderline grades are left to the discretion of the professor)

**Extra Credit:** Up to 1% of your grade will be allocated to post **two** real world applications of the reactions we discuss in class or the spectroscopic analysis of molecules. At least one *peer-reviewed reference* per example using [CiteULike](#) must be used for full credit. Students may also use the [class blog](#) to report on this class in general (i.e. study tips, difficulty of certain material, additional online resources found, etc.) Since blogs are public, students do not have to use their real names but can if they choose. The deadlines for completion of the **two** examples are midnight of November 4 and November 25, 2005. The sooner you put up your example the more feedback you will get from me to make it correct. Students are encouraged to comment on other students posts. We all learn better that way. Here are some [examples](#) to get ideas. Ask the instructor for access to the blog if you are doing the extra credit assignment. You may create a chemical [Unreal Tournament Map](#) instead of a blog entry. Contact instructor for details.

## Material Covered

### Electronic Configuration

Pauli Exclusion Principle:

- Only 2 electrons per orbital (opposite spin)
- Electrons like to be unpaired if possible

Types of bonds: covalent and ionic

Valence Periodic Table

Solving Lewis Structures

Resonance Hybrids and curved arrow formalism  
Lewis, skeletal and condensed structural formulas  
Molecular and empirical formulas

Acids and Bases

Lowry-Bronsted Acid: PROTONS (H<sup>+</sup>)

Lewis Base: Lone pair of electrons

## **Molecular Orbitals and Functional Groups**

Atomic and Molecular Orbitals: the geometry of electron probability distribution

s, p,

Hybrid orbitals sp, sp<sup>2</sup>, sp<sup>3</sup>

### **2 groups of electrons**

linear

sp

### **3 groups of electrons**

trigonal planar (120°)

sp<sup>2</sup>

### **4 groups of electrons**

tetrahedral (109.5°)

sp<sup>3</sup>

Pi and Sigma bonds-the ethylene example

Rigidity of Double Bonds

Isomerism- structural isomers and stereoisomers (geometrical isomers)

Bond polarity and dipole moment

Molecule Polarity: sum of dipole moments

Intermolecular Forces

Dipole-Dipole interaction (e.g. CH<sub>3</sub>COCH<sub>3</sub> acetone)

Hydrogen bonding (e.g. HF, H<sub>2</sub>O) NEED F, O or N and H

van der Waals forces (e.g. He, CH<sub>4</sub>)

Structure and physical properties

Melting point (higher for stronger intermolecular forces)

Boiling point (higher for stronger intermolecular forces)

Solubility (like dissolves like)

Alkanes, Alkenes, Alkynes, Alcohols, Ethers, Aldehydes and Ketones, Carboxylic Acids

Acid Chlorides, Esters, Amides, Amines

## **Hydrocarbons**

Let's count to 10: methane, ethane, propane, butane, pentane, hexane, heptane, octane, nonane, decane

Nomenclature: isopropyl, isobutyl, n-butyl, sec-butyl, t-butyl,

Primary, Secondary, Tertiary, Quaternary centers

Reactions of Alkanes

1) combustion

2) cracking

3) halogenation

Conformations of ethane, propane, butane

Newman projections

Steric Hindrance

Cycloalkanes

Cis-trans isomerism of cycloalkanes

Chair and boat configurations of cyclohexane

Axial and Equatorial positions

## **Halogenation of alkanes**

Bromination of methane

Bond Dissociation Energy

Homolysis and Heterolysis

Transition State (Predicting the geometry using the Hammond Postulate)

Rate-limiting step

Bromination of propane

Chlorination of propane (loss of selectivity)

Free-radical stabilities

Carbocations/Carbanions

## **Chirality**

R and S configurations

Optical activity: dextrorotatory and levorotatory

Specific rotation

Racemic mixture

Fisher Projection

Diastereomers and Enantiomers

Reactions involving chiral centers

## **Alkyl halides**

Nomenclature

### **Preparation**

1) Free-radical halogenation

2) Hydrohalogenation of alkenes

3) From alcohols

4) From other alkyl halides

Reactions

1) elimination

2) nucleophilic substitution

SN1 and SN2 reactions

Solvent effects on nucleophilicity

Walden inversion

Rearrangements in SN1 reactions (hydride and methyl shifts of carbocations)

E-1 and E-2 Reactions

Satyzeff Rule

## **Alkenes**

Unsaturation

Nomenclature

Z and E, cis and trans

8 Carbon Rule

Preparation

- 1) Dehydrohalogenation
- 2) Dehalogenation
- 3) Dehydration of alcohols
- 4) Catalytic cracking of alkanes
- 5) Wittig synthesis

## **Reactions**

- 1) elimination
  - 2) nucleophilic substitution SN1 and SN2 reactions
- Solvent effects on nucleophilicity
- Walden inversion
- Rearrangements in SN1 reactions (hydride and methyl shifts of carbocations)

E-1 and E-2 Reactions

Satyzeff Rule

## **Alkenes**

Unsaturation

### **Nomenclature**

Z and E, cis and trans

8 Carbon Rule

### **Preparation**

- 1) Dehydrohalogenation
- 2) Dehalogenation
- 3) Dehydration of alcohols
- 4) Catalytic cracking of alkanes
- 5) Wittig synthesis

### **Reactions:**

Electrophilic addition

Markovnikov's rule

Anti-Markovnikov addition

Hydration of Alkenes

Anti-Markovnikov hydration by hydroboration

Catalytic hydrogenation

Simmons-Smith reaction

Halogenation

Hydrohalogenation

Epoxidation

Permanganate hydroxylation (cold, dilute)

Permanganate (warm, concentrated)

Ozonolysis

OsO<sub>4</sub>

Carbenes

## **Alkynes**

### **Nomenclature**

Acidity of alkynes

### **Preparation**

From vicinal dihalides

From acetylides

### **Reactions**

Hydrogenation

Partial hydrogenation (Lindlar's catalyst)

Halogenation

Markovnikov addition of HBr

Hydration to ketones

Permanganate (cold, dilute)

Permanganate (warm, concentrated)