Midterm I Guide for Chem109C
(Kahn, Spring 2005)

Midterm I will be held on Tuesday, April 19th, 5–6:20 PM in Chem1179.

In general, exam questions are based on topics that we covered in the lectures. However, in some cases the textbook provides more detailed examples of these topics and you are expected to be familiar with this material as well. Topics covered in quizzes and vitamin problems may be revisited in the exam. Furthermore, I anticipate that you are familiar with basic concepts of organic nomenclature, stereochemistry, and reactivity that were taught in Chem 109A and Chem109B.

The exam questions are designed to test your knowledge and understanding of the following topics:

Molecular Orbital Theory

Bonding, nonbonding, and antibonding orbitals
Drawing molecular orbital diagrams
Recognizing HOMO and LUMO orbitals in ground state molecules
Description of chemical reactions as flow or electrons from one orbital to another
Electron delocalization
Stability of allyl cation; reactions of allyl halides
Conjugated vs. non-conjugated π systems
Properties of the amide bond

Ultraviolet Spectroscopy

Lambert–Beer law
$n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ transitions
Effect of conjugation in π system on λ_{max}
Solvatochromic shifts
MO-based explanation for the blue shift in $n \rightarrow \pi^*$ transition in carbonyl compounds

Pericyclic Reactions

Distinction between three kinds of pericyclic reactions
Frontier orbitals and orbital symmetry considerations, excited state HOMO
Thermal and photochemical reactions.
MO description of cycloaddition reactions
Diels–Alder reaction, prediction of product stereochemistry
Effect of electron-withdrawing substituents in dienophile on reaction rate
Electrocyclic reactions, prediction of product stereochemistry
Woodward–Hoffman rules for electrocyclic reactions.
Sigmatropic rearrangments, recognizing breaking bonds, forming bonds
Cope rearrangement: writing product structures (no stereochemistry required)
TE-AC mnemonic for selection rules
Synthetic utility of pericyclic reactions, simple retrosynthetic analysis

Carbohydrates

Structural aspects:

General formula and functional groups
Classification based on number of carbons
Classification based on the nature of the carbonyl functionality
Classification based on the extent of polymerization (mono-, di-, oligo-, polysaccharides)
Classification into D- and L-isomers
Fisher projections, R, S nomenclature
Enantiomers, diastereomers, epimers
Structure of D-glyceraldehyde and L-glyceraldehyde
Structures of D-ribose, D-glucose, D-mannose, D-galactose and D-fructose (open chain)
Structures of D-ribose, D-glucose, D-mannose, D-galactose and D-fructose (cyclic hemiacetal form both in Fisher and Haworth projections)
Aldonic acids and aldaric acids
Nomenclature of disaccharides: how to specify the linkage
Be able to recognize simple disaccharides: maltose, cellobiose, trehalose, and lactose

Chemical reactions:

Oxidative chemistry of the aldehyde functionality: aldonic acids
Oxidative chemistry of the primary alcohol functionality: aldaric acids
Tollens test with aldoses and ketoses; enolization of ketoses
Reductive chemistry of the aldehyde functionality
Osazone formation
Nucleophilic addition to carbonyl carbon;
Chain elongation: Kiliani-Fisher synthesis
Chain shortening: Ruff degradation
Formation and properties of hemiacetals
Formation and properties of acetals
Intramolecular hemiacetal formation: cyclic structures
α,β anomers; conformational stability in glucose
Furanoses and pyranoses
Formation of disaccharides
Reducing and non-reducing disaccharides
Alkylation of free hydroxyl groups with methyl iodide

Analysis and properties:

Chiral properties of polyhydroxyaldehydes
Chiral properties of aldonic acids
Chiral properties of aldaric acids
Historic importance of osazones
Identification of monosaccharides (e.g. Fisher's proof of glucose structure)
Mutarotation as tool to distinguish hemiacetals from acetals
Determination of ring size via methylation analysis
Determination of disaccharide structures via methylation analysis

Amino acids

- α-aminocarboxylic acids as a special group of amino acids
- General structure of α-aminocarboxylic acids
- D, L nomenclature
- R, S nomenclature
- Names and structures of:
  - glycine,
  - alanine,
  - serine,
  - cysteine,
  - aspartic acid,
  - glutamic acid,
  - asparagine,
  - glutamine,
  - phenylalanine,
  - tyrosine, and
  - lysine.

Miscellaneous

- Favoskii rearrangement
- Fenton reagent
- Distinction between S_N1, S_N2, and nucleophilic addition mechanisms