Midterm #1
Chemistry 1315 - Survey of Organic Chemistry

Date: 01-27-04
Time: 9:35 am - 10:55 am
Place: Boggs B-6

You MUST answer question #1 and can choose five out of the next six questions (questions 2 - 7). Mark the question you DO NOT want to have graded. If you do not mark a question, the grader will pick one at random and will not grade it!

You must sign the Honor Code Agreement (If you do not sign it, your exam will not be graded):
Having read the Georgia Institute of Technology Academic Honor Code, I understand and accept my responsibility as a member of the Georgia Tech Community to uphold the Honor Code at all times. In addition, I understand my options for reporting honor violations as detailed in the code.

Name: ___Answer KEY___

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<th>Question</th>
<th>Points possible</th>
<th>Your Score</th>
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Total: 150
Question 1 (25 points)
Explain the following concepts in the space provided below. Use two sentences or less, and/or a formula, and/or a graph:

(a) Rotational Isomer

Compounds with the same molecular formula that only differ by rotation angle around a single bond.

(b) E/Z nomenclature

Nomenclature that uses priority rules (1 point) to describe the configuration of the double bond (1 point). If the two substituents with the highest priority are on the same side of the double bond, that’s Z (1 point), different side Z (1 point).

(c) Hybridization of Atomic Orbitals

Combination (2 points) of atomic s and p orbitals that produces sp hybrids (2 points) that are on the same energy level and explain the spatial arrangement of substituents around the atom.

(d) Heterolytic Cleavage

When the breaking of a bond results in uneven splitting of electrons (2 points), resulting in separation of charges – a cation and an anion.
(e) Markovnikoff’s Rule

During electrophillic addition of a HX reagent to a double bond (1 point), the proton (1 point) will go to the carbon with the most hydrogen substituents (1 point), thus resulting in the most stable carbocation (1 point).

(f) Covalent Bond

A bond between two atoms where the electron pair is shared (4 points) between them.
**Question 2 (25 points)**
Mark all the bonds in the following molecules whether they are $\sigma$ or $\pi$ and also list, which orbitals participate in each of those bonds.

Each proper C or N hybrid identified – 2 points, p orbitals in $\pi$ bonds, 1 point, s orbitals from H - 2 points, proper $\pi$ and $\sigma$ identification 2 points.
Question 3 (25 points)

(a) The following compounds can exist in cis or trans configuration. Mark whether this statement is True / False for each compound.

\[
\begin{align*}
\text{H}_2\text{C} & \text{C} \text{C} \text{C} \text{CH}_3 \\
\text{H}_3\text{C} & \text{T} \text{R} \text{U} \text{E (2 POINTS)} \\
\text{H}_3\text{C} & \text{C} \text{C} \text{COOH} \\
\text{H} & \text{H} \text{T} \text{R} \text{U} \text{E (2 POINTS)} \\
\text{H}_2\text{C} & \text{C} \text{CH}_3 \\
\text{H} & \text{F} \text{A} \text{L} \text{S (2 POINTS)} \\
\text{HOOC} & \text{C} \text{C} \text{COOH} \\
\text{H} & \text{H} \text{T} \text{R} \text{U} \text{E (2 POINTS)}
\end{align*}
\]

(b) Mark the following compounds with the proper E/Z descriptors and name them according to the IUPAC nomenclature:

\[
\begin{align*}
\text{H}_3\text{C} & \text{CH}_2 \text{F} \\
\text{Br} & \text{H} \text{E (2 points) – 1 fluoro-2-bromo butene (2 points)} \\
\text{H}_3\text{C} & \text{Cl} \\
\text{H} & \text{H} \text{Z (2 points) – 3-chloro-2-pentene (2 points)} \\
\text{ClH}_2\text{C} & \text{Br} \\
\text{H}_3\text{CH}_2\text{C} & \text{CH}_2\text{CH}_3 \text{Z (2 points) 3-bromo-4-chloromethyl-3-hexene (2 points)}
\end{align*}
\]
Question 4 (25 points)

Name the following structures according to the IUPAC nomenclature:

5-bromo-7-chloro-4-ethyl-2-nonene

4-fluoro-1-iodopentyne

4-bromo-8-methyl-2,4,8-undecatriene

4-bromo-2-chloropentane

fluorocyclohexane

2-bromo-1-methylocyclohexane

3,3,3-trifluoropropyne

2,3-dibromo-2-methyl-butane

proper main chain and substituent identification – 2 points
proper numbering – 1 point
**Question 5 (25 points)**

Mark the acidic/basic sites on the following molecules by circling them and writing “acid” or “base” next to them. There could be more than one site per molecule, also a molecule might contain both acidic, and basic site.

Because no electron pairs were drawn on the last compound, those sites were not considered for grading. If you circled a site that could be either acidic or basic and only put one option down without explanation, credit was only given if the option you picked was the prevalent one – reflected in the grading scheme.
Question 6 (25 points)

Write step-by-step mechanisms for the following reactions. Make sure you show all the intermediates:

A) 
Each correct intermediate and product – 4 points. 
Each arrow – 2 points. 
Each charge – 1 point

B) 
(two products possible - show both)

Each intermediate and product – 2 points 
Each arrow set (mechanism step)– 2 points 
Each charge – 1 point
Question 7 (25 points)

Above are the chair conformation structures of *trans* and *cis* decalin. Explain why *trans*-decalin cannot undergo a ring-flip, while *cis*-decalin does undergo a ring flip, thus reverting all axial – equatorial positions. All the “sticks” sticking out in the structure are hydrogens.

In *trans* decalin, both alkyl chains are in equatorial position. If the ring flips, they will both become axial, thus resulting in an energetically unfavorable conformation. The species drawn is therefore the most stable conformation. (5 points) In *cis* decalin, one alkyl chain is axial and one equatorial. If the ring flips, their positions will switch, resulting in a species of exactly the same energy as before.

*Trans* more stable than *cis* - 5 points

Proper assignation of axial / equatorial substituents – 10 points

Proper axial / equatorial argument – 5 points.