**YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM**

- PRINT YOUR NAME ON EACH PAGE!
- READ THE DIRECTIONS CAREFULLY!
- USE BLANK PAGES AS SCRATCH PAPER
- WORK ON BLANK PAGES WILL NOT BE GRADED...
- DON'T CHEAT, USE COMMON SENSE!

**Infrared Correlation Chart**

- **Interaction Energies, kcal/mol**
  - Eclipsing
  - Gauche
  - H/H
  - Me/Me
  - Et/Me
  - i-Pr/Me
  - t-Bu/Me

- **NMR Correlation Charts**
  - Alkyl
  - Aromatic
  - Alkyl

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**Chemical Elements**

<table>
<thead>
<tr>
<th>Periodic Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
</tr>
<tr>
<td>Li Be</td>
</tr>
<tr>
<td>Na Mg</td>
</tr>
<tr>
<td>K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr</td>
</tr>
<tr>
<td>Rb Sr Y Ir Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe</td>
</tr>
<tr>
<td>Cs Ba Lu Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn</td>
</tr>
</tbody>
</table>
YOU MUST COMPLETE THIS PAGE WITH YOUR NAME
(EVEN THOUGH YOU ALREADY DID THIS ON THE COVER PAGE)
AND ALSO GIVE YOUR ASU OR POSTING ID NUMBER
WE NEED THIS NUMBER BECAUSE YOU WOULDN'T BELIEVE THE NUMBER OF
STUDENTS WHOSE NAMES WE CAN'T READ!

PRINTED ANSWER PRINTED KEY ASU ID or Posting ID
FIRST NAME ___________________ LAST NAME ___________________

Points by question
1 ____________/11
2 ____________/24
3 ____________/18
4 ____________/18
5 ____________/32
6 ____________/30
7 ____________/20
8 ____________/22

Points Removed for cover errors ___/2

Extra Credit___/5

Total (incl Extra) ________/175+5

**YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM**
Question 1 (11 pts.) Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.

\[(2S)-\text{ethoxyhex-(4E)-en-(3R)-ol}\]

Question 2 (24 pts.) Show how you would make the target compound on the right from the starting compound on the left. Show reagents and conditions where appropriate, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms. Ignore stereochemistry.
Question 3 (18 pts) Give the major organic products of the following reactions, indicate the stereochemistry using wedged/dashed bonds as appropriate and be sure to indicate the presence of any racemic mixtures.

a) \[
\begin{align*}
\text{O} & \quad \text{Na}^+ - \text{OMe} \\
\text{MeOH} & \quad \text{MeOH}
\end{align*}
\]

b) \[
\begin{align*}
\text{Me}_2\text{N} & \quad \text{CHO} \\
\text{heat} & \quad \text{heat}
\end{align*}
\]

Question 4 (18 pts.) For the following structure:
1. Decide which of the bonds A and B it is possible to make in a Grignard reaction
2. Indicate which bond you can make in a Grignard reaction, A or B, and give the Grignard reagent and the structure it would react with in the provided boxes (you can ignore the \( \text{H}_3\text{O}^+ \) acid workup step)
3. Briefly state why the other bond (A or B) cannot be made.

Bond \( \text{A} \) can be made as follows:

The problem with making bond \( \text{B} \) is: the Grignard would have to attack the most substituted side of an epoxide
Question 5 (32 pts.) For the following reaction, give a full curved-arrow pushing mechanism for formation of BOTH products and indicate the Lewis acid and base at each step (LA or LB) and whether they are also Bronsted acids and bases (BA or BB). Include all reasonable resonance contributors for any intermediates AND INDICATE THE MAJOR RESONANCE CONTRIBUTOR IF APPROPRIATE!!

b) Indicate which product, A or B, would be formed under thermodynamically controlled conditions and which would be formed under kinetically controlled conditions and give a BRIEF explanation of the role of temperature in determining kinetic and thermodynamic control.

kinetic = A, thermodynamic = B, B is more likely to be formed at HIGH temperature since higher temperature enables REVERSIBLE reactions and allows the reaction to explore the entire reaction energy surface and find the lowest energy product, at low temperatures the reactions are irreversible and the fastest formed product is the major product.
Question 6 (30 pts)
a) Give the curved arrow-pushing and the allowed product for the following cycloaddition reaction. Be sure to completely describe the stereochemistry in the product.

b) ON TOP of the structures as indicated, draw the requested F.M.O.s and give the total number of \( \pi \)-molecular orbitals and electrons associated with the \( \pi \)-system for each structure.

c) Is the ALLOWED reaction suprafacial or antarafacial with respect to reactant A?

d) Is the ALLOWED reaction suprafacial or antarafacial with respect to reactant B?

Extra Credit (5 pts) Which of the following chemical properties enables the pharmacological activity of the drug olanzapine?

- aromatic
- non-aromatic
- anti-aromatic
Question 7 (20 pts)
a) Give the curved arrow-pushing and the allowed product for the following electrocyclic ring closure reaction, indicate the stereochemistry using wedged/dashed bonds as appropriate and be sure to indicate the presence of any racemic mixtures.

\[
\begin{array}{c}
\text{heat} \\
\text{(±) OR... racemic mixture}
\end{array}
\]

b) ON TOP OF THE STRUCTURE, draw the HOMO of the reactant cation
c) To form YOUR ALLOWED product, did the reaction proceed via a conrotatory or a disrotatory ring closure? **conrotatory**

Question 8 (22 pts). For the following electrocyclic ring-opening reaction
a) Give the product, including stereochemistry and draw the curved arrow-pushing that describes bond making/breaking

\[
\begin{array}{c}
\text{heat} \\
\text{6}
\end{array}
\]

b) give the number of electrons involved in the reaction

c) For the number of electrons you gave in the answer to b) above, would that many electrons in a Huckel loop be aromatic, nonaromatic or antiaromatic? **aromatic**

d) For the number of electrons you gave in the answer to b) above, would that many electrons in a Mobius loop be aromatic, nonaromatic or antiaromatic? **antiaromatic**

e) State whether the allowed reaction would proceed via a Huckel or a Mobius transition state **Hückel**

f) State whether the allowed reaction is conrotatory or disrotatory **Disrotatory**

e) Is the transition state for the allowed reaction, aromatic, nonaromatic or anti-aromatic? **aromatic**