Exam II
28 July 2005
Name: ________________________________

• This exam contains 5 pages of questions – confirm this once you begin.
• You will have 50 minutes
• An abbreviated Periodic Table can be found on page 5.
• No calculators or models are permitted.
• Read all questions carefully – answer the question that is asked!
• Illegible or indecipherable answers may not receive potential partial credit.
• Good luck!

1. (4 pts) Mark with an asterisk (*) all chiral centers in the following molecules.

\[
\begin{align*}
\text{O} & \quad \text{C} & \quad \text{H}_3 \\
\text{Ph} & \quad & \\
\text{OCH}_3 & \quad & \text{Ph}
\end{align*}
\]

2. (4 pts) Assign absolute configuration (R or S) to each chiral center.

\[
\begin{align*}
\text{Br} & \quad \text{H}_4 \\
1 & \quad 2 & \quad 3
\end{align*}
\]

low priority group is in back - read directly

\[
\begin{align*}
\text{H}_2 & \quad \text{OCH}_3 \\
1 & \quad 2 & \quad 3 & \quad 4
\end{align*}
\]

low priority group is in front - assign opposite of what is shown

3. (5 pts) Fill in the missing structures.

\[
\begin{align*}
\text{Br} & \quad \text{Br}_2 \\
\text{FeBr}_3 & \quad \text{Br}_2 \\
\text{FeBr}_3 & \quad \text{Br} & \quad \text{Br}_2 \\
\text{Br} & \quad \text{NO}_2 & \quad \text{Br} & \quad \text{NO}_2
\end{align*}
\]

Starting monosubstituted benzene

reactant and catalyst

You cannot start with bromobenzene as Br is an o,p-director and would give only the following products.
4. (6 pts) What are the three steps common to every electrophilic aromatic substitution reaction?

1) Generation of a good electrophile (E⁺)

2) Attack of the aromatic pi-bond on the E⁺

3) Loss of a proton (at the site of substitution) to restore aromaticity

5. (6 pts) Provide resonance structures for the following species.

6. (4 pts) Circle the monomer that would lead to the corresponding polymer.
7. (6 pts) Provide the 1,2- and 1,4-addition products for the reaction between bromine and 1,3-cyclohexadiene.

![Reaction Diagram]

*Note: this is not an aromatic ring!!*

8. (9 pts) From the following group of molecules identify:

   a) a pair of enantiomers: __A__ + __E__  
      (or C + G)

   b) a pair of diastereomers: __A__ + __B__  
      (or A + F or B + E or E + F)

   c) two identical compounds: __B__ = __F__

   d) a meso compound: __B or F__

   e) two optically *inactive* compounds: __B, D, or F__

9. (6 pts) 1-Bromo-1,2-dimethylcyclopentane can be produced by the addition of H-Br to three different alkenes. Provide the structures of these alkenes on the lines.

![Alkenes Diagram]

*These are all positional isomers that, if treated with H-Br, will lead to the product shown. Be sure to count carbons!*
10. (16 pts) Clearly circle the correct answer for the following questions. There is only one correct answer for each; no credit will be given if more than one answer is circled for each question.

a) Circle the one structure that is optically active.

b) Circle the compound that will react fastest in an electrophilic aromatic substitution reaction.

c) Circle the compound that will react slowest in an electrophilic aromatic substitution reaction.

d) Identify the most stable carbocation.

e) Identify the most stable carbocation.

f) Identify the most stable alkene.

g) Which of the following represent naphthalene?

h) Identify the aromatic compound possessing a meta-directing substituent.
11. (9 pts) Provide the two products that are possible from the following hydrohalogenation reaction.

![Reaction Diagram]

The expected major product is: \( \text{A} \)

The Markovnikov product is: \( \text{A} \)

Draw a mechanism showing how the Markovnikov product is formed. Pay attention to your lone pairs and formal charges where appropriate.

Two steps!

This is the nucleophile; the arrow starts from the source of electron density - the pi bond - and points toward the \( \delta^+ \).

The bromide is now the nucleophile - start an arrow from it and point to the electron-deficient carbocation.

<table>
<thead>
<tr>
<th>Page</th>
<th>Score</th>
<th>Possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>