Due in class: Tuesday, Feb. 20, 2007 at 12:05 pm.

1. For each molecule:
   - Indicate whether or not it is chiral or achiral at 25 °C.
   - Assign absolute configuration to all stereocenters using the Cahn-Ingold-Prelog convention.
   - For achiral molecules, describe the symmetry element.

   a. ![Molecule a](image)
   b. ![Molecule b](image)
   c. ![Molecule c](image)
   d. ![Molecule d](image)
   e. ![Molecule e](image)
   f. ![Molecule f](image)
   g. ![Molecule g](image)
   h. ![Molecule h](image)

2. For each pair of compounds:
   - Specify the isomeric relationship (i.e., identical, constitutional isomers, diastereomers, or enantiomers).
   - Assign absolute configuration to all stereocenters using the Cahn-Ingold-Prelog convention.

   a. ![Compound a](image)
   b. ![Compound b](image)
   c. ![Compound c](image)

3. For each of the circled groups indicate their topological relationship.

   ![Group 1](image)
   ![Group 2](image)
   ![Group 3](image)
4. Consider the following reaction:

\[
\text{CH}_2=\text{CHMgBr} \quad \xrightarrow{\text{THF, 0 °C; H}_2\text{O (workup)}} \quad \stackrel{\text{SM (optically pure)}}{\text{P-I}} \quad \stackrel{\text{P-II}}{\text{SM}}
\]

a) Provide the structure of the two principal addition products, clearly indicating stereochemistry, and assign the Cahn-Ingold-Prelog configuration to each stereocenter of the SM and products.

b) Indicate whether each product is a chiral or an achiral compound.

- P-I: Chiral
- P-II: Chiral
- SM: Achiral
- P-I: Achiral
- P-II: Achiral

c) What is the isomeric relationship between the two products (i.e. constitutional isomers, enantiomers, or diastereomers).

d) Do you expect the products to be formed in equal (1:1) or unequal amounts.

e) Draw a reaction coordinate diagram that is consistent with your answer in part 4d, clearly labeling the position of P-I, P-II, SM, and transition state structure(s).

5. Consider the following data:

<table>
<thead>
<tr>
<th>Compound</th>
<th>( \Delta G^\circ ) for inversion (kcal/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.0</td>
</tr>
<tr>
<td>2</td>
<td>20.5</td>
</tr>
<tr>
<td>3</td>
<td>17.1</td>
</tr>
<tr>
<td>4</td>
<td>11.7</td>
</tr>
</tbody>
</table>

a) Explain why the activation energy for inversion of 2 is greater than that for 1. Provide an energy diagram.

b) Why is the activation energy for inversion of 3 less than that for 2. Provide an energy diagram.

c) Why is the activation energy for inversion of 4 less than that for 2. Provide an energy diagram.

6. Consider the following two esters:

\[
\begin{align*}
\text{CO}_2\text{Et} & \quad \text{Bu} \quad \text{CO}_2\text{Et} \\
\text{Ester A} & \quad \text{B}
\end{align*}
\]

Ester A is observed to undergo base catalyzed hydrolysis 20 times faster than ester B. Provide an explanation for this result and support your answer using clear and detailed drawings.