1. Name the following two compounds [8 pts]. Where it is important, points are explicitly allocated for stereochemistry.

(a)  
(b)  

2. Draw the structures of the following two compounds [8 pts].
(a) cis-1-bromo-2,2-dimethyl-4-octene.  
(b) E-1,3-diethylcyclobutane.

3. Draw the following compound in the lowest-energy chair conformation and name it [6 pts].

4. Draw the structure of the major organic product of each of the following reactions. Where stereochemistry is important, points have been allotted explicitly to it [4 pts each; 40 pts].

(a)  
(b)  
(c)  
(d)  
(e)  
(f)  
(g)  
(h)  
(i)  
(j)  

5. (a) Draw a fully-labeled reaction potential energy profile (reaction coordinate diagram) for the following reaction, which proceeds via the intermediates shown [8 pts]. Your diagram should show the location and relative energy of every transition state and intermediate.

Cl slow  fast  fast  Cl
(b) Draw the mechanism of the reaction in question 5(a) by using the appropriate curly arrows and reagents [6 pts]

6. In each of the following reactions, either the starting compound or the reagent is missing. Complete each reaction by supplying the missing information [4 pts each; 24 pts]

(a) ? \(\xrightarrow{\text{Br}_2/\text{H}_2\text{O}}\) \(\text{OH-Br}\) (d) ? \(\xrightarrow{\text{Br}_2/\text{CCl}_4}\) \(\text{OH-Br}\)

(b) \(\begin{array}{c} \text{cyclohexene} \\ \end{array}\) \(\xrightarrow{?}\) \(\text{cyclohexene-\text{OH}}\) (e) \(\begin{array}{c} \text{cyclopentene} \\ \end{array}\) \(\xrightarrow{?}\) \(\text{cyclopentene-\text{OH}}\)

(c) ? \(\xrightarrow{\text{Br}_2/\text{H}_2\text{O}}\) \(\text{OH-Br}\) (f) \(\begin{array}{c} \text{cyclohexene} \\ \end{array}\) \(\xrightarrow{?}\) \(\text{cyclohexene-\text{OH}}\)

1. Name the following two compounds [8 pts]. Where it is important, points are explicitly allocated for stereochemistry.

(a) \(\begin{array}{c} \text{cyclopentane} \\ \end{array}\) (b) \(\begin{array}{c} \text{cyclohexene} \\ \end{array}\)

2. Draw the structures of the following two compounds [8 pts].
(a) \(R\)-1-bromo-2-methylpentane. (b) \(E,3,4\)-dimethyl-1,3-hexadiene.

3. How many chiral centers are there in the podocarpic acid molecule, below? [2 points]

![Podocarpic Acid](image)

4. In each of the following reactions, either the starting compound or the reagent is missing. Complete each reaction by supplying the missing information. Note that more than one step may be required to complete each transformation shown. [4 pts each; 24 pts]
5. What is the relationship between the two compounds of each of the pairs of structures below, are they enantiomers, diastereoisomers or constitutional isomers, are they totally different compounds, or are they identical? [2 pts each, 12 pts]

(a) ![Structure A](image1) → ![Structure B](image2)  
(b) ![Structure C](image3) → ![Structure D](image4)  
(c) ![Structure E](image5) → ![Structure F](image6)

6. The cation below is resonance-stabilized. Draw two other reasonable contributing structures for this cation, and specify which is the major contributor. [6 pts]

![Cation](image7)

7. Draw the structure of the major organic product of each of the following reactions. Where stereochemistry is important, points have been allotted explicitly to it [4 pts each; 32 pts].

(a) ![Reaction A](image8)  
(b) ![Reaction B](image9)  
(c) ![Reaction C](image10)  
(d) ![Reaction D](image11)  
(e) ![Reaction E](image12)  
(f) ![Reaction F](image13)
8. Design a synthesis of the molecule below beginning from acetylene and any other compounds. Where appropriate, stereochemistry is important. [8 pts]

\[
\begin{align*}
&\text{(c)} \quad \text{acetylene} \xrightarrow{\text{Br}_2/\text{CCl}_4/\Delta} \text{brass role}\text{ (1 mol Br}_2\text{ only)} \\
&\text{(d)} \quad \text{C≡C} \xrightarrow{1) \text{NaNH}_2, 2) \text{CH}_3\text{CH}_2\text{Br}} \text{alkene} \\
&\text{(g)} \quad \text{cyclohexane} \xrightarrow{\text{H}_2/\text{Pd-C}} \text{product} \\
&\text{(h)} \quad \text{alkene} \xrightarrow{1) \text{BH}_3\cdot\text{THF}, 2) \text{H}_2\text{O}_2/\text{NaOH}/\text{H}_2\text{O}} \text{product}
\end{align*}
\]

1. Name the following four compounds [16 pts]. Where it is important, points are explicitly allocated for stereochemistry.

(a) \[
\end{align*}
\]

(b) \[
\end{align*}
\]

(c) \[
\end{align*}
\]

(d) \[
\end{align*}
\]

2. Draw the structures of the following four compounds [16 pts].

(a) \text{R-1-bromo-2-chloropentane.} \\
(b) \text{E-3,4-dibromo-1,3-hexadiene.}
3. Draw the lowest energy conformations of the two compounds below [8 pts].
   (a) E-1,3-difluorocyclohexane. 
   (b) 1,1,2,2-tetrachloroethane.

4. Draw the structure of the major organic product of each of the following reactions. Where stereochemistry is important, points have been allotted explicitly to it [4 pts each; 32 pts].

   (a) \[ \text{H}_2\text{C} \equiv \text{C} \quad \overset{\text{H}_2\text{SO}_4/\text{H}_2\text{O}}{\longrightarrow} \quad \text{HgSO}_4 \]

   (b) \[ \text{H}_2/\text{Pt} \]

   (c) \[ \text{Br}_2/\text{CCl}_4/\Delta \quad (1 \text{ mol } \text{Br}_2 \text{ only}) \]
5. What is the relationship between the two compounds of each of the pairs of structures below, are they identical in all respects, are they isomers (specify if they are enantiomers, diastereoisomers or constitutional isomers), or are they totally different compounds? [2 pts each, 6 pts]

(a) \( \text{H}_2\text{C} = \text{C} \) and \( \text{H}_2\text{C} = \text{C} \)

(b) \( \text{H}_3\text{C} - \text{C} - \text{N} - \text{CH}_3 \) and \( \text{H}_3\text{C} - \text{C} - \text{N} - \text{CH}_3 \)

(c) \( \text{H}_3\text{C} = \text{C} - \text{O} \) and \( \text{H}_3\text{C} = \text{O} \)
6. The ion below is resonance-stabilized with the formal charge on the oxygen atom. All non-hydrogen atoms in this structure have a complete octet of electrons. What is the charge on the ion?

Complete the structure of this ion, draw another reasonable contributing structure for this ion, and specify which is the major contributor. [6 pts]

7. In each of the following reactions, either the starting compound or the reagent is missing. Complete each reaction by supplying the missing information. Note that more than one step may be required to complete each transformation shown. [4 pts each; 24 pts]

(a) 

(b) 

(c) 

(d) 

(e) 

(f) 

8. Complete the following synthesis sequence by supplying the missing structures or reagents as appropriate [9 pts.]

\[
\text{Br} \quad \xrightarrow{\text{HC=CNa}} \quad \text{HC=CNNa} \xrightarrow{\text{HCl}} \quad \text{HCl}
\]

9. Draw the structure of the major organic product of each of the following reactions. Where regiochemistry and/or stereochemistry are important, points have been allotted explicitly to them [4 pts each; 28 pts].

(a) \[
\text{HC=CN} \quad \xrightarrow{\text{C}} \quad \text{HC=CN}
\]

(b) \[
\text{Br} \quad \xrightarrow{\text{KSC} \text{H}_3/\text{DMSO}} \quad \text{KSC} \text{H}_3/\text{DMSO}
\]

(c) \[
\text{Br} \quad \xrightarrow{\text{AgNO}_3/\text{H}_2\text{O}/\text{CH}_3\text{CH}_2\text{OH}} \quad \text{(C}_7\text{H}_{14}\text{O)}
\]
10. (a) Arrange the following halides in increasing order of their S_N2 reactions with CH_3S^- ion. Mark the slowest "1," the fastest "4" [3 pts].

(b) Arrange the following halides in increasing order of their S_N1 reactions with H_2O. Mark the slowest "1," and the fastest "4" [3 pts].

11. In each of the following reactions, either the starting compound or the reagent is missing. Complete each reaction by supplying the missing information. Note that more than one step may be required to complete each transformation shown. [4 pts each; 24 pts]
12. Draw the structure of the major resonance contributor to the resonance hybrid of the cation below, and assign hybridization to each carbon and oxygen atom in the major resonance contributor [6 pts].

\[ \text{CH}_3\text{—CO}^+ \]
13. Write a rational mechanism to account for the conversion of the starting compound below to the product given. Your mechanism should account for the stereochemistry of the reaction [9 pts].

14. Design a synthesis of the following compound from any starting material containing 6 carbon atoms or less. You may use ANY starting material provided that it has no more than 6 carbon atoms [10 pts].

(What does ANY mean??).

1. [5 pts.] Give the correct IUPAC name of the compound in the table below corresponding to digit D of your BLUGOLD:

<table>
<thead>
<tr>
<th>0 or 1</th>
<th>2 or 3</th>
<th>4 or 5</th>
<th>6 or 7</th>
<th>8 or 9</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
</tbody>
</table>

2. [5 pts.] Draw the structure of the compound below corresponding to digit C of your BLUGOLD:

| 0 or 1: Z-3-fluorocyclohexanol | 2 or 3: E-2-fluorocyclohexanol |
| 4 or 5: E-4-fluorocyclohexanol | 6 or 7: Z-4-fluorocyclohexanol |
| 8 or 9: E-4-fluorocyclohexanol |

3. [5 pts.] Draw the lowest energy conformation of the compound in Question 2 corresponding to digit G of your BLUGOLD.
The synthesis of 1-bromo-1-methylcyclohexane from Z-2-methylcyclohexanol proceeds through the following sequence of compounds:

\[
\text{Me} \quad \overset{\text{Me}}{\text{Me}} \quad \overset{\text{OH}}{\text{Me}} \quad \overset{\text{OH}_2}{\text{Me}} \quad \overset{\text{H}}{\text{Me}} \quad \overset{\text{Me}}{\text{Me}} \quad \overset{\text{Me}}{\text{Br}}
\]

(a) [5 pts.]
BLUGOLD digit E: 0-4: What is the highest-energy intermediate in this reaction? 
BLUGOLD digit E: 5-9: What is the lowest-energy intermediate in this reaction?

(b) [10 pts.] Draw a fully-labeled reaction potential energy profile (reaction coordinate diagram) for the reaction. Your diagram should show the location and relative energy of every transition state and intermediate. PAY PARTICULAR ATTENTION TO THE RELATIVE ENERGIES OF ALL SPECIES INVOLVED

(c) [5 pts] Draw the mechanism of this reaction by using the appropriate curly arrows and other needed reactant species [5 pts].

5. [5 pts. each] Complete the following reactions by drawing the structure of the final product, using the starting compound based on your BLUGOLD nimber as specified.

**ALKENES:**

<table>
<thead>
<tr>
<th>BLUGOLD digit</th>
<th>Reaction Conditions</th>
<th>Product Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>(\text{H}_2\text{SO}_4/\text{H}_2\text{O})</td>
<td>![Product Image]</td>
</tr>
<tr>
<td>D</td>
<td>(\text{Br}_2/\text{H}_2\text{O})</td>
<td>![Product Image]</td>
</tr>
<tr>
<td>B</td>
<td>(\text{IN}_3/\text{CH}_2\text{Cl}_2)</td>
<td>![Product Image]</td>
</tr>
<tr>
<td>G</td>
<td>(\text{HCl})</td>
<td>![Product Image]</td>
</tr>
</tbody>
</table>

(a) BLUGOLD digit F

(b) BLUGOLD digit D

(c) BLUGOLD digit B

(d) BLUGOLD digit G
6. [5 pts. each] Complete the following reactions by drawing the structure of the final product, using the starting compound based on your BLUGOLD nimber as specified.

**ALKENES:**

<table>
<thead>
<tr>
<th>0 or 1</th>
<th>2 or 3</th>
<th>4 or 5</th>
<th>6 or 7</th>
<th>8 or 9</th>
</tr>
</thead>
<tbody>
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<td><img src="image" alt="alkene structure" /></td>
<td><img src="image" alt="alkene structure" /></td>
<td><img src="image" alt="alkene structure" /></td>
<td><img src="image" alt="alkene structure" /></td>
</tr>
</tbody>
</table>

(a) BLUGOLD **digit B**
(b) BLUGOLD **digit C**
(c) BLUGOLD **digit G**
(d) BLUGOLD **digit F**
(e) BLUGOLD **digit G**
(f) BLUGOLD **digit F**

7. [5 pts. each] Complete the following reactions by drawing the structure of the starting alkene or providing the structure of the missing reagent, using the final compound based on your BLUGOLD number as specified.

(a) alkene \( \xrightarrow{\text{Br}_2/\text{H}_2\text{O}} \) ![alkene structure](image)
   - **BLUGOLD digit B:**
     - 0-4
     - 5-9

(b) alkene \( \xrightarrow{\text{DBr}} \) ![alkene structure](image)
   - **BLUGOLD digit E:**
     - 0-4
     - 5-9

(c) alkene \( \xrightarrow{?} \) ![alkene structure](image)
   - **BLUGOLD digit D:**
     - 0-4
     - 5-9
1. Name the following compounds based on digit C of your BLUGOLD [4 pts each; 8 pts].

<table>
<thead>
<tr>
<th>BLUGOLD</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

1 (a)

<table>
<thead>
<tr>
<th></th>
<th>0.1</th>
<th>2.3</th>
<th>4.5</th>
<th>6.7</th>
<th>8.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 (b)

<table>
<thead>
<tr>
<th></th>
<th>0.1</th>
<th>2.3</th>
<th>4.5</th>
<th>6.7</th>
<th>8.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2 Draw the structures of the following compounds based on digit D of your BLUGOLD [4 pts each; 8 pts].

<table>
<thead>
<tr>
<th>BLUGOLD</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

2 (a)

<table>
<thead>
<tr>
<th></th>
<th>0 or 1: R-2-pentanol</th>
<th>2 or 3: S-1-cyclopentylethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 or 1</td>
<td>4 or 5: S-5-hexen-2-ol</td>
<td>6 or 7: R-2-cyclohexenol</td>
</tr>
<tr>
<td>0 or 1</td>
<td>8 or 9: R-3-bromo-4,4-diethyloctane</td>
<td></td>
</tr>
</tbody>
</table>

2 (b)

<table>
<thead>
<tr>
<th></th>
<th>0 or 1: 1,4-dicyclobutyl-1-butyne</th>
<th>2 or 3: 1,4-dicyclobutyl-2-butyne</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 or 1</td>
<td>4 or 5: 5-pentyn-1-ol</td>
<td>6 or 7: 1,2-dicyclohexylethylene</td>
</tr>
<tr>
<td>0 or 1</td>
<td>8 or 9: R-3-bromo-4,4-diethyloctane</td>
<td></td>
</tr>
</tbody>
</table>

3. Select the chiral compound corresponding to on digit E of your BLUGOLD. Give the correct IUPAC name of this compound, INCLUDING STEREOCHEMISTRY [12 pts; 9 pts allocated to stereochemistry].

<table>
<thead>
<tr>
<th>BLUGOLD</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
4. From the compounds in Question 4, select a pair of compounds related to each other as enantiomers [3 pts].

5. Draw the structure of the major organic product for the reactions corresponding to digit F of your BLUGOLD. [4 pts. each; 24 pts.] Points have been explicitly allocated to stereochemistry.

<table>
<thead>
<tr>
<th>BLUGOLD NUIMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (a) 0,1</td>
<td><img src="image1.png" alt="Image of structure" /></td>
<td><img src="image2.png" alt="Image of structure" /></td>
<td>2,3</td>
<td><img src="image3.png" alt="Image of structure" /></td>
<td><img src="image4.png" alt="Image of structure" /></td>
<td>6,7</td>
<td>8,9</td>
</tr>
<tr>
<td>4,5</td>
<td><img src="image5.png" alt="Image of structure" /></td>
<td><img src="image6.png" alt="Image of structure" /></td>
<td>6,7</td>
<td>8,9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5 (b)

<table>
<thead>
<tr>
<th>BLUGOLD NUIMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (b) 0,1</td>
<td><img src="image7.png" alt="Image of structure" /></td>
<td><img src="image8.png" alt="Image of structure" /></td>
<td>2,3</td>
<td><img src="image9.png" alt="Image of structure" /></td>
<td><img src="image10.png" alt="Image of structure" /></td>
<td>6,7</td>
<td>8,9</td>
</tr>
<tr>
<td>4,5</td>
<td><img src="image11.png" alt="Image of structure" /></td>
<td><img src="image12.png" alt="Image of structure" /></td>
<td>6,7</td>
<td>8,9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5 (c)

<table>
<thead>
<tr>
<th>BLUGOLD NUIMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (c) 0,1</td>
<td><img src="image13.png" alt="Image of structure" /></td>
<td><img src="image14.png" alt="Image of structure" /></td>
<td>2,3</td>
<td><img src="image15.png" alt="Image of structure" /></td>
<td><img src="image16.png" alt="Image of structure" /></td>
<td>6,7</td>
<td>8,9</td>
</tr>
<tr>
<td>4,5</td>
<td><img src="image17.png" alt="Image of structure" /></td>
<td><img src="image18.png" alt="Image of structure" /></td>
<td>6,7</td>
<td>8,9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Write a reasonable mechanism for the following transformation based on digit G of your 
BLUGOLD. [8 pts.]

BLUGOLD A B C D E F G
7. From the sets of pairs of compounds below, select the set which represents
   (a) a pair of enantiomers [2 pts]  
   (b) a pair of diastereomers [2 pts]  
   (c) a pair of tautomers [2 pts]  
   (d) a meso compound [2 pts]

   A. \[ \text{Br} \quad \text{and} \quad \text{CH(CH}_3)_2 \text{Br} \]
   B. \[ \text{O} \quad \text{and} \quad \text{OH} \quad \text{OH} \]
   C. \[ \text{Br} \quad \text{CH}_3 \quad \text{and} \quad \text{H} \quad \text{CH(CH}_3)_2 \text{H} \]
   D. \[ \text{OH} \quad \text{and} \quad \text{OH} \quad \text{OH} \]
   E. \[ \text{OH} \quad \text{and} \quad \text{CO} \quad \text{and} \quad \text{CH}_3 \]
   F. \[ \text{OH} \quad \text{and} \quad \text{OH} \quad \text{OH} \]

8. In each of the following reactions, either the starting compound or the reagent is missing. Complete the reaction corresponding to digit G of your BLUGOLD by supplying the missing information. Note that more than one step may be required to complete each transformation shown. [4 pts each; 16 pts]

   8 (a)

   \[
   \begin{array}{lllllll}
   \text{BLUGOLD} & A & B & C & D & E & F & G \\
   \text{NUIMBER} & & & & & & & \\
   \end{array}
   \]

   0, 1  \[ ? \quad 1) \text{NaNH}_2 \quad 2) \text{BrCH}_2\text{CH}_2\text{CH}_3 \quad 3) \text{H}_2/\text{Pt} \quad ? \quad 1) \text{NaNH}_2 \quad 2) \text{BrCH(CH}_3)_2 \quad 3) \text{H}_2/\text{Pt} \\
   \]
9. Arrange the following species in increasing order of their stability (least stable first, most stable last) [2 pts].

\[ \text{A} \quad \text{B} \quad \text{C} \quad \text{D} \quad \text{E} \]

10. What is (are) the major organic product(s) of the reaction in the set below corresponding to digit D of your BLUGOLD? [6 pts] Note that stereochemistry is important.

<table>
<thead>
<tr>
<th>BLUGOLD</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUIMBER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \begin{array}{c|c|c} 
0,1,2 & \text{Br}_2/H_2O & 3,4,5 \\
6,7 & \text{Br}_2/H_2O & 8,9 \\
\end{array} \]

11. Design a synthesis of the molecule below beginning from acetylene and any other compounds. Where appropriate, stereochemistry is important. [8 pts]

\[ \text{D} \quad \text{D} \quad \text{D} \quad \text{D} \quad \text{D} \]

1. Name the following compounds based on digit C of your BLUGOLD [5 pts each; 20 pts]. Where appropriate, points are explicitly allocated to stereochemistry.

<table>
<thead>
<tr>
<th>BLUGOLD</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUIMBER</td>
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</tbody>
</table>

1 (a) \quad 1 (b)
2. Draw the structures of the following compounds based on digit D of your BLUGOLD [5 pts each; 20 pts]. Where appropriate, points are explicitly allocated to stereochemistry.

<table>
<thead>
<tr>
<th>BLUGOLD NUMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>2 (a)</td>
<td></td>
<td></td>
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<tr>
<td>1,1,4-triethylcyclohexane</td>
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<tr>
<td>1,1,5-tripropylcyclooctane</td>
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<td>0-4</td>
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<tr>
<td>5-9</td>
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<tr>
<td>2 (b)</td>
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<tr>
<td>(2E,4Z)-4-fluoro-2,4-heptadiene</td>
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<tr>
<td>(2Z,4E)-4-fluoro-2,4-heptadiene</td>
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<td>0-4</td>
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<td>5-9</td>
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<tr>
<td>2 (c)</td>
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<tr>
<td>R-3-bromohexane</td>
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<tr>
<td>S-2-chloro-5-methylhexane</td>
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<tr>
<td>0-4</td>
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<td>5-9</td>
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<td>2 (d)</td>
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<tr>
<td>E-2-ethynylcyclohexanol</td>
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<tr>
<td>Z-3-ethynylcyclohexanol</td>
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<tr>
<td>0-4</td>
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<td></td>
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<tr>
<td>5-9</td>
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</tbody>
</table>

3. Draw the lowest energy conformation of either neomenthol or epimenthol, depending on digit E of your BLUGOLD [5 pts.]
4. When anisole (C₆H₅OCH₃) reacts with bromine and a Lewis acid, two substitution products are isolated. The two cations below are formed as intermediates in these reactions. Draw the resonance contributors to the structure of the ion corresponding to digit B of your BLUGOLD, and circle the major contributor [15 pts.]

<table>
<thead>
<tr>
<th>BLUGOLD NUMBER</th>
<th>A</th>
<th>B</th>
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<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
</table>

| H₃CO | H₃CO |
| Br- | Br- |

4. When anisole (C₆H₅OCH₃) reacts with bromine and a Lewis acid, two substitution products are isolated. The two cations below are formed as intermediates in these reactions. Draw the resonance contributors to the structure of the ion corresponding to digit B of your BLUGOLD, and circle the major contributor [15 pts.]

5. (a) Write a rational mechanism for the reaction below [10 pts]. Ignore stereochemistry.

5. (b) Draw a fully-labeled reaction energy profile for the reaction [5 pts]. Pay particular attention to the energy of all species involved.
6. Draw the structure of the major organic product for the reactions corresponding to digit F of your BLUGOLD. [5 pts. each; 30 pts.] Points have been explicitly allocated to stereochemistry where appropriate.

<table>
<thead>
<tr>
<th>BLUGOLD NUMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
</table>

6. (a)  
\[ \text{Br} + \text{OH} \xrightarrow{\text{KOH}} \text{Br} \xrightarrow{\text{SN1}} \text{CH}=\text{O} \]

6. (b)  
\[ \text{Br} + \text{C}=\text{Na} \xrightarrow{\text{(SN2)}} \text{CH}=\text{O} \]

6. (c)  
\[ \text{C}=\text{Na} \xrightarrow{\text{ROOR}} \text{Br} \xrightarrow{\text{SN2}} \]

6. (d)  
\[ \text{Br} \xrightarrow{\text{KOH}} \text{CH}=\text{O} \]

6. (e)  
\[ \text{CH}=\text{O} \xrightarrow{\text{KOH}} \text{CH}=\text{O} \]

6. (f)  
\[ \text{Br} \xrightarrow{\text{KOH}} \text{Br} \xrightarrow{\text{ROOR}} \]
7. Draw the structure of the major organic product for the reactions corresponding to digit G of your BLUGOLD. [5 pts. each; 30 pts.] Points have been explicitly allocated to stereochemistry where appropriate.

<table>
<thead>
<tr>
<th>BLUGOLD</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
</table>

7. (a)

\[
\begin{array}{c|c}
\text{Reagent} & \text{Structure} \\
\hline
\text{Br}_2/\text{CH}_2\text{Cl}_2 & \text{Br}_2/\text{CH}_2\text{Cl}_2 \\
0-4 & 5-9 \\
\end{array}
\]

7. (b)

\[
\begin{array}{c|c}
\text{Reagent} & \text{Structure} \\
\hline
\text{BH}_3\cdot\text{THF} & \text{BH}_3\cdot\text{THF} \\
\text{H}_2\text{O}_2/\text{NaOH}/\text{H}_2\text{O} & \text{H}_2\text{O}_2/\text{NaOH}/\text{H}_2\text{O} \\
0-4 & 5-9 \\
\end{array}
\]

7. (c)

\[
\begin{array}{c|c}
\text{Reagent} & \text{Structure} \\
\hline
\text{H}_2\text{SO}_4/\text{CH}_3\text{OH} & \text{H}_2\text{SO}_4/\text{CH}_3\text{OH} \\
\ \ & \ \ \\
0-4 & 5-9 \\
\end{array}
\]

7. (d)

\[
\begin{array}{c|c}
\text{Reagent} & \text{Structure} \\
\hline
\text{NaNH}_2 & \text{NaNH}_2 \\
\text{(CH}_3)_2\text{CHBr} & \text{(CH}_3)_2\text{CHBr} \\
1) & 1) \\
2) & 2) \\
0-4 & 5-9 \\
\end{array}
\]

7. (e)

\[
\begin{array}{c|c}
\text{Reagent} & \text{Structure} \\
\hline
\text{Br}_2/\text{CCl}_4/\Delta & \text{Br}_2/\text{CH}_2\text{Cl}_2 \\
\ \ & -78^\circ\text{C} \\
0-4 & 5-9 \\
\end{array}
\]

7. (f)

\[
\begin{array}{c|c}
\text{Reagent} & \text{Structure} \\
\hline
\text{H}_2/\text{Pd-BaSO}_4/\text{PbSO}_4/\text{quinoline} & \text{Na/NH}_3 \\
\ \ & \ \ \\
0-4 & 5-9 \\
\end{array}
\]
8. In each of the following reactions, either the starting compound or the reagent is missing. Complete the reaction corresponding to digit B of your BLUGOLD by supplying the missing information. Note that more than one step may be required to complete each transformation shown. [5 pts each; 30 pts]

<table>
<thead>
<tr>
<th>BLUGOLD NUMBER</th>
<th>A</th>
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<tbody>
<tr>
<td>8. (a)</td>
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<td></td>
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<tr>
<td>? + [CN]</td>
<td></td>
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<tr>
<td>0-4</td>
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<tr>
<td>? [Sn2]</td>
<td></td>
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<tr>
<td>5-9</td>
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</tbody>
</table>

8. (b)

| ? [H2O/H2SO4 (HgSO4)] |   |   |   |   |   |   |   |
| 0-4                    |   |   |   |   |   |   |   |
| ?                       |   |   |   |   |   |   |   |
| 5-9                    |   |   |   |   |   |   |   |

8. (c)

| ?                       |   |   |   |   |   |   |   |
| 0-4                    |   |   |   |   |   |   |   |
| ?                       |   |   |   |   |   |   |   |
| 5-9                    |   |   |   |   |   |   |   |

8. (d)

| ? [Sn2] |   |   |   |   |   |   |   |
| 0-4                 |   |   |   |   |   |   |   |
| ?                       |   |   |   |   |   |   |   |
| 5-9                    |   |   |   |   |   |   |   |

8. (e)

| ?                       |   |   |   |   |   |   |   |
| 0-4                    |   |   |   |   |   |   |   |
| ? + [CN]               |   |   |   |   |   |   |   |
| 5-9                    |   |   |   |   |   |   |   |

8. (f)
9. What are the products formed in the following reaction? [10 pts]

\[
\begin{array}{c}
\text{this enantiomer only} \\
\end{array}
\]

10. Design a synthesis of the molecule below beginning from and starting compounds with 6 or fewer carbon atoms. You may use any other reagents provided that all carbon atoms in the product are obtained only from compounds with 6 or fewer carbon atoms. Where appropriate, stereochemistry is important. [15 pts].

1. Draw the structures of the following two compounds [5 points each]
   (a) Z-hept-5-en-1-ol.   (b) 1,3-cyclohexadiene

2. Give the full names of the following compounds [5 points each]
   (a)  
   (b)  

3. Draw the structure of the major product of each of the following reactions [5 points each]
   (a)  
   (b)  
   (c)  
4. Draw the lowest-energy conformation of *meso*-1,1-dichloro-3,5-dimethylcyclohexane [8 points]

5. (a) Write a mechanism for the reaction at right [8 points]

(b) Draw a reaction energy profile for this reaction [6 points]

6. Supply the missing reagents or reactants needed to complete the following reactions [5 points each]

(a) 

(b) 

(c) 

7. Which of the following is not superimposable on its mirror image? [5 points]

8. Complete each of the reactions below with an appropriate arrow (forward, reverse, or equilibrium). [4 points each]

(a) 

(b) 

Typical pKₐ values: alkanes >45; alkenes 42-45; alkynes ≈26; aldehydes 25-27; ketones 25-28; alcohols 15-18; carboxylic acids 4-6; amines 32-35; amides 15-18; ammonium ions 7-10; imidazole cation 7.
9. (a) Alkyl halides react with silver ion to give an insoluble silver halide, and a carbocation. Reactions giving the most stable cation occur most rapidly. Arrange the following alkyl bromides in decreasing order (fastest first) of their expected rates of reaction with silver nitrate in ethanol. [5 points]

(b) Draw the major contributor to the resonance hybrid of the most stable cation. [5 points]

---

1. Draw the structures of the following two compounds [4 points each]
(a) E-3-bromo-3-hexen-1-ol.  (b) R-2-bromo-1-fluorobutane

2. Give the full names of the following compounds [4 points each]
(a) \( \text{Br} \) \( \text{OH} \) \( \text{Br} \) \( \text{Br} \)

(b)  \( \text{Br} \) \( \text{Br} \) \( \text{Br} \) \( \text{Br} \)

3. Draw the structure of the major product of each of the following reactions [4 points each]

(a) \( \text{Br}_2/\text{H}_2\text{O} \)

(b) \( \text{Br}_2/\text{H}_2\text{O} \)

(c) \( \text{OsO}_4/\text{Me}_3\text{C-O-OH} \) \( \text{Me}_3\text{C-OH} \)

(d) \( 1) \text{Hg(OAc)}_2/\text{THF/H}_2\text{O} \)

2) \( \text{NaBH}_4/\text{NaOH/\text{H}_2\text{O}} \)

(e) \( \text{NBS/AIBN/CCl}_4/\text{h} \text{v} \)

(f) \( \text{KCN/EtOH/\Delta} \)

(g) \( 1) \text{NaNH}_2/\text{NH}_3 \text{H}_2\text{O} \text{Br} \)

2) \( \text{KOH (10}^\text{M} \text{) H}_2\text{O-THF} \)

4. (a) Write a mechanism for the reaction at right [6 points]

(b) Draw a reaction energy profile for this reaction [4 points]

5. Supply the missing reagents or reactants needed to complete the following reactions [5 points each]
6. Design a synthesis of the compound below. All of the carbon atoms in the molecule must come from cyclopentene or acetylene, but you may use any other reactants, reagents, or solvents that you need. [12 points]

Partial credit will be awarded in this question for partial solutions.

\[ \text{(±)} \]

I. Nomenclature (24 points)

1. Write an acceptable name for each of the following compounds [4 pts each; 12 pts total]

(a) 

(b) 

(c) 

2. Draw the structure of each of the following compounds [4 pts each; 12 pts total]

(a) 4-cycloheptenol 

(b) R-3,3-dimethylbutan-2-ol 

(c) E-3-methyl-2-octen-4-yne
II. Reactions (114 points)

3. Write the structure of the major organic product of each of the following reactions. [4 pts each; 64 pts total]

(a) \[
\text{\includegraphics{reaction_a.png}}
\]
(b) \[
\text{\includegraphics{reaction_b.png}}
\]
(c) \[
\text{\includegraphics{reaction_c.png}}
\]
(d) \[
\text{\includegraphics{reaction_d.png}}
\]
(e) \[
\text{\includegraphics{reaction_e.png}}
\]
(f) \[
\text{\includegraphics{reaction_f.png}}
\]
(g) \[
\text{\includegraphics{reaction_g.png}}
\]
4. Complete the following reactions by drawing the structure of the missing reactant or supplying the missing reagent. Note that more than one step may be required to complete some of these transformations. [5 pts each; 50 pts total]

(a) \( \text{C}_6\text{H}_{11}\text{Br} \xrightarrow{\text{KOH/EtOH/\Delta}} \text{H} \)

(b) \( \text{C}_9\text{H}_{16} \xrightarrow{1) \text{BH}_3\cdot\text{THF}} \xrightarrow{2) \text{H}_2\text{O}_2/\text{NaOH/\text{H}_2\text{O}}} \)

(c) \( \text{Br} \xrightarrow{} \text{H} \)

(d) \( \text{H} \xrightarrow{} \text{OHCH}_{\text{CH}}\text{CHO} \)

(e) \( \text{H} \xrightarrow{} \text{CO}_2\text{H} \)

(f) \( \text{C}_6\text{H}_{12} \xrightarrow{\text{Os}_4/\text{Me}_3\text{C-O-H}} \xrightarrow{\text{Me}_3\text{COH}} \)

(p) \( \text{H}_2\text{SO}_4/\text{H}_2\text{O} \xrightarrow{\text{HgSO}_4} \text{H}_2\text{SO}_4/\text{H}_2\text{O} \)
III. Mechanism and Theory (50 points)

5. Draw the structures of the two species below, and indicate which of the two is the major contributor to the resonance hybrid. [4 pts each; 8 points total]

(a) the conjugate acid of acetonitrile, \( \text{CH}_3\text{CNH}^+ \)

(b) the conjugate base of acetamide, \( \text{CH}_3\text{CONH}^- \)

6. When pent-4-en-1-ol is treated with hydrogen bromide and peroxide, and the product of that reaction is treated with and sodium hydride in THF, the product is tetrahydropyran (structure shown at right). Write a mechanism for the second reaction in this sequence. [6 points]
7. (a) Write a mechanism to account for the following observation. [8 pts]

\[
\begin{align*}
\text{H}_2\text{C} & \quad \text{OH} \quad \text{HCl} \\
\text{H} & \quad \text{C} \quad \text{Cl} \\
\end{align*}
\]

7 (b) Sketch the reaction energy profile of the reaction in question 6 (a). [8 pts]

\[
\begin{align*}
\text{H}_2\text{C} & \quad \text{OH} \quad \text{HCl} \\
\text{H} & \quad \text{C} \quad \text{Cl} \\
\end{align*}
\]
8. Find the specified compound or compounds from the list given. [4 pts each; 12 points total]

(a)

\[
\begin{array}{cccc}
\text{A} & \text{B} & \text{C} & \text{D} \\
\end{array}
\]

most exothermic reaction with hydrogen

(b)

\[
\begin{array}{cccc}
\text{A} & \text{B} & \text{C} & \text{D} \\
\end{array}
\]

strongest acid

(c)

\[
\begin{array}{cccc}
\text{A} & \text{B} & \text{C} & \text{D} \\
\end{array}
\]

will give the same product in an S_N1 reaction with H_2O

9. The two questions below refer to the single stereoisomer of 1,2,3,4,5,6-hexachlorocyclohexane does not participate readily in the E2 reaction. Draw the most stable conformation of that isomer. [4 pts each; 8 points]
IV. Synthesis (12 points)

10. Design a synthesis of the ether shown at right from hydrocarbons and any needed organic solvents, free elements, or ionic reagents. [12 points]

1. [5 pts.] Give the correct IUPAC name of the compound below:
2. [5 pts.] Draw the structure of \((2\text{Z},5\text{E})\)-2-fluoro-7-methyl-2,5-octadiene.

3. [10 pts.] Draw the lowest energy conformation of \(E\)-1,2-dibromo-1-methylcyclohexane.

4. The synthesis of 1-chloro-1-ethylcyclopentane from \(Z\)-2-ethylcyclopentanol proceeds through the following sequence of compounds:

   \[
   \text{HO} \xrightarrow{} \text{H}_2\text{O} \xrightarrow{} \text{H}^+ \xrightarrow{} \text{Cl}^{-} \xrightarrow{} \text{Cl}^+ \xrightarrow{} \text{Cl}^{-}
   \]

   (a) [5 pts.] What is the highest-energy reactive intermediate in this sequence of reactions?

   (b) [12 pts.] Draw a fully-labeled reaction potential energy profile (reaction coordinate diagram) for the reaction. Your diagram should show the location and relative energy of every transition state and intermediate. **PAY PARTICULAR ATTENTION TO THE RELATIVE ENERGIES OF ALL SPECIES INVOLVED**

   (c) [10 pts] Draw the mechanism of this reaction by using the appropriate curly arrows and other needed reactant species.

5. [5 pts. each] Complete the following reactions by drawing the structure of the final product.

   (a) \[
   \text{HCl} \xrightarrow{}
   \]

   (b) \[
   \text{Br}_2/\text{CH}_2\text{Cl}_2 \xrightarrow{}
   \]

   (c) \[
   \text{D}_2\text{O/D}^+ \xrightarrow{}
   \]

   (d) \[
   \text{Br}_2/\text{CH}_2\text{Cl}_2 \xrightarrow{}
   \]

6. [8 pts. each] Complete the following reactions by drawing the structure of the starting alkene or providing the structure of the missing reagent.

   (a) \[
   \text{alkene} \xrightarrow{\text{Br}_2/\text{CH}_2\text{Cl}_2} \text{Br}
   \]
7. [12 pts] Which of the following reactions will proceed most rapidly? Write the complete reaction, including the structure of the final product.

A. \[
\begin{array}{c}
\text{alkene} \\
\rightarrow \text{HCl} \\
\end{array}
\]

B. \[
\begin{array}{c}
\text{Me} \\
\rightarrow \text{HCl} \\
\end{array}
\]

C. \[
\begin{array}{c}
\text{Me} \\
\rightarrow \text{HCl} \\
\end{array}
\]

D. \[
\begin{array}{c}
\text{Me} \\
\rightarrow \text{HCl} \\
\end{array}
\]

8. [5 pts.] Will the compound below rotate the plane of polarized light? You may assume that the structure of the compound is exactly as written.

![Compound](image)

1. [5 pts.] Give the correct IUPAC name of the compound at right:

2. [5 pts.] Draw the structure of R-2-octyn-4-ol.

3. [5 pts. each] Complete the following reactions by drawing the structure of the final product.

(a) \[
\begin{array}{c}
\text{H} \\
\rightarrow \text{NaBrO}_3/\text{NaHSO}_3 \\
\text{H}_2\text{SO}_4/\text{H}_2\text{O}/\text{acetonitrile} \\
\end{array}
\]

(b) \[
\begin{array}{c}
\text{H} \\
\rightarrow \text{BH}_3/\text{THF} \\
\text{H}_2\text{O}_2/\text{NaOH}/\text{H}_2\text{O} \\
\end{array}
\]

(c) \[
\begin{array}{c}
\text{H} \\
\rightarrow \text{OsO}_4/\text{Me}_3\text{C}--\text{O}--\text{OH} \\
\text{Me}_3\text{C}--\text{OH} \\
\end{array}
\]

(d) \[
\begin{array}{c}
\text{H} \\
\rightarrow \text{Hg(OAc)}_2/\text{THF}/\text{H}_2\text{O} \\
\text{NaBH}_4/\text{NaOH}/\text{H}_2\text{O} \\
\end{array}
\]

4 [5 pts. each] Complete the following reactions by providing the missing starting compound or the missing reagent.
5. [5 pts. each] Complete the following reactions by drawing the structure of the final product.

(a) \( ? \xrightarrow{\text{NBS/CCl}_4, \Delta} \)

(b) \( ? \xrightarrow{\text{Br}_2/H_2O} \)

(c) \( ? \xrightarrow{\text{H}_2\text{SO}_4/H_2O (\text{HgSO}_4)} \)

(d) \( \text{H-} \equiv \text{C-} \xrightarrow{?} \text{C-} \equiv \text{H} \)

6. [5 pts. each] Complete the following reactions by providing the missing starting compound or the missing reagent.

(a) \( \text{Br} \xrightarrow{\text{AgNO}_3, \text{EtOH/H}_2\text{O}} \)

(b) \( \text{H}_\equiv \text{C-} \xrightarrow{\text{H}_2/\text{Pd-BaSO}_4, \text{quinoline/PbSO}_4} \)

(c) \( \text{Br} \xrightarrow{\text{KOH/EtOH, } \Delta} \)

(d) \( \text{Br} \xrightarrow{\text{DMF/0°C}} \)

7. [8 pts] Ethylcyclohexane reacts with bromine under the influence of ultraviolet light to give a major product with the molecular formula \( \text{C}_8\text{H}_{15}\text{Br} \) in a free radical chain reaction. Draw a
reaction cycle diagram that shows how this reaction occurs using this hydrocarbon as the example.

8. [12 pts] Design a reasonable synthesis of the compound below from hydrocarbons with 6 or less carbon atoms. You may use any other reagent you like, but all of the carbon atoms of the product must originate with hydrocarbons with 6 or less hydrogen atoms.

![Hydrocarbon Structure](image)

1. Name the following compounds based on digit C of your BLUGOLD [5 pts each; 20 pts]. Where appropriate, points are explicitly allocated to stereochemistry.

<table>
<thead>
<tr>
<th>BLUGOLD NUMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>1 (a)</td>
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<td>1 (c)</td>
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<td>1 (d)</td>
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</tbody>
</table>

2. Draw the structures of the following compounds based on digit D of your BLUGOLD [5 pts each; 20 pts]. Where appropriate, points are explicitly allocated to stereochemistry.

<table>
<thead>
<tr>
<th>BLUGOLD NUMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2 (a)</td>
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</tbody>
</table>
2 (b)  
(E)-3,6-dimethyl-1,4-cyclohexadiene  (Z)-3,5-dimethylcyclopentene

2 (c)  
$R$-3-hexanol  $S$-2-methyl-3-hexanol

2(d)  
$R$-1-hexyn-3-ol  $S$-2-octyn-4-ol

3. Draw the lowest energy conformation of the major organic product of one of the reactions shown, depending on digit E of your BLUGOLD [5 pts.]

4. When dimethylaniline, $C_6H_5N(CH_3)_2$, reacts with iodine, two substitution products are isolated. Instead of a three-membered iodinium ion, one of two cations below is formed as an intermediate in each these reactions. Draw all the important resonance contributors to the structure of the ion corresponding to digit B of your BLUGOLD, and circle the major contributor [15 pts.]
5. (a) The reaction below is known as the pinacol rearrangement. Write an acceptable mechanism for this reaction [10 pts].

\[
\text{HO} \quad \text{Me} \quad \text{OH} \quad \text{Me} \quad \text{H}_2\text{SO}_4 \quad \Delta \quad \text{Me} \quad \text{Me} \quad \text{Me} \quad \text{O} \quad \text{Me} \quad \text{Me} \quad \text{Me}
\]

5. (b) Draw a fully-labeled reaction energy profile for the reaction [5 pts]. Pay particular attention to the energy of all species involved.

6. Draw the structure of the major organic product for the reactions corresponding to digit F of your BLUGOLD. [5 pts. each; 30 pts.] Points have been explicitly allocated to stereochemistry where appropriate.

<table>
<thead>
<tr>
<th>BLUGOLD NUMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
</table>

6. (a)

\[
\text{OH} \quad \xrightarrow{\text{PBr}_3} \quad \text{HBr/\Delta}
\]

0-4 5-9

6. (b)

\[
\text{CH}_3\text{ONa/CH}_3\text{OH} \quad 0^\circ \text{C}
\]

0-4 5-9

6. (c)

\[
\text{HBr/\Delta} \quad 1) \text{BH}_3\text{•THF} \quad 2) \text{H}_2\text{O}_2/\text{NaOH}/\text{H}_2\text{O}
\]

0-4 5-9

6. (d)
\[
\begin{array}{c|c}
\text{HO} & \text{OH} \\
\text{H}_2\text{SO}_4/\Delta & \text{PBr}_3 \\
0-4 & 5-9
\end{array}
\]

6. (e)

\[
\begin{array}{c|c}
\text{H} & \text{H} \\
\text{H}_2\text{C}=\text{C} & \text{H}_3\text{C}=\text{C} \\
\text{H}_2 & \text{H}_3 \\
\text{1) BH}_3\cdot\text{THF} & \text{1) NaH/THF} \\
\text{2) H}_2\text{O}_2/\text{NaOH}/\text{H}_2\text{O} & \text{2) R-2-bromobutane} \\
0-4 & 5-9
\end{array}
\]

6. (f)

\[
\begin{array}{c|c}
\text{Br} & \text{HO} \\
\text{H}_2\text{SO}_4/\Delta & \text{H}_2\text{SO}_4/\Delta \\
\text{0-4} & \text{5-9}
\end{array}
\]

\[
\begin{array}{c|c}
\text{Br} & \text{CH}_3\text{ONa/CH}_3\text{OH} \\
\text{0°C} & \text{0°C} \\
\text{CH}_3\text{ONa/CH}_3\text{OH} & \text{CH}_3\text{ONa/CH}_3\text{OH} \\
0-4 & 0-4
\end{array}
\]
7. Draw the structure of the major organic product for the reactions corresponding to digit G of your BLUGOLD. [5 pts. each; 25 pts.] Points have been explicitly allocated to stereochemistry where appropriate.

<table>
<thead>
<tr>
<th>BLUGOLD NUMBER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. (a)</td>
<td>![Reaction 1]</td>
<td>![Reaction 2]</td>
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<tr>
<td>7. (b)</td>
<td>![Reaction 3]</td>
<td>![Reaction 4]</td>
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<tr>
<td>7. (c)</td>
<td>![Reaction 5]</td>
<td>![Reaction 6]</td>
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<tr>
<td>7. (d)</td>
<td>![Reaction 7]</td>
<td>![Reaction 8]</td>
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<tr>
<td>7. (e)</td>
<td>![Reaction 9]</td>
<td>![Reaction 10]</td>
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</tbody>
</table>

8. Draw the Newman projection of a staggered conformation of the major organic product of the one of the following reactions corresponding to digit B of your BLUGOLD. [5 pts]

<table>
<thead>
<tr>
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<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
</table>
9. In each of the following reactions, either the starting compound or the reagent is missing. Complete the reaction corresponding to digit B of your BLUGOLD by supplying the missing information. Note that more than one step may be required to complete each transformation shown. [5 pts each; 30 pts]

<table>
<thead>
<tr>
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<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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</thead>
</table>

9. (a)  
\[
\begin{array}{c|c}
\text{0-4} & \text{5-9} \\
\hline
\text{C}_6\text{H}_{12} & ? & ?
\end{array}
\]

\[\begin{array}{c|c}
\text{C}_6\text{H}_{12} & \text{MeSO}_2\text{Cl/py} \\
\hline
\text{C}_6\text{H}_{12} & \text{MeC}=\text{CNa}
\end{array}\]

9. (b)  
\[
\begin{array}{c|c}
\text{0-4} & \text{5-9} \\
\hline
? & \text{H}_2\text{O}/\text{H}_2\text{SO}_4 (\text{HgSO}_4)
\end{array}
\]

\[\begin{array}{c|c}
? & \text{NaOEt/EtOH} \\
\hline
? & \text{S}_\text{N}2
\end{array}\]

9. (c)  
\[
\begin{array}{c|c}
\text{0-4} & \text{5-9} \\
\hline
\text{C}_6\text{H}_{12} & ?
\end{array}
\]

9. (d)  
\[
\begin{array}{c|c}
\text{0-4} & \text{5-9} \\
\hline
? & \text{NaOEt/EtOH}
\end{array}
\]

9. (e)  
\[
\begin{array}{c|c}
\text{0-4} & \text{5-9} \\
\hline
? & ?
\end{array}
\]

\[\begin{array}{c|c}
? & \text{1) MeSO}_2\text{Cl/py} \\
\hline
? & \text{2) MeC}=\text{CNa}
\end{array}\]
10. What are the products formed in the following reaction? [10 pts]

11. Design a synthesis of the molecule below beginning from any alcohols or hydrocarbons with 6 or fewer carbon atoms. You may use any other reagents provided that all carbon atoms in the product are obtained only from alcohols or hydrocarbons with 6 or fewer carbon atoms. Where appropriate, stereochemistry is important. [15 pts].