Before you begin this exam:  First:  You are allowed to have a simple model set at your seat. Please put away all other materials.  Second:  Place your student identification on your desk. A proctor will come around to check everyone’s ID. If you do not have ID, tell the proctor.  Third:  Read through the entire exam. Your goal, as always, is to score as many points as possible. Do not waste time on problems that you can’t do if there are others that look easy.  Fourth:  It is critically important that your answers be written in a clear, unambiguous manner. Answers in which your intentions are unclear will not receive credit.  Fifth:  READ THE INSTRUCTIONS FOR EACH PROBLEM.

If you wish to have your exam score posted beside your student ID number in the glass case (1st floor, CP Building, behind CP-139) with the exam key, place an ‘X’ in this space.  If you do not mark this space, your exam score will not be posted.

You have 75 minutes to complete this exam. There will be no extensions, so budget your time carefully.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Points</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
1. (4 points) Classify each of the following compounds as either an aldohexose, a ketohexose, an aldopentose, or a ketopentose.

   Aldohexose
   Aldopentose
   Ketopentose
   Aldohexose

2. (6 points) Translate the ‘zig-zag’ structure into a Fischer projection and the Fischer projection into a ‘zig-zag’ structure. Be sure your drawings are oriented properly.
3. (12 points) Provide the definitions of the following terms. Only one or two sentences are needed, so do not exceed the space provided.

a) Provide a definition of the primary structure of a peptide.

The primary structure is the sequence of amino acids.

b) Name an example of peptide secondary structure.

α-helix, β-pleated sheet

4. (30 points) Provide the expected organic product from the following reactions. If you believe that two products will be formed in roughly equal amounts, show both. DO ANY 6 OF THE 8 PROBLEMS GIVEN.

a)

\[
\begin{align*}
\text{1. KOH} \\
\text{2. CH}_2\text{CH}_2\text{CH}_2\text{Br} \\
\text{3. NaOH, H}_2\text{O}
\end{align*}
\]

b)

\[
\begin{align*}
\text{H}_3\text{N} & \quad \text{H}_3\text{N} \\
\text{CO}_2\text{H} & \quad \text{CO}_2\text{H} \\
\text{reflux} & \quad \text{reflux}
\end{align*}
\]

c)

\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{OH} & \quad \text{OCH}_2\text{Ph} \\
\text{PhCH}_2\text{OH} & \quad \text{catalytic H}^+ \\
\end{align*}
\]
d) 
\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} & \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2 \\
& \text{NaCNBH}_3
\end{align*}
\]

e) 
\[
\begin{align*}
\text{CHO} & \rightarrow \text{CH}_2\text{OH} \\
& \text{NaBH}_4
\end{align*}
\]

f) 
\[
\begin{align*}
\text{CHO} & \rightarrow \text{H}_3\text{N}\text{CO}_2\text{H} \\
& 1. \text{NaCN, NH}_4\text{Cl} \\
& 2. \text{H}_3\text{O}^+
\end{align*}
\]

g) 
\[
\begin{align*}
\text{CHO} & \rightarrow \text{O}\text{AN}_2 \\
& \text{NH}_3, \text{H}^+ \text{catalyst}
\end{align*}
\]

h) 
\[
\begin{align*}
\text{CHO} & \rightarrow \text{H}_2\text{O}, \text{CH}_2\text{OH} \\
& 1. \text{KCN} \\
& 2. \text{H}_3\text{O}^+, \text{H}_2\text{O}
\end{align*}
\]
5. (12 points) Linking two amino acids is a bit trickier than it may seem. For example, if you try to prepare the acid chloride of N-acetyl glycine (below), a major product is the oxazolidinone shown. **Starting with the acid chloride of N-acetyl glycine, draw a mechanism for the formation of the oxazolidinone.**
6. (12 points) You should remember that in class we discussed the fact that heating optically pure (single enantiomer) tosylate 1 with acetic acid produces racemic acetate products (enantiomers 2 and 3).

\[
\text{O} \quad \text{T}s \quad \text{O} \quad \text{A}c \quad \text{O} \quad \text{A}c \\
\text{H} \quad \text{O} \quad \text{A}c \\
\]

Provide an explanation for why the reaction of optically pure tosylate 4 results in a single enantiomer of acetate 5. Suggestion: draw the intermediate formed, and analyze the stereochemistry.

\[
\text{O} \quad \text{T}s \quad \text{O} \quad \text{A}c \quad \text{O} \quad \text{A}c \\
\]

In the upper case (1), the intermediate formed on route to 2 and 3 is achiral, so the optical activity has been destroyed. The two secondary carbons in the cyclopropane are equivalent, and products that result from opening of the ring must be racemic.

\[
\text{H} \\
\]

In the lower case (4), the intermediate is still chiral (no plane of symmetry), so the product will be a single enantiomer. The two stereogenic carbons are equivalent, and opening the ring by attack at either carbon leads to 5.

\[
\text{H} \\
\]
7. (12 points) Provide a synthesis of the alcohol shown, starting from ethyl acetoacetate, benzene, and other carbon sources of 3 carbons or less. You may also use other organic and inorganic reagents that do not contribute carbons to the product.

Preparation of benzyl bromide (one of several possible routes)

Br

\[ \text{Br}_2, \text{FeBr}_3 \]

\[ \text{Br} \]

\[ \text{Mg} \]

\[ \text{CH}_2\text{OH} \]

\[ \text{PBr}_3 \]

\[ \text{CH}_2\text{Br} \]
8. (12 points) Provide a viable mechanism for the reaction shown below. Pay careful attention to the use of mechanism arrows, and do not add any additional reagents!