CHE 232-001 Organic Chemistry
Final Exam
May 1, 1996

Name_______________________________ Student ID No.____________________

Before you begin this exam:  First:  You are allowed to have a calculator and 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 every one’s ID.  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 EACH QUESTION CAREFULLY.

If you want your score to be posted next to your student number, check here__________

<table>
<thead>
<tr>
<th>Problem Number</th>
<th>Points possible</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
1. (2 points) Draw structures that correspond to the following names.
   
a) N,N-Dimethyl ethylamine
   
b) 2-chloro-3-phenylphenol

2. (6 points) Classify each of the following carbohydrates as being an aldotetrose, ketotetrose, etc.
   
   ![Carbohydrate Structure 1]
   
   ![Carbohydrate Structure 2]
3. (3 points) Draw the following carbohydrate in a Haworth drawing.

a)

\[
\begin{array}{c}
\text{CHO} \\
\text{OH} \\
\text{HO} \\
\text{OH} \\
\text{CH}_2\text{OH}
\end{array}
\]

4. (2 points) Circle and label the *MOST* basic and the *LEAST* basic of the following compounds.

\[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2 \Theta \\
\text{NH}_2 \\
\text{OCH}_3 \\
\text{OCH}_3 \\
\text{CH}_3 \\
\text{CH}_3
\end{array}
\]

5. (2 points) Circle and label the *MOST* acidic and the *LEAST* acidic of the following compounds.

\[
\begin{array}{c}
\text{OH} \\
\text{OCH}_3 \\
\text{NH} \\
\text{CH}_3\text{COOH}
\end{array}
\]
6. (21 points) Provide the expected organic product from each of the following reactions. If you believe that two products will be formed (like ortho and para isomers, or diastereomers), show both. If you believe that there will be no reaction under the conditions given, write "no reaction." Show all relevant stereochemistry.

a)  
\[
\begin{align*}
\text{NO}_2 & \quad \text{O} \\
\text{OCH}_3 & \quad \text{Cl} \\
& \quad \text{AlCl}_3 \\
\end{align*}
\]

b)  
\[
\text{O} \\
\text{O} \\
\text{O} \\
\text{heat} \\
\]

C)
\[
\text{O} \\
1. \text{(CH}_3\text{CH}_2\text{CH}_2\text{CH}_2)_2\text{CuLi} \\
2. \text{H}_3\text{O}^+ \\
\]

d)  
\[
\text{Br} \\
1. \text{NaN}_3 \\
2. \text{LiAlH}_4 \\
3. \text{H}_2\text{O} \\
\]

e)  
\[
\text{OCH}_3 \\
\text{OCH}_3 \\
\text{OH} \\
\text{CH}_3\text{COCl} \\
\]

f)  
\[
\text{Cl} \\
\text{Cl} \\
\]

7. (12 points) Provide reagents that will accomplish the following transformations. Include any
important workup steps.

a)

\[
\text{CH} = \text{CH} - \text{CH} = \text{CH} - \text{CH} = \text{CH} - \text{OH} \xrightarrow{1. \text{NaN}_3} \text{H}_3\text{C} - \text{OCH}_3 - \text{CH}_3 \\
\]

\[
\xrightarrow{2. \text{heat}} \text{H}_3\text{C} - \text{CH}_2\text{OH} - \text{CH}_3 + \text{CH}_3\text{OH} \\
\]

b)

\[
\text{CH} = \text{CH} - \text{CH} = \text{CH} - \text{CH} = \text{CH} - \text{OH} \xrightarrow{1. \text{LiAlH}_4} \text{H}_2\text{C} = \text{CH} - \text{CH} = \text{CH}_2 - \text{OH} \\
\]

\[
\xrightarrow{2. \text{H}_3\text{O}^+} \text{H}_2\text{C} = \text{CH} - \text{CH} = \text{CH}_2 - \text{O} \\
\]
8. (5 points) Draw a section of a β-sheet peptide. Specifically, draw two tripeptides in the proper orientation for this secondary structure, and show the H-bonds between these segments. Molecular detail is expected, not a “cartoon.”
9. (5 points) Label each of the species below as being either aromatic, anti-aromatic, or not aromatic.

\[
\begin{align*}
\text{Aromatic} & \quad \text{Anti-aromatic} & \quad \text{Non-aromatic} \\
\text{Furan} & \quad \text{Indazole} & \quad \text{Borane} & \quad \text{Thiophene} & \quad \text{Pyridine}
\end{align*}
\]

10. (5 points total) Below are given two molecules of glucose.

a) (3 points) Draw an arrow connecting the atoms necessary for a 1,4-\(\alpha\) disaccharide linkage.

\[
\begin{align*}
\text{Glucose 1} & \quad \text{Glucose 2}
\end{align*}
\]

b) (2 points) Is the product a 1,4-(\(\alpha\)-D-glucopyranosyl)-\(\alpha\)-D-glucopyranoside or a 1,4-(\(\alpha\)-D-glucopyranosyl)-\(\beta\)-D-glucopyranoside? (Circle one)

11. (5 points) The reaction of ammonia with alkyl halides is not generally a useful way to make alkyl amines. Explain why this is. Drawings can be used to supplement your answer, and please do not exceed the space provided.
12. (3 points) The Koenigs-Knorr synthesis of glycosides from glucosyl bromides and alcohols is shown below.

The Koenigs-Knorr Reaction

This reaction produces a single anomer (β) of the product glycoside. Draw the critical intermediate that shows why attack of the alcohol on the α-face of the cation intermediate is not possible.

13. (5 points) Bromoether 1 is a simplified version of the glycosyl bromide used in the Koenigs-Knorr reaction above. Draw a viable mechanism for the formation of acetal 2. Note: The mechanism for 1 -> 2 is nearly identical to the mechanism for the Koenigs-Knorr reaction, and does NOT involve an Sn2 reaction.
14. (5 points) Show how cyclohexanol can be converted to N,N-dimethylcyclohexylamine. Specify all reagents necessary, in the order you would use them. It may be very helpful to show each compound formed along the synthetic pathway.

\[ \text{OH} \quad \text{Several Steps} \quad \text{N} \]

15. (5 points) Explain why cation A is much less stable than cation B. Please do not exceed the space provided.

\[ \text{A} \quad \text{B} \]
16. (5 points) Treatment of β-keto ester 3 with base (followed by a mild acid workup) produces the β-keto ester 4. Draw a viable mechanism for this transformation. Note: Four membered rings are very highly strained and unlikely to form. Remember: The reversibility of chemical equilibria is a wonderful thing.

\[
\begin{align*}
\text{3} & \xrightarrow{1. \text{ NaOEt, EtOH, } \Delta} \text{4} \\
& \quad \xrightarrow{2. \text{ H}_3\text{O}^+} \\
\end{align*}
\]