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. 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 (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 until 9:50 to complete this exam. There will be no extensions, so budget your time carefully.

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<thead>
<tr>
<th>Problem Number</th>
<th>Points possible</th>
<th>Score</th>
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</table>
1. (9 points) For each pair of compounds, circle the one which will undergo Sn\textsubscript{2} reactions the **FASTEST**. (Note: in all cases these compounds would be the *electrophiles* in any Sn\textsubscript{2} reaction)
   a) 
   ![Diagram](image1)
   b) 
   ![Diagram](image2)
   c) 
   ![Diagram](image3)

2. (9 points) For each pair of compounds, circle the one which will undergo E\textsubscript{1}/Sn\textsubscript{1} reactions the **FASTEST**. (Note: assume that the same strong, non-nucleophilic base is used in all cases)
   a) 
   ![Diagram](image4)
   b) 
   ![Diagram](image5)
   c) 
   ![Diagram](image6)
3. (30 points) Provide the major organic product from each of the following reactions. If you believe that no reaction will occur, write “No Reaction.” Be sure to show any relevant stereochemistry.

a)\[
\begin{align*}
&\text{OH} \\
&\text{PBr}_3 \\
&\text{Br}
\end{align*}
\]

b)\[
\begin{align*}
&\text{NO}_2 \\
&\text{Cl} \\
&\text{KCN} \\
&\text{DMF} \\
&\text{NO}_2 \\
&\text{CN}
\end{align*}
\]

c)\[
\begin{align*}
&\text{OH} \\
&\text{NaOH} \\
&\text{EtOH} \\
&\text{No Reaction}
\end{align*}
\]

d)\[
\begin{align*}
&\text{TsO} \\
&\text{H} \\
&\text{CH}_3 \\
&\text{H} \\
&\text{CH}_3 \\
&\text{Ph} \\
&\text{EtONa, EtOH} \\
&\text{H} \\
&\text{CH}_3 \\
&\text{Ph}
\end{align*}
\]

e)\[
\begin{align*}
&\text{OH} \\
&\text{PCC} \\
&\text{H} \\
&\text{C} = \text{O}
\end{align*}
\]

f)\[
\begin{align*}
&\text{OH} \\
&\text{SOCl}_2 \\
&\text{Cl}
\end{align*}
\]
4. (20 points) What reagents would you use to accomplish each of the transformations below?

a)\[ \text{HO} \quad \text{CrO}_3, \text{H}_2\text{SO}_4 \quad \rightarrow \quad \text{HO-}\text{CO} \]

b)\[ \text{HO} \quad \text{NaI, DMF} \quad \rightarrow \quad \text{HO-} \]

c)\[ \text{Br} \quad \text{1. NaNH}_2 \quad \text{2. CH}_3\text{CH}_2\text{CH}_2\text{Br} \quad \rightarrow \quad \text{CH}_2\text{CH}_2\text{CH}_3 \]

d)\[ \text{PCC} \quad \rightarrow \quad \text{H} \]

5. (5 points) In the E2 elimination of the labeled bromocyclohexane shown below, which cycloalkene is formed? (Circle one) Note: The reactivity of deuterium (D) is essentially the same as normal hydrogen (H).
6. (5 points) Draw the transition state for the Sn2 reaction of CH₃-I and CH₃NH anion (the reaction shown below). Be sure to show all partial bonds and charges.

\[
\begin{align*}
\text{CH}_3\text{I} & \quad \text{CH}_3\text{NH} \\
\text{CH}_3\text{N}^-\text{CH}_3 & \quad + \quad \text{I}^-
\end{align*}
\]

7. (10 points) Show how the starting material given can be converted into the product shown. More than one step may be required. Show the reagents needed for each step.

\[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{H}_2\text{C} & \quad \text{H} \\
\text{H}_3\text{CHN} & \quad \text{C} \\
\text{H}_3\text{CHN} & \quad \text{CH}_3
\end{align*}
\]

\[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{H}_2\text{C} & \quad \text{H} \\
\text{H}_3\text{CHN} & \quad \text{C} \\
\text{H}_3\text{CHN} & \quad \text{CH}_3
\end{align*}
\]

\[\text{NaNH}_2\]

\[\text{PBr}_3\]
8. (12 points) The alcohol below undergoes Sn1 substitution, but three different products are formed. Write viable mechanisms for the formation of each product from the starting material shown. Be sure your use of arrows conforms to the established conventions.

END OF EXAM