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 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 1:50 to complete this exam. There will be no extensions, so budget your time carefully.

<table>
<thead>
<tr>
<th>Problem Number</th>
<th>Points possible</th>
<th>Score</th>
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1. (5 points) Match the name with the structure by writing the NUMBER of the name next to the corresponding structure.

1. 2-Chlorobutanal
2. Methyl 2-chlorobutanoate
3. Ethylbenzene
4. ortho-Chloroethylbenzene
5. para-Chloroethylbenzene

2. (20 points) Draw the major organic product for each of the following reactions. If you believe that no reaction will occur, write “No Reaction.” Be sure to show any relevant stereochemistry.

a)  

b)  

1. BH$_3$
2. H$_2$O$_2$, NaOH

2. H$_2$O$_2$, NaOH

2. H$_2$O$_2$, NaOH

3.)
3. (10 points) Treatment of the deuterated chloroexpoxide I with NaCN results in the formation of 2 different products (II and III). Draw a viable mechanism for the formation of compound III. Be sure that your use of arrows conforms to the established conventions. Note: D (deuterium) is a heavy isomer of H, and serves only to label a carbon.
4. (20 points) In each of the cases below, fill in the box with an appropriate starting material. Be sure that the compound you draw will be transformed to the product shown by treatment with the reagents given. (There may be more than one right answer)

a)

\[
\begin{aligned}
&\text{1. } \text{O}_3 \\
&\text{2. } (\text{CH}_3)_2\text{S}
\end{aligned}
\]

\[
\xrightarrow{\text{1. O}_3} \xrightarrow{\text{2. (CH}_3\text{)}_2\text{S}} \xrightarrow{} \text{OCH}_3
\]

b)

\[
\begin{aligned}
&\text{1. BH}_3 \\
&\text{2. NaOH, H}_2\text{O}_2 \\
&\text{PCC}
\end{aligned}
\]

\[
\xrightarrow{\text{1. BH}_3} \xrightarrow{\text{2. NaOH, H}_2\text{O}_2} \xrightarrow{\text{PCC}} \text{CH}_3
\]

c)

\[
\begin{aligned}
&\text{MCPBA} \\
&\text{LiCN}
\end{aligned}
\]

\[
\xrightarrow{\text{MCPBA}} \xrightarrow{\text{LiCN}} \text{CN}
\]

d)

\[
\begin{aligned}
&\text{1. NaNH}_2 \\
&\text{2. Lindlar Catalyst}
\end{aligned}
\]

\[
\xrightarrow{\text{1. NaNH}_2} \xrightarrow{\text{2. Lindlar Catalyst}} \text{CH}_3
\]
5. a) (3 points) Which spectroscopic method would most definitively distinguish between the two compounds below? (Circle the method)

\[
\text{CH}_3\ 	ext{CH}_3 \\
\text{Br} \\
\text{CH}_3\ 	ext{CH}_3
\]

Mass Spectrometry  IR Spectroscopy  NMR Spectroscopy

b) (6 points) Explain what you would look for in the spectrum of your choice and how it would allow you to distinguish between the two compounds. Do not exceed the space provided.

6. (6 points) Treatment of alkene A with BH\textsubscript{3}, then with NaOH and H\textsubscript{2}O\textsubscript{2} produces primary alcohol B. The mass spectrum of B is shown below.

\[
\begin{array}{c}
\text{Intensity} \\
\begin{array}{c}
20 \\
30 \\
40 \\
50 \\
60 \\
70 \\
80 \\
90 \\
100 \\
\end{array} \\
\begin{array}{c}
\text{m/e} \\
\begin{array}{c}
42 \\
55 \\
70 \\
88 \\
\end{array} \\
\end{array}
\end{array}
\]

a) What is the structure of alkene A?
b) What is the structure of B?

7. (15 points) Below are the mass spectrum, the IR spectrum, and the $^1$H NMR spectrum of a common dipolar aprotic organic solvent.
a) Propose a viable molecular formula for this compound. Note: A “viable” formula corresponds to at least one stable, neutral compound.

b) Propose a structure for the compound that is consistent with all of the spectral data given above. (Draw the structure)

c) What bond vibration in your proposed structure is responsible for the IR absorption at ca. 2250 cm\(^{-1}\)?
8. (15 points) Below are the mass spectrum, the IR spectrum, and the $^{13}$C and $^1$H NMR spectra of an organic compound.

Mass Spectrum

![Mass Spectrum Graph]

Infrared Spectrum

![Infrared Spectrum Graph]

$^{13}$C NMR Spectrum:

207.1 (singlet), 159.3 (singlet), 131.1 (singlet), 129.3 (doublet), 114.2 (doublet), 56.0 (quartet), 51.3 (triplet), 24.4 (quartet).
a) What kind of functional group is responsible for the strong IR absorption at ca. 1700 cm⁻¹?

b) Propose a viable molecular formula for this compound. Note: A “viable” formula corresponds to at least one stable, neutral compound.

c) Propose a structure for the compound that is consistent with all of the spectral data given above. (Draw the structure)