General Instructions:
(i) Use scratch paper at back of exam to work out answers; final answers must be recorded at the proper place on the exam itself for credit.
(ii) Print your name on each page.
(iii) Please keep your paper covered and your eyes on your own work. Misconduct will lead to failure in the course.

1. (20 points) Show the major product or products expected from each reaction.

(a) \[
\text{\begin{tikzpicture}
    \draw (0,0) circle (1);
    \node at (1,0) {1) excess OsO_4};
    \node at (1,-1) {2) NaHSO_3};
\end{tikzpicture}}
\]

(b) \[
\text{\begin{tikzpicture}
    \draw (0,0) circle (0.6);
    \node at (0.6,0) {HBr};
    \node at (0.6,-0.8) {peroxides};
\end{tikzpicture}}
\]

(c) \[
\text{\begin{tikzpicture}
    \draw (0,0) -- (1,0) -- (1,1) -- (0,1) -- cycle;
    \node at (0.5,0.5) {H};
    \node at (0.5,0) {CH_3};
    \node at (1.5,0) {CH_3CH_2};
    \node at (1.5,1) {H};
    \node at (0.5,1) {1) BH_3\cdot THF};
    \node at (1.5,1.5) {2) H_2O_2, NaOH};
    \node at (1.5,2) {H_2O};
\end{tikzpicture}}
\]

(d) \[
\text{\begin{tikzpicture}
    \draw (0,0) -- (1,0) -- (1,1) -- (0,1) -- cycle;
    \node at (0.5,0.5) {H_3C\cdots C\cdots C\cdots CH_2CH_3};
    \node at (1.5,0) {H_2SO_4\rightarrow};
    \node at (1.5,1) {HgSO_4\rightarrow};
    \node at (1.5,2) {H_2O};
\end{tikzpicture}}
\]
2. (30 points) Show the reagents required to convert the starting molecule to the indicated product. If necessary, be sure to differentiate clearly between distinct steps, by using "1)", "2)", etc. over the arrow.

(a) \[
\begin{array}{c}
\text{starting molecule} \\
\end{array}
\xrightarrow{} 
\begin{array}{c}
ketone + cyclopentane \\
\end{array}
\]

(b) \[
\begin{array}{c}
\text{starting molecule} \\
\xrightarrow{} 
\begin{array}{c}
cyclopentane \\
\end{array}
\]

(c) \[
\begin{array}{c}
 \text{starting molecule} \\
\xrightarrow{} 
\begin{array}{c}
cyclopentane \\
\end{array}
\]

(d) \[
\begin{array}{c}
 \text{starting molecule} \\
\xrightarrow{} 
\begin{array}{c}
bromoalkane \\
\end{array}
\]

(e) \[
\begin{array}{c}
 \text{starting molecule} \\
\xrightarrow{} 
\begin{array}{c}
cyclopropane \\
\end{array}
\]

Name: ___________________
3. (12 points) Circle the structure expected to be more stable in each pair below. Briefly explain your reasoning.

(a) \[ \text{Structure A} \quad \text{vs.} \quad \text{Structure B} \]

(b) \[ \text{Structure C} \quad \text{vs.} \quad \text{Structure D} \]

4. (15 points) For each alkene below, indicate whether the molecule is E configuration, Z configuration, or neither.

- \[ \text{Alkene 1} \quad \text{Alkene 2} \quad \text{Alkene 3} \]
- \[ \text{Alkene 4} \quad \text{Alkene 5} \]
5. (15 points) Provide a mechanism (curved arrows) for the reaction shown below.
6. (8 points) When molecule X is treated with CHCl\textsubscript{3} and KOH, the resulting product has four chlorine atoms in it. When X is treated with KMnO\textsubscript{4} under acidic conditions, diacid Y is produced, along with two equivalents of CO\textsubscript{2}. What is molecule X?

\[ Y = \text{diacid} \]

\[ X = \text{molecule} \]
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