Note: Your exam should consist of 5 pages including the cover page and grade tabulation sheet. A periodic table is on page 5. Skim the entire exam, and solve the easiest problems first. Exams not returned when time is called will not be graded.

My friends, as a result of our experimentation, we have just lost a dear and valued colleague....

On the other hand, we have just gained a publication.

PLEASE DO NOT OPEN THIS EXAM UNTIL YOU ARE INSTRUCTED TO DO SO.
1. (4 pts) The sex attractant of the fruit fly is (E)-6-nonen-1-ol. Write an accurate structure for this compound.

2. (15 pts) Provide the structure of the expected major product(s) in each of the following reactions. You must clearly show stereochemistry where appropriate.

   a. \[
   \text{Cl} \quad \text{tBu} \quad 2^\circ \\
   \xrightarrow{\text{WEAK NaI acetone}} \quad \text{tBu} \quad \text{H} \\
   \]
   
   b. 2-bromo-3-methylbutane
   \[
   \text{Br} \quad 2^\circ \\
   \xrightarrow{\text{STRONG} \ \text{EtONa EtOH}} \quad \text{CH}_3 \quad \text{CH}_2 \\
   \]
   
   c. \[
   \text{CH}_3\text{CHClCH}_2\text{Cl} \quad \text{DOUBLE ELIMINATION} \\
   \xrightarrow{2\text{NaNH}_2 \ \text{NH}_3} \quad \text{CH}_3 \quad \text{C} = \text{C} \quad \text{H} \\
   \]
   
   d. 3-chloro-3-methylhexane
   \[
   \text{Cl} \\
   \xrightarrow{\text{HF MARK}} \quad \text{CH}_3 \quad \text{CH}_2 \quad \text{CH}_2 \\
   \]
   
   3. (8 pts) A given SN1 reaction will proceed at a faster rate in polar aprotic or polar protic solvent (choose one). Clearly explain your choice using a combination of words and drawings.

   A protic solvent can solvate/stabilize both cations and anions. For SN1, the RDS involves formation of a carbocation and LG, so these and the preceding TS are stabilized. A more stable TS (a lower barrier) = a faster reaction.

   ![Diagram of SN1 reaction]

   ![Diagram of carbocation and LG stabilization]

   ![Diagram of solvent stabilization]

   ![Diagram of H-bonding stabilization]

   ![Diagram of δ- of polar solvent stabilization]

   ![Diagram of cation and anion stabilization]
4. (16 pts) Explain the results below. For full credit, you must draw a mechanism and a labeled reaction coordinate for the reaction that occurs.

\[
\begin{align*}
\text{OH} & \quad \text{OH} \\
\text{NaBr} & \quad \text{HBr} \\
\text{no reaction} & \quad \text{Br} \\
\end{align*}
\]

\[\text{OH is a strong base and a terrible LG, so the substitution can't occur.}\]

\[\text{H}_2\text{O}:\] Acid protonates the OH, so the LG is H\text{H}_2\text{O}, good b/c it's a weak base.

5. (24 pts) For parts a through c, outline a synthesis starting from the given reactant. You may use any other needed reagents. More than one reaction may be necessary. Mechanisms are not required.

a. ethyne \[\rightarrow\] 1-pentyne

\[\begin{align*}
\equiv & \quad \equiv \\
1. \text{NaNH}_2 & \quad 2. \text{Br} \\
\end{align*}\]

b. cyclopentanol \[\rightarrow\] cyclopentane

\[\begin{align*}
\text{OH} & \quad \text{H}_2\text{O}^{+} \\
\text{H}_2\text{O} & \quad \text{Pd} \\
\end{align*}\]

C. alkyl halide of your choosing \[\rightarrow\] 1-aromatic

\[\text{CH}_3\text{Br} + \text{Sn}_2 \rightarrow \text{CH}_3\text{O-aryl}\]
6. (18 pts) a. Provide reagent(s) in the box for step 1. b. Write a mechanism for reaction 2. c. In the box draw a chair representation of the product formed in reaction 3.

7. (15 pts) The alkyl bromide at right gives a mixture of cis- and trans-2-butene upon reaction with sodium hydroxide. Only one of these alkene products retains the deuterium atom. Draw the two sets of transition states and their corresponding alkene product. Use your drawings to explain why only one product retains the deuterium atom. (D = $^2$H)

$\text{H}^\dagger \text{LG must be anti } \frac{1}{2} \text{ coplanar for } \text{E}_2$. 

\[ \text{HO}^- \text{H} \text{CH}_3 \text{D} \text{LBr} \rightarrow \left[ \begin{array}{c} \text{HO}^- \text{H} \text{CH}_3 \text{D} \\ \text{CH}_3 \text{H} \text{D} \text{LBr} \end{array} \right]^+ \rightarrow \left[ \begin{array}{c} \text{CH}_3 \text{H} \text{D} \\ \text{CH}_3 \text{H} \text{D} \text{LBr} \end{array} \right] \rightarrow \text{cis.} \]

\[ \text{HO}^- \text{H} \text{CH}_3 \text{D} \text{LBr} \rightarrow \left[ \begin{array}{c} \text{HO}^- \text{D} \text{H} \\ \text{CH}_3 \text{D} \text{H} \end{array} \right]^+ \rightarrow \left[ \begin{array}{c} \text{CH}_3 \text{H} \\ \text{CH}_3 \text{H} \text{D} \end{array} \right] \rightarrow \text{trans.} \]