Exam III
17 August 2005

Name: ___________________________________________

• This exam contains 5 pages of questions – confirm this once you begin.
• You will have 50 minutes.
• An abbreviated Periodic Table can be found on page 6.
• No calculators or models are permitted.
• Read all questions carefully – answer the question that is asked!
• Illegible or indecipherable answers may not receive potential partial credit.
• Good luck!

1. (4 pts) For each of the alcohols shown below, indicate with an X in the corresponding box, if an aldehyde or ketone will be produced on treatment with PCC. Leave both boxes blank if neither of these will be produced.

![Chemical structures showing aldehydes and ketones](image)

aldehyde: □ □
ketone: □ □

2. (6 pts) The alcohol product shown below can be prepared using two different Grignard reactions. Complete the missing components for each approach.

![Reaction pathways](image)
3. (14 pts) Provide the structure of the **major** organic product or products expected from each of the following reactions. Write "NR" if no reaction. Address stereochemistry where applicable.
4. (10 pts) Answer the questions below about the following potential energy diagram.

\[ \begin{array}{c}
\text{A} \rightarrow \text{B} \rightarrow \text{C} \rightarrow \text{D} \rightarrow \text{E} \rightarrow \text{F} \rightarrow \text{G} \rightarrow \text{H} \rightarrow \text{J}
\end{array} \]

- a) How many steps are in the mechanism represented by this diagram: ______
- b) The overall reaction is: endothermic  exothermic  cannot be determined
- c) Which energy controls the position of the equilibrium: C  D  E  H
- d) Which energy controls the rate of the reaction: C  D  E  H
- e) Which chemical species represents an intermediate in the mechanism: A  B  F  J
- f) Which chemical species represents a transition state in the mechanism: A  B  F  J
- g) At equilibrium, which would be favored: reactants  products  cannot be determined

5. (6 pts) Circle the major product for each of the following reactions. Circle “None” if none of the provided answers are correct.

a) 
\[
\begin{array}{c}
\text{CH}_2=CH\text{CH}_2\text{OH} + \text{H}_2\text{SO}_4 \rightarrow
\end{array}
\]

\[
\begin{array}{c}
\text{H}_2\text{C} = \text{CH}_2 \quad \text{O} \quad \text{HO} \quad \text{None}
\end{array}
\]

b) 
\[
\begin{array}{c}
\text{PhC} = \text{CCH}_3 + \text{Br} \rightarrow
\end{array}
\]

\[
\begin{array}{c}
\text{PhC} = \text{CPh} \quad \text{PhC} = \text{CPh} \quad \text{None}
\end{array}
\]
6. (6 pts) (R)-2-Bromobutane can react by way of an S\textsubscript{N}2 or S\textsubscript{N}1 mechanism. Provide the expected percent of each of the two possible products for these two cases.

\[
\text{Br} \quad \text{Nuc} \quad \text{Nuc} \quad \text{Nuc} \quad \text{S}\textsubscript{N2:} \quad \text{S}\textsubscript{N1:}
\]

\[
\begin{align*}
\text{A} & \quad + \quad \text{B} \\
\text{S}\textsubscript{N2:} & \quad \text{=} \quad 100\% \\
\text{S}\textsubscript{N1:} & \quad \text{=} \quad 100\%
\end{align*}
\]

7. (BONUS QUESTION - 2 pts) From the previous problem, consider the case if the percent of A and B was 40% and 60%, respectively. What does this suggest about how the products are formed?

8. (5 pts) Provide a complete and detailed mechanism that accounts for the following product. Include all arrows, formal charges, and lone pairs for full credit.

\[
\text{CH}_3\text{S}\quad \text{Na}\quad \text{CH}_3\text{SCH}_3
\]

\[
\begin{align*}
\text{Br} \quad \text{CH}_3\text{S}\quad \text{Na} \quad \text{S}\textsubscript{N2:} \\
\text{CH}_3\text{SCH}_3
\end{align*}
\]
9. (18 pts) Clearly circle the correct answer for the following questions. There is only one correct answer for each; no credit will be given if more than one answer is circled for each question.

a) Which of the following represents an enol?

b) Which of the following compounds was most likely formed via the aldol condensation?

c) Which of the following alkenes is the expected major product from dehydrohalogenation of 3-chloro-2-methylpentane (shown at right) with KOH?

d) Which of the following molecules is most likely to participate in an $S_{N2}$ reaction?

e) Which of the following molecules is most likely to participate in an $S_{N1}$ reaction?

f) The E2 elimination mechanism prefers when the $\beta$-proton and the leaving group are ______.

anti staggered  anti eclipsed  syn eclipsed


g) Assign a $pK_a$ value to each of the following molecules; choose from the list of values shown at right.


h) Identify the strongest amine base from among the following molecules.


10. (6 pts) Provide a complete and detailed mechanism that accounts for the following product. Include all arrows, formal charges, and lone pairs for full credit.

\[ \text{Cyclohexyl}^+ \xrightarrow{\text{KOH}} \text{Product} \]

\[ E2 \]