FIRST EXAMINATION

All answers should be written on the exam in the spaces provided. Clearly indicate your answers in the spaces provided; if I have to guess as to what or where your answer is, it is wrong. Where applicable, outline the logic or mystical principle you used to arrive at your answer, as partial credit may be awarded for correct approaches.

You may assume that standard work-up conditions (i.e. those required to obtain a stable, neutral product, like aqueous acid as example) follow each reaction on the exam. You are strongly advised to read through the entire exam completely before you begin.

(1) …8 pts....................._____
(2) …6 pts....................._____
(3) …14 pts....................._____
(4) …21 pts....................._____
(5) …15 pts....................._____
(6) …15 pts....................._____
(7) …16 pts....................._____
(8) …8 pts....................._____
TOTAL (103 pts)............_____

__________________________
Percentage ………...______
1. [8 pts] IUPAC Nomenclature: (watch your numbering!)
   a. 7-ethyl-8-methyl-6-oxononanal

   ![Chemical structure of 7-ethyl-8-methyl-6-oxononanal]

   6-hydroxy-2-cyclohexenone
   (alkene has higher priority than alcohol)

2. [6 pts] Oxidations/Reductions: Determine if each of the reactions shown are oxidations, reductions or neither.
   a. reduction

   ![Reaction with reduction]

   b. reduction

   ![Reaction with reduction]

   c. neither

   ![Reaction with neither]

3. [14 pts] Functional Group Identification:
   a. Each molecule contains **TWO** functional groups. Name the two types in each molecule.
      Ester, aromatic ring       amine, ether

   ![Chemical structure of molecules containing ester and aromatic ring]

   ![Chemical structure of molecules containing amine and ether]

   b. What functional group forms when each of the following are adding to a ketone?
      1. NaCN, 2. H₃O⁺       ____ cyanohydrin ______
      NaBH₄                   ____ alcohol ______
      NH(CH₃)₂, H⁺            ____ enamine ______
4. [21 pts] Draw the reagent, major product or provide the necessary reagent for each of the single step transformations shown below. You may assume standard conditions to achieve a neutral stable product.

a. 

\[
\begin{align*}
\text{HO} & \quad \text{O} & \quad \text{O} \\
\text{NaBH}_4 & \\
\text{HO} & \quad \text{O} & \quad \text{H} \\
\end{align*}
\]

b. 

\[
\begin{align*}
\text{H} & \quad \text{OH} & \quad \text{O} \\
\text{PCC} & \\
\text{H} & \quad \text{O} & \quad \text{O} \\
\end{align*}
\]

c. 

\[
\begin{align*}
\text{HO} & \quad \text{Zn(Hg), H}_3\text{O}^+ \\
\end{align*}
\]

d. 

\[
\begin{align*}
\text{O} & \quad \text{(CH}_3\text{CH}_2)_2\text{CuLi} \\
\end{align*}
\]

e. 

\[
\begin{align*}
\text{Et}_2\text{AlCN} & \\
\end{align*}
\]

f. 

\[
\begin{align*}
\text{Ph}_3\text{P}=\text{C(CH}_3)_2 & \\
\end{align*}
\]

g. 

\[
\begin{align*}
\text{NH(CH}_3)_2, \text{H}^+ & \\
\end{align*}
\]
5. [15 pts] Show all the steps of the mechanism for the reaction shown below using curved arrows to represent movement of electron pairs. Remember: the only reagents you may use are those provided below.

\[
\begin{align*}
\text{N(CH}_3\text{)}^+ & \quad \text{NH}_2\text{CH}_3, \text{H}^+ \\
\text{H}_2\text{O} \quad \text{N(CH}_3\text{)}^+ & \quad + \quad \text{H}_2\text{O}
\end{align*}
\]

6. [15 pts] Sequence Problem: Fill in the blanks (A-E) for each compound or reagent that is missing.

A. BH₃
   1. BH₃
   2. NaOH, H₂O₂

B. PCC
   hexanal

C. \text{MgBr}

D. E. \text{NH}_2\text{NH}_2, \text{KOH}
   OR \ Zn(\text{Hg}), \text{H}_3\text{O}^+

E. 2-methylnonane
   PCC
   2-methyl-4-nonanol
7. [16 pts] The following problems will require more than one step of reagents to arrive at the final product. Write the appropriate reagents in their appropriate orders. Partial credit may be given for approaches without reagents, if intermediate structures are shown.

a. [4 pts]

b. [4 pts]

c. [8 pts] You have to use a protecting group!!
8. [8 pts] Short Answers Questions: Please answer two of the following three questions:

a. Explain why the monitoring the pH of a reaction involving an amine in the formation of an imine is required.

The reaction of an amine with an aldehyde or ketone to form an imine can be adversely affected by a reaction solution that is too acidic. Amines have a lone pair and therefore act as a base. Bases react with acids. Once the amine is protonated by the acid, it no longer has a reactive lone pair of electrons and is no longer a nucleophile! Reaction cannot occur.

b. The following sequence does not form the desired product as shown when tried in the organic laboratory. Explain why.

The sequence of reaction here implies that the primary alcohol needs to be oxidized prior to the addition of the Grignard reagent, followed by removal of the protecting group from the ketone. The sequence will not work as shown as Step 1 (Tollens’ Reagent) does not oxidize alcohols to aldehydes.

c. Sterically, aldehydes react faster than ketones because they only have one alkyl group attached to the carbonyl carbon, making the carbonyl less sterically hindered. What is the other reason that aldehydes react faster than ketones?

Electronically, aldehydes are more reactive than ketones as electrophiles (i.e. larger partial positive charge on the carbonyl of the aldehyde). Why? Ketones have two alkyl groups attached, which are electron-donating and stabilize the partial positive charge on the carbonyl carbon. Aldehydes only have one alkyl group attached, thus less stabilization and a larger partial positive charge – better electrophile!