YOU MUST COMPLETE THIS PAGE WITH YOUR NAME
(EVEN THOUGH YOU ALREADY DID THIS ON THE COVER PAGE)
AND ALSO GIVE YOUR ASU OR POSTING ID NUMBER
WE NEED THIS NUMBER BECAUSE YOU WOULDN'T BELIEVE THE NUMBER OF
STUDENTS WHOSE NAMES WE CAN'T READ!

Points by question
1__________/13
2__________/18
3__________/32
4__________/15
5__________/15
6__________/12
7__________/36
8__________/34

Points Removed for cover errors ____/2

Extra Credit ____/5

Total (incl Extra) ________/175+5

**YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM**
Question 1 (13 pts.) Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.

\[
\text{1-cyclohexylbut-(2E)-en-(1R)-ol} \\
OR \\
(R)-1\text{-cyclohexylbut-(2E)-en-1-ol} \\
OR \\
(1\text{R})\text{-cyclohexylbut-(2E)-en-1-ol} \text{ etc.}
\]

Question 2 (18 pts). Rank in order of INCREASING Bronsted acidity (ignore keto isomers). Give a BRIEF explanation that include drawings of each conjugate base anion, including all relevant resonance contributors. Your explanation must include the term "energy of electrons" and must also include a discussion of base strength.

\[
\begin{align*}
\text{A} & \quad \text{CF}_3 \\
\text{B} & \quad \text{CF}_3 \\
\text{C} & \quad \text{CF}_3
\end{align*}
\]

the electrons in the anion from A are stabilized by resonance and are also directly stabilized by the -CF3 withdrawing group, they are the lowest in energy, A has the strongest base, A is the strongest acid.

the electrons in the anion from B are not resonance stabilized, they are highest in energy, B is the strongest base, B is the weakest acid.

the electrons in the anion from C are stabilized by resonance but are not directly stabilized by the -CF3 withdrawing group, they are intermediate in energy, C has the intermediate base, C has intermediate acidity.

5 pts Extra Credit. organic metals can be made by polymerizing... epoxides alkenes alcohols alkynes
Question 3 (first part, 14 pts.) For each reaction
1) Provide the missing reagents/conditions
2) State whether each reaction is an Addition, Elimination, Substitution or Rearrangement
3) State whether each reaction is Reduction, Oxidation or Neither

a)

\[
\begin{align*}
\text{EtOH} & \quad \text{NaBH}_4 \\
\text{O} & \quad \text{O} \\
\text{OCH}_3 & \quad \text{OH} \\
\text{H} & \quad \text{OCH}_3 \\
\text{addition} & \quad \text{neither}
\end{align*}
\]

b)

\[
\begin{align*}
\text{EtOH} & \quad \text{NaBH}_4 \\
\text{addition} & \quad \text{reduction}
\end{align*}
\]

Question 3 (second part, 18 pts.) Give the major organic product of the following reactions
DO NOT STATE whether the reaction is Addition/Elimination/Substitution/Rearrangement
DO NOT STATE whether each reaction is reduction/oxidation/neither

c)

\[
\begin{align*}
\text{ignore stereochemistry}
\end{align*}
\]

d)

\[
\begin{align*}
\text{1. Excess NaNH}_2/\text{heat} \\
\text{2. } \text{H}_2\text{O} \\
\text{3. HgSO}_4/\text{H}_2\text{SO}_4/\text{H}_2\text{O}
\end{align*}
\]

e)

\[
\begin{align*}
\text{1. Excess LiAlH}_4 \\
\text{2. H}_3\text{O}^+
\end{align*}
\]
Question 4 (15 pts.)
a) Show how you would make the indicated bond A using an acetylide anion reaction by giving the structure of the anion in the first box and appropriate structures/reagents/conditions in the second box.

\[
\text{Na}^+ \quad \cdot \quad \cdot \\ \text{acetylide anion}
\]

\[
\begin{align*}
1. & \quad \text{structure of the anion} \\
2. & \quad \text{H}_3\text{O}^+ \quad \text{reagents/conditions}
\end{align*}
\]

b) Bond B can NOT be made via an acetylide anion reaction, give a BRIEF explanation

the acetylide anion can't be formed, deprotonation would occur at OXYGEN, not the alkyne - or words to that effect - these exact words are not necessary, just the idea has to be correct

Question 5 (15 pts.) For EACH of the two indicated bonds A and B, perform retrosynthetic analysis and draw the best synthons. Only one of these bond can actually be made, indicate which one, give the actual reactants/synthetic equivalents you would use to make that bond, give the curved arrow pushing showing bond formation and BRIEFLY explain why the other bond can not be made

Question 6 (12 pts.) Give a curved arrow-pushing mechanism for the following reaction, indicate the Lewis acids/bases (LA/LB) and Bronsted acids/bases (BA/BB) at each intermolecular step, as appropriate). ONE of the steps in the mechanism is SN2, clearly indicate which one this is.
Question 6 (36 pts.) Show how you would synthesize the target compounds on the right from the starting compounds on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.

a) 
\[
\begin{align*}
\text{Br}_2 & \quad \rightarrow \quad \text{Br} \\
\text{Br} & \quad \rightarrow \quad \text{Br} \\
1. \text{Excess Na}^+{-}\text{NH}_2, 2. \text{H}_2\text{O} & \quad \rightarrow \quad \text{Br} \\
\end{align*}
\]

b) 
\[
\begin{align*}
\text{NaNH}_2 & \quad \rightarrow \quad \text{CH}_3\text{Br} \\
\text{CH}_3\text{Br} & \quad \rightarrow \quad \text{NaNH}_2 \\
\end{align*}
\]

these 2 steps can be combined

these 2 steps can be reversed
Question 7 (34 pts). Give a curved arrow pushing mechanisms for the following two reactions.

1) Add non-bonding electrons and C-H bonds to the line-angle structures as required.

2) Indicate the Lewis acid/Lewis base (LA, LB) at each INTERMOLECULAR step as appropriate, and whether they are also Brønsted acids/bases (LA/BA, LB,BB).

3) Include ALL IMPORTANT RESONANCE CONTRIBUTORS for intermediates.

4) GIVE THE NUMBER OF STEPS IN YOUR MECHANISMS.

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**a)**

\[ \text{H}_2\text{SO}_4 \text{(cat.)} \]

\[ \text{H}_2\text{O} \rightarrow \]

\[ \text{LA/BA} \]

\[ \text{LB/BB} \]

Number of steps = 2

---

**b)**

\[ \text{HCl} \text{(cat.)} \]

\[ \text{H}_2\text{O} \rightarrow \]

\[ \text{LA/BA} \]

\[ \text{LB/BB} \]

Number of steps = 4