If you would like your grade early, you must email me. I will reply once the grades are complete.

Name ___________________________

ORGANIC CHEMISTRY CH 351-04 (Wilson)
Final Exam
December 18, 2003

Question 1 _________  (24)
Question 2 _________  (24)
Question 3 _________  (21)
Question 4 _________  (30)
Question 5 _________  (38)
Question 6 _________  (33)
Question 7 _________  (18)
Question 8 _________  (12)
E. C. _________  (8)

TOTAL _________  (200)

"Some of these flakes of snow are enormous Leonard ... Leonard?"

"Do, or do not. There is no 'try'." - Yoda in The Empire Strikes Back
1. The following molecule is Cyanobrucine. Use it to answer the questions below.

![Molecule Diagram]

a. Circle and name four functional groups present. (2 pts each)

b. Give the hybridization of the non-hydrogen atoms next to the indicated arrows on the drawing. (2 pts each)

c. How many stereocenters are present in this molecule? (2 pts) How many possible stereoisomers could there be for this molecule? (4 pts)

2. Use 1, 2, 4, 5-tetrachlorocyclohexene for the following questions.

a. Draw the structure using a “flat” representation below. (4 pts)
b. Draw four of the possible stereoisomers of this compound using “wedge and dash” on the flat representation. Label each stereocenter R or S. (6 pts)

c. Label each of the drawings in part b as A, B, C etc. Give the relationship between each of the compounds (i.e.: A&B are ____; B&C are ____; etc.). (6 pts)

d. Draw any one of the compounds in part b in the most stable chair conformation. Clearly indicate your choice, and be sure that you have maintained stereocenters! (4 pts)

e. Draw the Newman projection of the chair you have drawn in part d. [Hint! Sight down the C1-C2 and C5-C4 bonds.] (4 pts)
3. What is the relationship between the **seven** of the following **eight** sets of molecules (3 pts each)? Your choices are: identical compound; resonance structure; structural (constitutional) isomer; geometric isomer; enantiomer; diastereomer; completely different compound.

a. \[
\begin{align*}
\text{CH}_3 & \text{NH}_2 & \text{H} & \text{NH}_2 & \text{H} & \text{CH}_3 \\
& & \text{H}_2 & \text{N} & \text{H} & \text{CH}_3
\end{align*}
\]

b. \[
\begin{align*}
\text{CH}_3 & \\
& \text{CH}_3
\end{align*}
\]

c. \[
\begin{align*}
\text{HO}_2 & \text{C} & \text{H} & \text{OH} & \text{CO}_2 & \text{H} \\
\text{HO}_2 & \text{C} & \text{H} & \text{OH} & \text{CO}_2 & \text{H}
\end{align*}
\]

d. \[
\begin{align*}
\text{H}_3 & \text{C} & \text{H} \\
& \text{H}
\end{align*}
\]

e. \[
\begin{align*}
\text{CH}_3 & \text{CH}_2 & \text{CH}_2 & \text{CH}_3
\end{align*}
\]

f. \[
\begin{align*}
\text{HC} & \equiv & \text{CCH}_2 & \text{CH}_2 & \text{C} & \equiv & \text{CH}
\end{align*}
\]
4. Synthesize the **two** of following three molecules using reasonable synthetic steps. Your legal starting materials include: **mono**-alkyl halides of five carbons or less, acetylene (HCCH), bases for elimination and deprotonation (KOTBu, nBuLi, NaNH₂, NaH, etc.), inorganic reagents ("CN, NBS, TsCl, and MsCl are all “inorganic”), and solvents as needed. Keep in mind that if a carbon-containing group is added to a molecule, **you must use legal starting materials or synthesize the appropriate piece**. Use good, high yielding steps **that will work**. There may be many correct answers to these questions. Use hints and clues scattered through the rest of the exam!
[This space left blank for your answer(s) for problem 4]
5. Draw the starting material for EACH of the indicated reactions (2 pts each). Give the product(s) for six out of the eight questions below (5 pts each). Indicate clearly which questions you would like graded.

a. (2R, 3S) 2-bromo-3-methylpentane

b. $$\text{OMs}$$

1) EtOH, heat
2) Br₂ (xs), CH₂Cl₂
3) KOTBu (xs), DMSO

c. $$\text{C}_8\text{H}_{16}$$

1) OsO₄, NMO
2) PBr₃

d. $$\text{Ph} - \equiv - \text{Ph}$$

1) H₂, Lindlar's cat.
2) O₃
3) Zn
e. bicyclo[5.4.0]undecane

1) Br₂, heat
2) iPrOH, heat

---

e. bicyclo[5.4.0]undecane

1) Br₂, heat
2) iPrOH, heat

---

f. NC

1) nBuLi, THF
2) CH₃-Br, THF
3) , heat

---

f. NC

1) nBuLi, THF
2) CH₃-Br, THF
3) CH₂O, heat

---

g. cis 1,3-dibromocycloheptane

1) HCCO⁻Li (xs), THF
2) HgSO₄, H₂SO₄

---

g. cis 1,3-dibromocycloheptane

1) HCCO⁻Li (xs), THF
2) HgSO₄, H₂SO₄

---

h. 2,7-dimethyl-4-octyne

1) NBS (1 eq), heat
2) Na⁺, NH₃ (l), -33°C
3) CH₂I₂, Zn

---

h. 2,7-dimethyl-4-octyne

1) NBS (1 eq), heat
2) Na⁺, NH₃ (l), -33°C
3) CH₂I₂, Zn
6. Given the following four reactions, choose three and give reasonable mechanisms. Be sure to show each step, all intermediates, the flow of electrons from one step to the next, ALL resonance structures (if any), and form only the products indicated. There may be other products formed which are not shown. (11 pts each)

i. 

ii. 

iii. 

iv. 

\[ \text{O} \]
[This space left blank for your answer for problem 6]
7. For six out of the following nine statements, circle the answer that agrees most (3 pts each). Choose only SIX! There is no partial credit for this question.

a. This is a reasonable $S_N2$ substrate.
   
   a 3° alkyl halide OR a 2° alcohol OR a 1° tosylate

b. This is a better base.

   \[
   \begin{align*}
   \text{CH}_2\text{C}_2\text{CH}_2\text{CH}_3 & \quad \text{OR} \quad \text{C}==\text{CH} \quad \text{OR} \quad \text{C}==\text{N} \\
   \end{align*}
   \]

c. The following will give a pair of enantiomers after a Diels-Alder reaction with cyclopentadiene.

    \[
    \begin{align*}
    \text{CN} & \quad \text{OR} \quad \text{CO}_2\text{Me} \\
    \text{NC} & \quad \text{OR} \quad \text{CO}_2\text{Me} \\
    \end{align*}
    \]

d. The following is the correct IUPAC name for this compound.

    \[
    \text{3,6-diisopropyloctane} \quad \text{OR} \quad \text{3,6-diethyl-2,7-dimethyloctane}
    \]

e. This is the “best” resonance structure.

    \[
    \begin{align*}
    \text{N}==\text{O} & \quad \text{OR} \quad \text{N}==\text{O} \quad \text{OR} \quad \text{N}==\text{O} \\
    \end{align*}
    \]

f. This will give a pair of enantiomers upon reaction with Cl$_2$.

    \[
    \begin{align*}
    \text{Z-cyclononene} & \quad \text{OR} \quad \text{E-cyclononene} \\
    \end{align*}
    \]

g. The following is a reaction which gives Markovnikov products.

    \[
    \begin{align*}
    \text{H-Cl} & \quad \text{OR} \quad \text{H-Cl} \\
    \end{align*}
    \]
h. This is the most stable carbocation.

\[
\begin{align*}
\text{CH}_3
\end{align*}
\]

i. This is the most stable chair conformation.

\[
\begin{align*}
\text{CH}_3
\end{align*}
\]

(12) 8. Given the following “roadmap” question, give structures for A, B and C (4 pts each). There is only one correct answer for each, however, partial credit may be given for correct answers carried through the reaction sequence. Keep in mind that there are molecular formulas given for a reason!

A = B = C =

(5) BONUS: Give an example of your favorite organic reaction. Use a real substrate and reagents that will work!

(3) BONUS BONUS: Give the polymer which would result from the following monomer.

\[
\begin{align*}
\text{Ph}
\end{align*}
\]