Chemistry 59-230/232
Time: 3 h

Final Exam
Dec. 16, 2005

NAME $\qquad$ ID\# $\qquad$

## LAB SECTION (or TA name)

Note: Please answer on the test paper. There is an extra sheet for rough work at the back, but it will not be marked. In some questions, there is a choice of questions to answer. If all are answered, all will be marked. There are 140 marks on this exam.

1. Fill in the blanks with the structural formula or reagents required to complete the equation. Show any required catalysts over the arrow. Make sure your drawings show stereochemistry if it is important. Do any ten (10) (40 marks)
a.

b.

C.

d.

1) $\mathrm{LiAlH}_{4}$
2) $\mathrm{H}_{2} \mathrm{O}$
only need largest organic product
e.

f.


g.

h.


2a. (12 marks total) Draw the structure of cis 1-iodo-4-(isopropyl)cyclohexane is its most stable chair conformation. Label the non hydrogen substituents on the cyclohexane as axial or equatorial. In terms of size, an iso propyl is larger than an iodo group. (5 marks)
b. Draw the N ewman projection of the following compound in its least stable staggered conformation, as viewed down the C2-C3 bond. W ith respect to size, $\mathrm{CH}_{2} \mathrm{CH}_{2} \mathrm{CH}_{3}>\mathrm{CH}_{3}>\mathrm{C}(\mathrm{H})=\mathrm{CH}_{2}>\mathrm{Br}>\mathrm{H}$. W hat is the name of this compound, including its stereochemical descriptor(s) ? (7 marks)


## 3. a. (14 marks total)

Draw the complete mechanism for the following reaction. Take the reaction to completion. Indicate which steps are reversible (or irreversible). Provide a valid IUPAC name for the starting material, including the stereochemical descriptor. (9 marks)

b. In the reaction of an ester (lets say ethyl propanoate) with a Grignard reagents (let's say it's $\mathrm{CH}_{3} \mathrm{MgBr}$ ) one never gets a ketone as a product. Show by intermediates and reaction steps why is this the case ( 5 marks). The complete answer will include the structure of ethyl propanoate.
4. (27 marks total) Describe the relationship that exists between the following sets of compounds (i.e., enantiomer, diastereomer, geometric isomer, structural isomer, identical). Indicate any meso forms.
a.


b.


C.



Also, identify the chiral centres for the right compound in $C$ ) as ( R )- or (S)- (3 of 27 marks)
d. Draw the Fischer projection of (2S, 3S, 5R)-5-fluoro-2,3-hexanediol. (5 of the 27 marks).
e. Identify each carbon atom of the following with its hybridization. (3 marks)

f. In the above compound (in e), assign the appropriate stereochemical descriptor to each alkene. Show your work (6 marks)
5. $0 n$ the axes below, draw the energy/reaction coordinate profile for:
a. The reaction between $\left(\mathrm{CH}_{3}\right)_{3} \mathrm{C}-\mathrm{Cl}+\mathrm{NH}_{3}$ to give $\left(\mathrm{CH}_{3}\right)_{3} \mathrm{C}-\mathrm{N}^{+} \mathrm{H}_{3}$ (the mechanism should be implied in the answer).
b. $\quad A$ four step reaction betw een $A$ and $B$, where $A$ is consumed in the $1^{\text {st }}$ step and $B$ is involved in the $2^{\text {nd }}$ step. The $3^{\text {rd }}$ step is the slow est one.

In each of these cases, give the rate equation for the reaction. (10 marks total)
a) $\qquad$
rate $(\mathrm{v})=$
b) $\qquad$
rate $(\mathrm{v})=$
6. ( 16 markstotal) Rank the following in terms of tendency to undergo $S_{N} 1$ substitution (as opposed to $S_{N} 2$ ). Give reasons for your ordering and the expected products. (13 of the 16 marks) $N$ ote the following dielectric constants: $\mathrm{H}_{2} \mathrm{O}$ (81); acetone (23); $\mathrm{CH}_{3} \mathrm{CN}$ (38); $\mathrm{CHCl}_{3}$ (2).
a)

$\mathrm{I}^{-} \xrightarrow{\text { in acetone }}$
b)

in $\mathrm{CH}_{3} \mathrm{CN}$
I
in $\mathrm{CH}_{3} \mathrm{CN}$
c)

d. Rank the following from best leaving group to worst leaving group ? (3 of the 16 marks)
7. ( $\mathbf{1 0}$ marks) a and $b$ Indicate all reasonable resonance forms of the following ions, using curved arrows to indicate electron movement. If there are unreasonable resonance forms, either do not draw them or label them as unreasonable. If there is a case for which there are no other resonance forms, state that fact.
a.

b

8. (11 marks total) Show by equation how you carry out the following overall transformations. Show all reagents and the structures of each reaction product. There is quite possibly more than one correct way to accomplish this overall transformation. DO one of a and b, but answer c regardless.
a.

b.

c. W hat is the name of the final product compound in $\mathbf{8 b}$ ? (3 of the 11 marks)

Bonus (up to +5 )
The reaction of ketones in the presence of hydroxide ion often gives 3-hydroxy ketones in a well known reaction called the aldol condensation. C ould you suggest a plausible mechanism for this reaction?


