

Chemistry 3351
Organic Chemistry/Final Exam/CHEM 142
Monday: Dec. 13th from 7:30 pm → 10:00pm

Name: KEY! (please print)

Page	Possible Points	Score
2	<u>9</u>	_____
3	<u>10</u>	_____
4	<u>12</u>	_____
5	<u>14</u>	_____
6	<u>12 14</u>	_____
7	<u>10</u>	_____
8	<u>6</u>	_____
9	<u>10</u>	_____
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11	<u>10</u>	_____
12	<u>9</u>	_____
13	<u>8</u>	_____
14	<u>10</u>	_____
15	<u>10</u>	_____
TOTAL	<u>118 150</u>	_____

1. (9 pts) Clickers in Action:

i) Your assignment is to convert (1*R*, 2*S*)-2-methylcyclopentanol to (1*R*, 2*S*)-1-cyano-2-methylcyclopentane. The reagents provided are:

D

- (1) NaCN, acetone
- (2) TsCl, pyridine
- (3) NaI, acetone

Select the best sequence of reactions, starting with substrate, to obtain the highest yield of product.

- A) 1
- B) 2, 1
- C) 2, 3
- D) 2, 3, 1

ii) Propose a synthetic route for isopropyl propyl ether using any of the reagents shown below. Select the sequence in which you will use the reagents.

- 1) 1-Propanol
- 2) 2-Propanol
- 3) 1-Bromopropane
- 4) 2-Bromopropane
- 5) NaH, THF

B

- A) 1, 5, 4
- B) 2, 5, 3
- C) 3, 5, 2
- D) 4, 5, 1

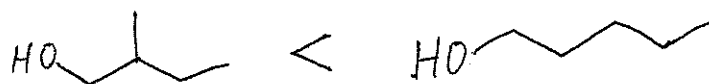
iii) Consider the reaction of propene with Hg(OAc)₂ in THF-H₂O, followed by reaction with NaBH₄ in aqueous NaOH. Classify this reaction using oxidation-reduction concepts.

C

- A) Oxidation
- B) Reduction
- C) Neither

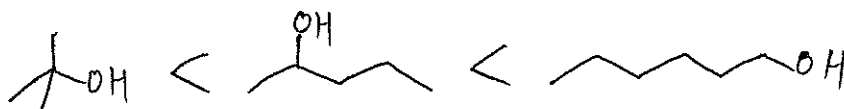
2. (10 pts) Arrange the compounds within each of the following sets in order of increasing boiling point, and give your reasoning (concisely).

(a) 1-pentanol, 2-methyl-1-butanol



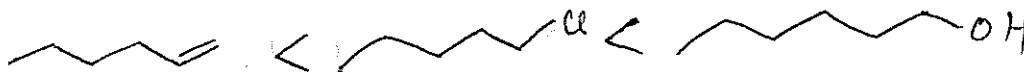
Unbranched alcohols have higher b.p.

(b) 1-hexanol, 2-pentanol, *tert*-butyl alcohol



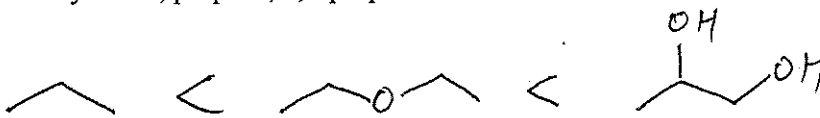
More carbon, higher b.p.

(c) 1-hexanol, 1-hexene, 1-chloropentane



1-chloropentane has a higher molecular weight + is more polar than 1-hexene.
1-hexanol can form hydrogen bonding.

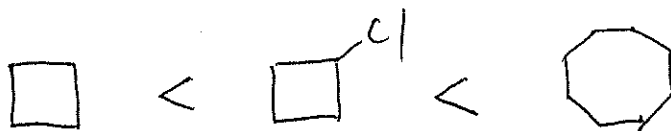
(d) diethyl ether, propane, 1,2-propanediol



propane has the shortest carbon chain.

1,2-propanediol can form hydrogen bonding.

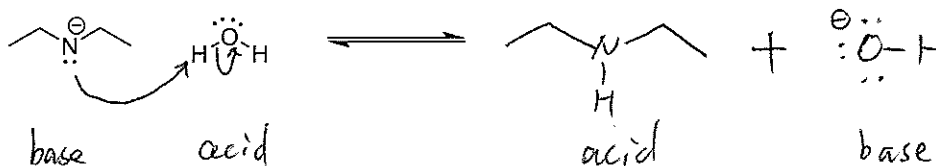
(e) cyclooctane, chlorocyclobutane, cyclobutane



Higher molecular weight, higher b.p.

3. (12 pts) Acid-Base Chemistry

- a. Complete the following equation. Use curved arrow notation and show all formal charges and lone pairs. Also, clearly label the Bronsted acid-base pairs.



- b. Using the choices from the table provided, identify the acidic and basic components of the following solutions:

10% H_2SO_4 in H_2O

Acidic: H_3O^+ , H_2SO_4 , HSO_4^-
 Basic: H_2O , HSO_4^-

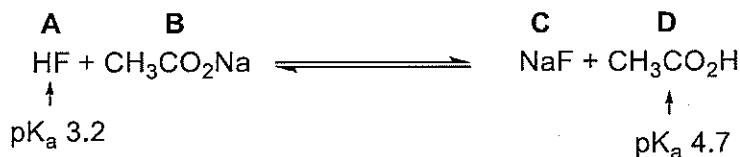
15% NH_3 in H_2O

Acidic: NH_4^+ , H_2O
 Basic: NH_3 , OH^-

Choices

H_2O
 H_3O^+
 OH^-
 H_2SO_4
 HSO_4^-
 NH_3
 NH_4^+

- c. Answer the questions concerning the following reaction:



- i. Which species act as acids?

A and D

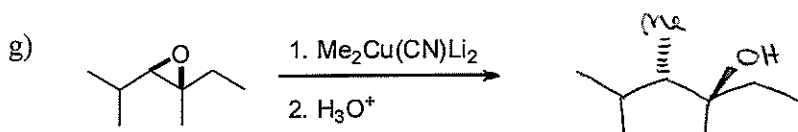
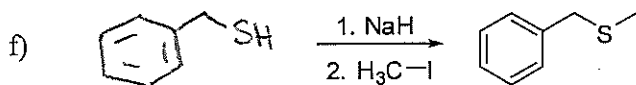
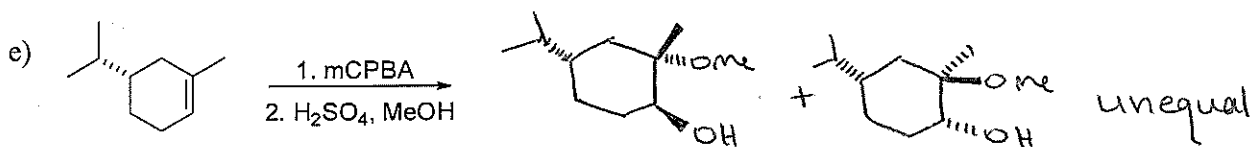
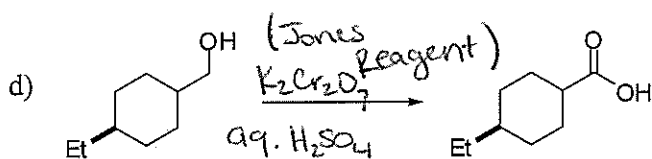
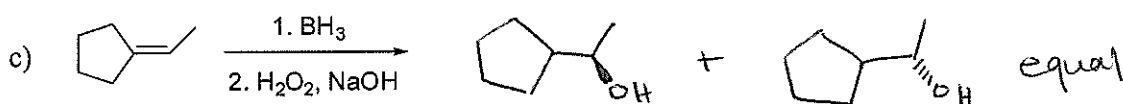
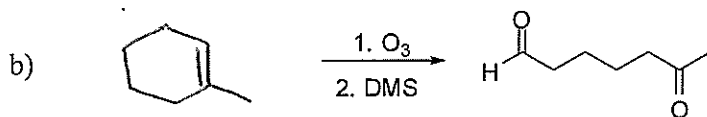
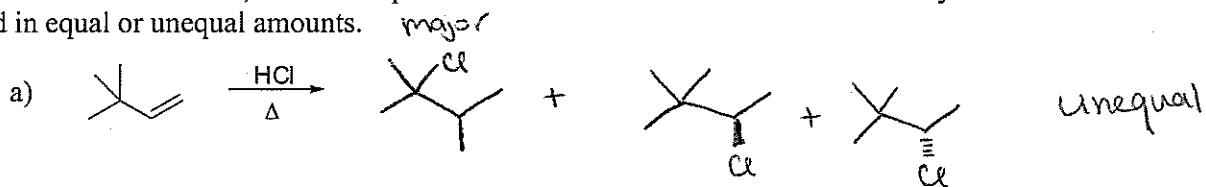
- ii. What is the strongest base?

B

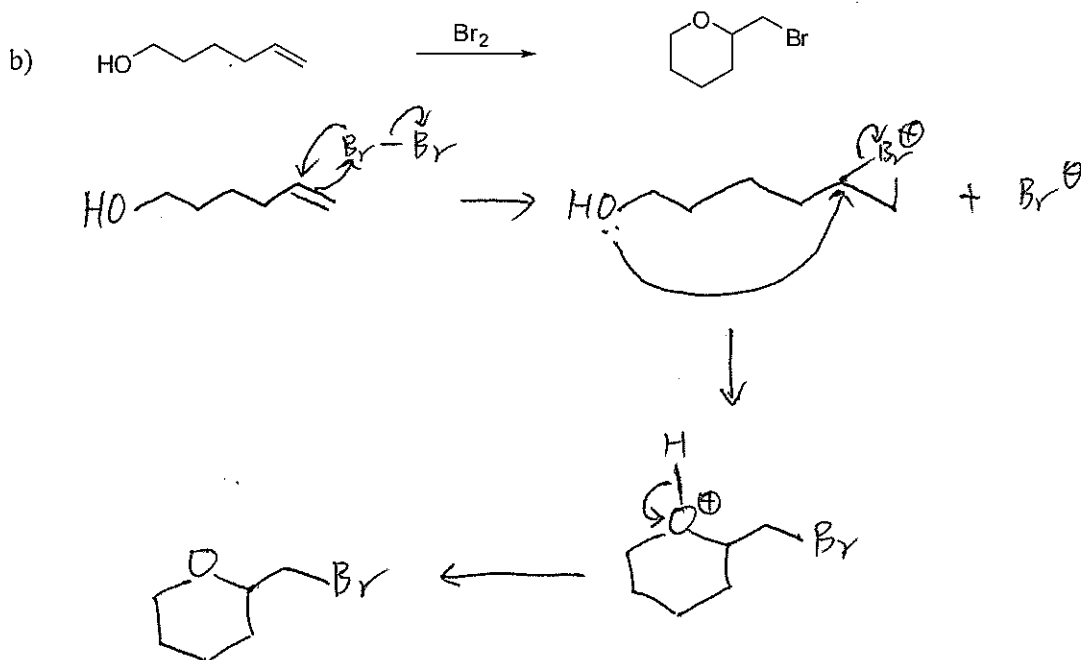
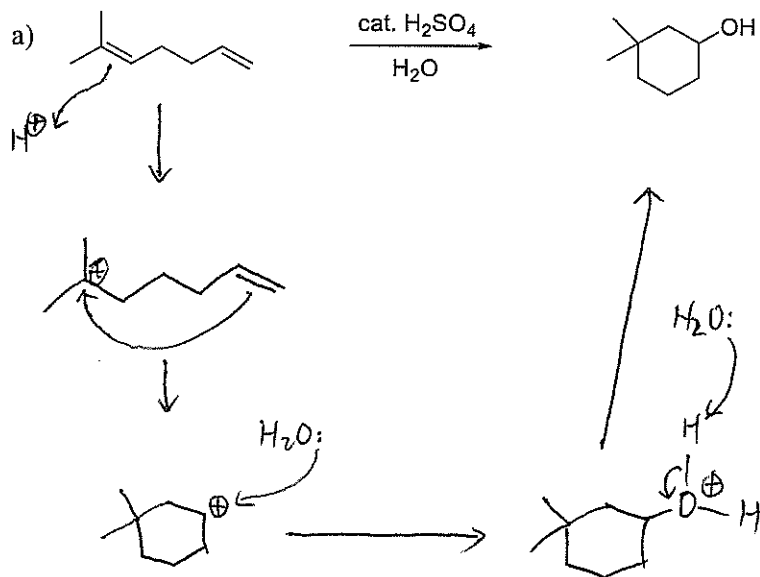
- iii. To which side does the equilibrium lie?

to the right side.

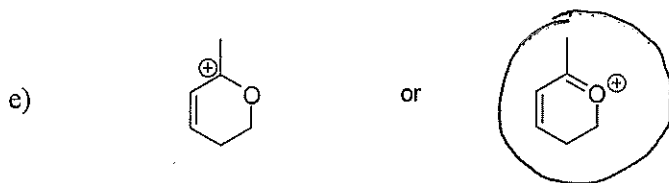
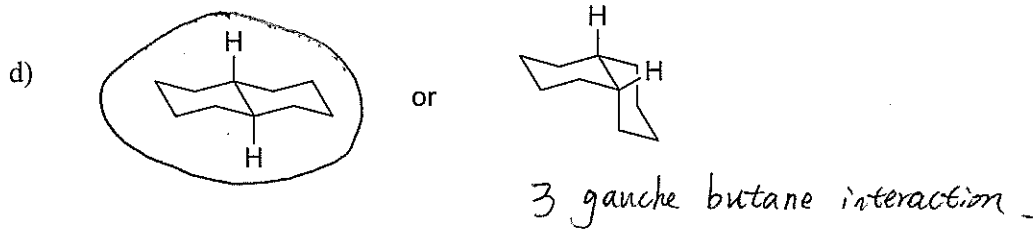
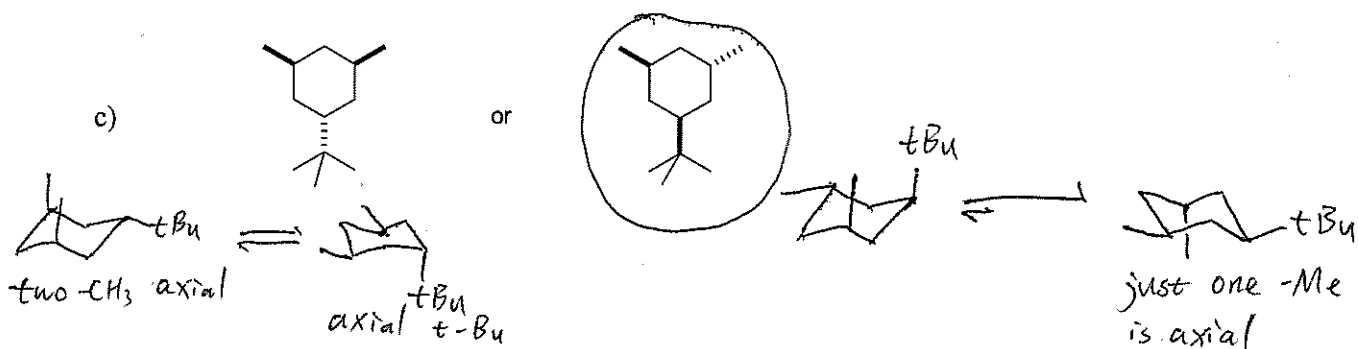
4. (14 pts) Provide the missing products or reactants for the following reactions. For reactions that produce stereoisomers, draw ALL possible stereoisomers and INDICATE if they would be formed in equal or unequal amounts.



14
5. (10 pts) Provide full and complete mechanisms for the reactions below. Be sure to include every intermediate and all arrows required for each step of the reaction.

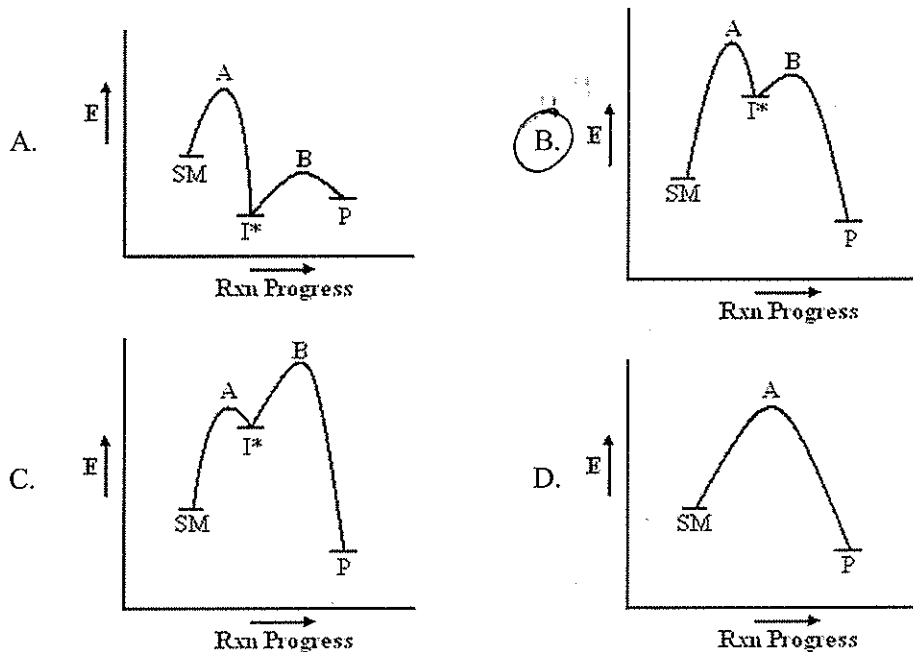
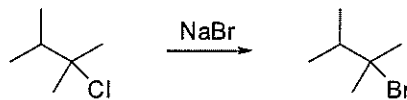


6. (10 pts) Circle the most stable structure in each pair of structures below.



6 pts
7. (30 pts)

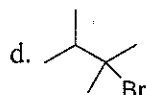
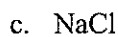
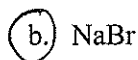
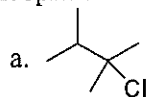
a) Which energy diagram best represents the reaction shown below? Please circle your answer. (SM: Starting material, I*: Intermediate, P: Product)



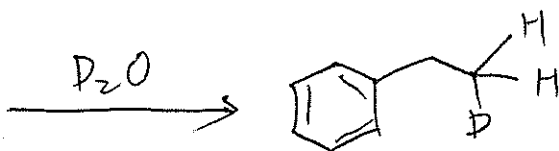
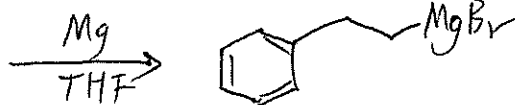
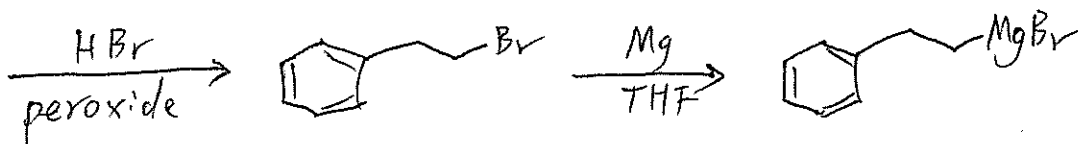
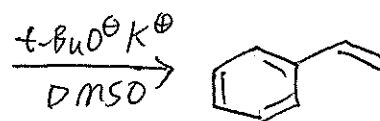
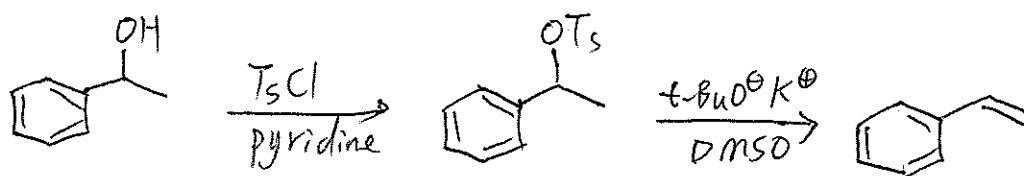
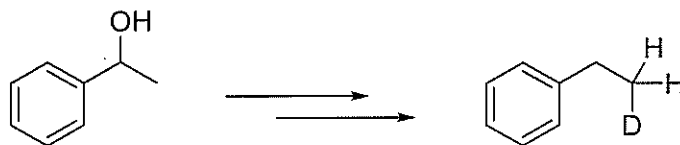
b) In regards to your answer for part a), which step is rate limiting? Please circle your answer.

- i. Step A
- ii. Step B
- iii. Neither Step A nor Step B

c) In regards to the reaction above, which of the following compounds is the nucleophile? Please circle your answer.

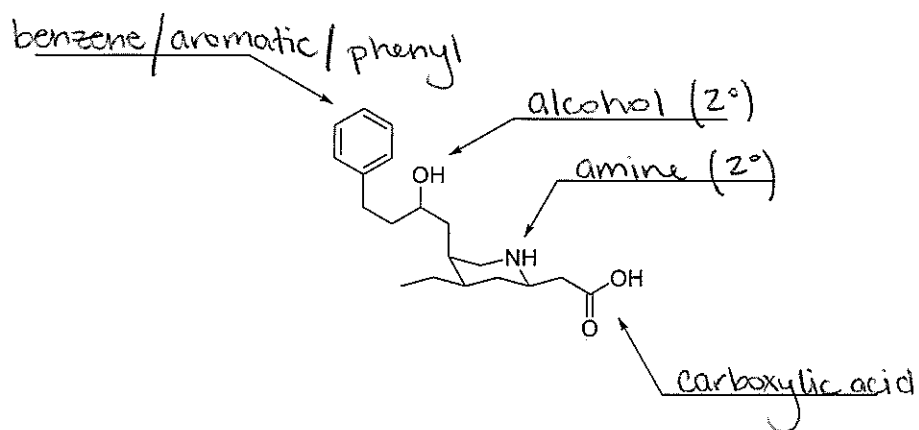


8. (10 pts) Design a synthetic route for the transformation below. The synthesis requires more than one step; therefore, please show all intermediates for full credit.

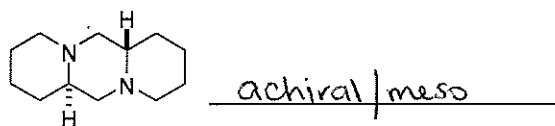
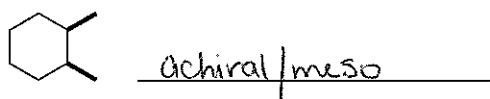


It's not the only answer.

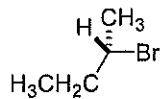
9. (10 pts) a) Label all functional groups in the following compound.



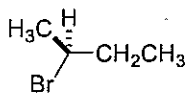
b) Identify the following compounds as either chiral, achiral, or achiral/meso.



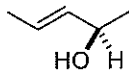
10. (10 pts) Identify the relationship between the following pairs. Are they identical, constitutional isomers, enantiomers, or diastereomers?



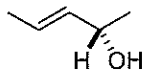
and



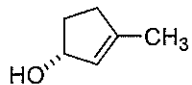
identical



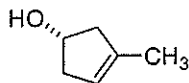
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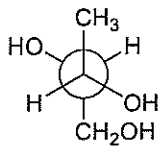
enantiomers



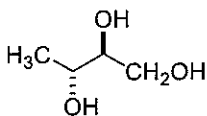
and



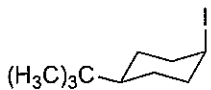
constitutional isomers



and



enantiomers

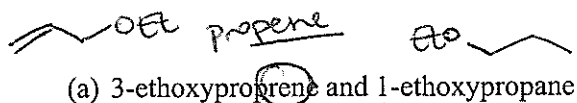


and

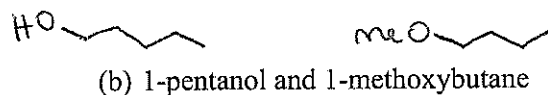


diastereomers

8 pts
12. (10 pts) Explain how you could differentiate between the compounds in each of the following pairs by using simple physical or chemical tests that give readily observable results, such as obvious solubility differences, color changes, evolution of gases, or formation of precipitates.

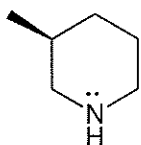


CCOC=C undergoes Br_2 addition, + therefore decolorizes a solution of Br_2 in an inert solvent; CCOC does not.



CCCCO is somewhat / fairly soluble in water; CCCCOC is not. Also, when CCCCO is treated with NaH , H_2 gas is evolved, + when treated with CH_3MgBr , CH_4 gas is evolved. No gas is evolved in either rxn with CCCCOC.

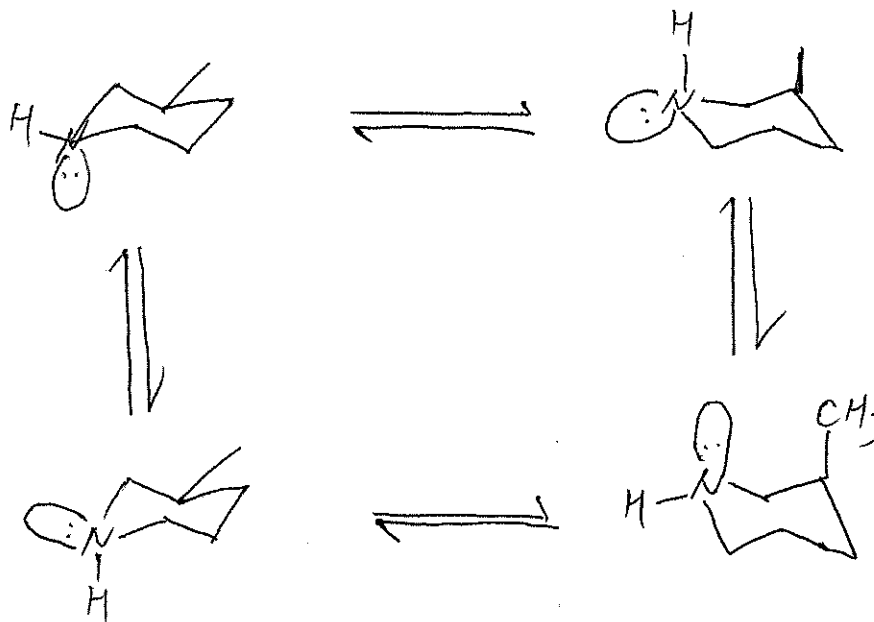
13. (10 pts) Draw a chair conformation for (*S*)-methylpiperidine showing the sp^3 orbital that contains the nitrogen unshared electron pair. How many chair conformations of this compound are in rapid equilibrium?



(*S*)-3-methylpiperidine

Four.

Both chair interconversion and amine inversion can occur.



14. (10 pts) Propose a structure for the compound (C_nH_mX , $X = \text{halogen}$) given the spectra shown below. Be sure to show your reasoning by labeling definitive signals on each spectrum. Also, please label the hydrogens in your proposed structure and match them to their corresponding signals on the NMR spectrum.

