WestVirginiaUniversity

Bennett Department of Chemistry
Chemistry 234

Midterm

March 5th, 2015

Last Name: Answer Key
First Name: _____
ID: _____

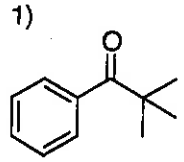
This exam is a closed book, closed notes.
Calculators and a molecular model set are allowed.
You must show your work in order to receive partial credited.

Question I (30 points): _____
Question II (41 points): _____
Question III (25 points): _____
Question IV (25 points): _____
Question V (20 points): _____
Question VI (26 points): _____
Question VII (33 points): _____

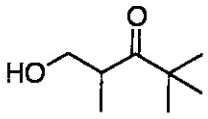
Total (out of 200): _____

Question I. Multiple Choice (1.5 point each, 30 points total)

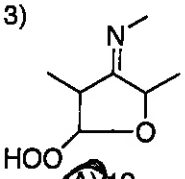
a) Please give the pKa of the MOST ACIDIC proton in each molecule.

1) 

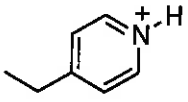
A) 10
B) 16
C) 20
D) 40
E) 45

2) 

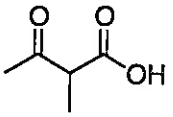
A) 10
B) 16
C) 20
D) 40
E) 45

3) 

A) 12
B) 16
C) 20
D) 35
E) 45

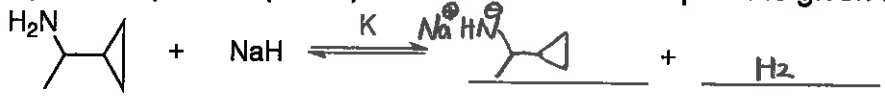
4) 

A) 0
B) 10
C) 35
D) 40
E) 45

5) 

A) 0
B) 5
C) 10
D) 16
E) 20

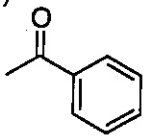
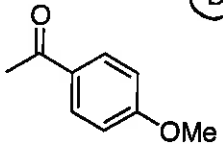
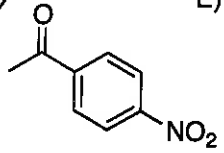
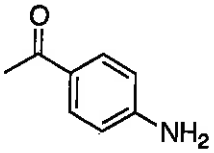
b) Provide the product (3 extra points) in the box and the Keq for the given reaction

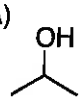
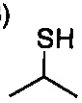
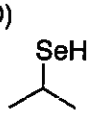


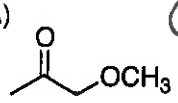
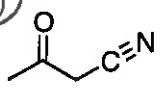
6) Keq: A) 10^{-15}; B) 10^{-10}; C) 10^{-5}; D) 1; E) 10^{10}

7) ΔG: A) 24; B) 14; C) 0; D) -14; E) -24

Select the most acidic compound in the following group of molecules.

8) A)  B)  C)  D)  E) 

9) A)  B)  C)  D) 

10) A)  B)  C) 

Identify the strongest labeled bond in the following group of molecules.

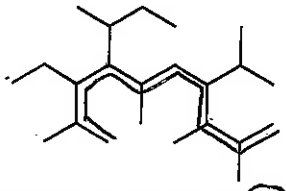
11)

CH_3-Cl	CH_3-NH_2	CH_3-OH	CH_3-PH_2	CH_3-CH_3
A	**B**	**C**	**D**	**E**

12)

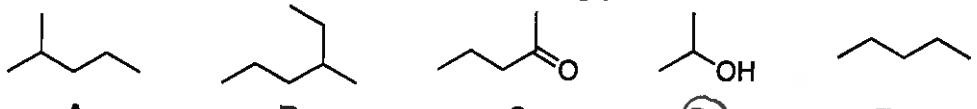
CH_2=O	H_2C=S	H_2C=AsH	CH_3-PH_2	CH_3-CH_3
A	**B**	**C**	**D**	**E**

13) The number of the longest carbon chain in the following molecules.



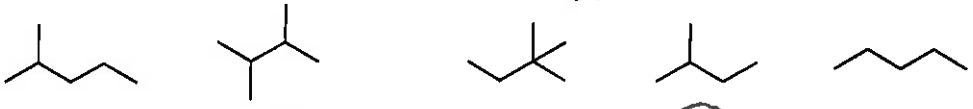
A) 12; B) 8; C) 9; (D) 10; E) 11

14) The molecule with the **highest** boiling point.



A **B** **C** (D) **E**

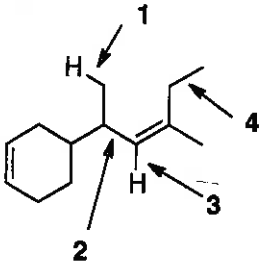
15) The molecule with the **lowest** melting point.



A **B** **C** (D) **E**

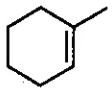
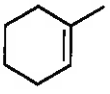
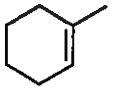
16) Which atom in the following group has **highest** electron negativity?
(A) F; **B)** O; **C)** N; **D)** H; **E)** C

17) Rank the strength of the indicated bonds in the following molecule.

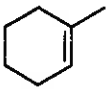
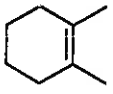


A) 1>2>3>4; B) 4>3>2>1; C) 3>1>4>2; D) 2>4>3>1; (E) 3>1>2>4

18) Which reaction runs faster?

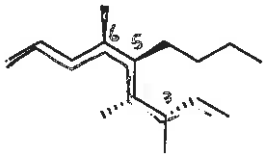
A)  + HBr B)  + HCl (C)  + HI

19) Which reaction runs faster?

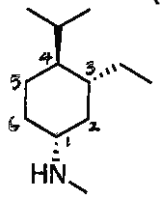
A)  + Br_2 B)  + Br_2 (C)  + Br_2

Question II. Nomenclature, Lewis structures (41 points):

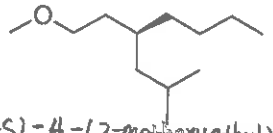
2a) Name the following molecules (3 points each, 24 points total).



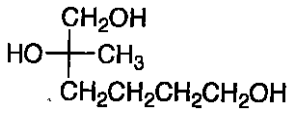
(3S,4S,5R,6R)-5-butyl-3,4,6-trimethylnonane



(1R,3R,4S)-3-ethyl-N-methyl-4-(1-methylethyl)cyclohexanamine

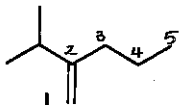


(4S)-4-(2-methoxyethyl)-2-methyl octane

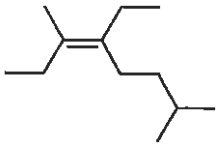


(2S)-2-methyl-1,2,6-hexanetriol

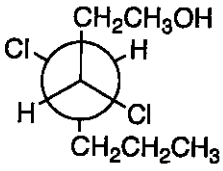
(2S)-2-methylhexane-1,2,6-triol



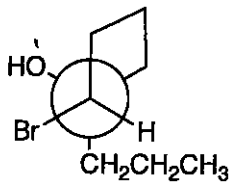
2-(1-methylethyl)-1-pentene



(Z)-4-ethyl-3,7-dimethyl-3-octene



(3S,4R)-3,4-dichloro-1-heptanol

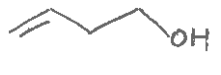


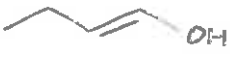
(1S,2R)-2-bromo-1-propylcyclopentanol

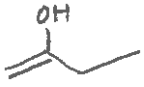
2b) Draw 20 different isomers of molecule C_4H_8O (5 points total; 12, 2 points; 15, 3 points; 18, 4 points).

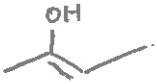
DOU = 1 one π bond or one ring

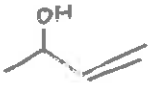
Acylic :

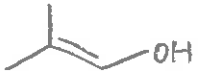


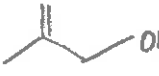


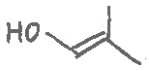


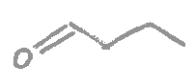


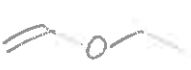


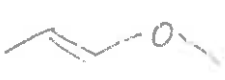


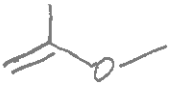




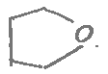


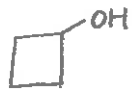


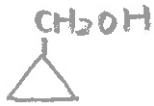


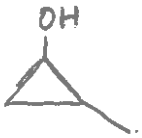


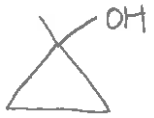
Cyclic :







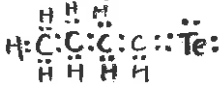




Will be more is stereochemistry considered.

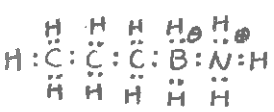
2c) Draw the Lewis structure of the following molecules (2 points each, 6 points total).

C_4H_8Te



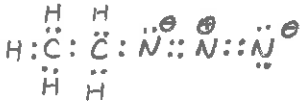
or other reasonable answer.

$C_3H_{12}BN$



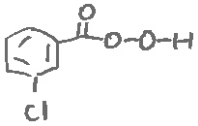
or other reasonable answer

$C_2H_5N_3$



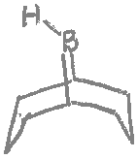
2d) Draw the structure of the following molecules (1.5 each, 6 points).

MCPBA

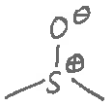


THF

9-BBN

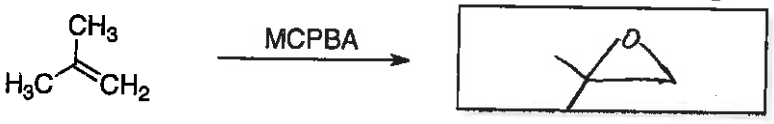


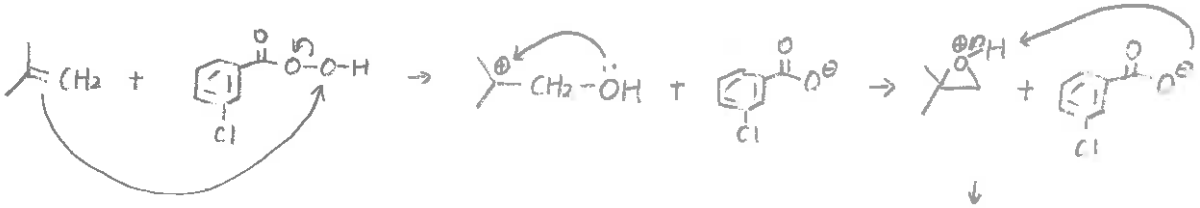
DMSO



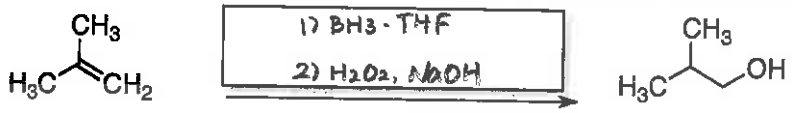
Question III. Reaction mechanism (25 points)

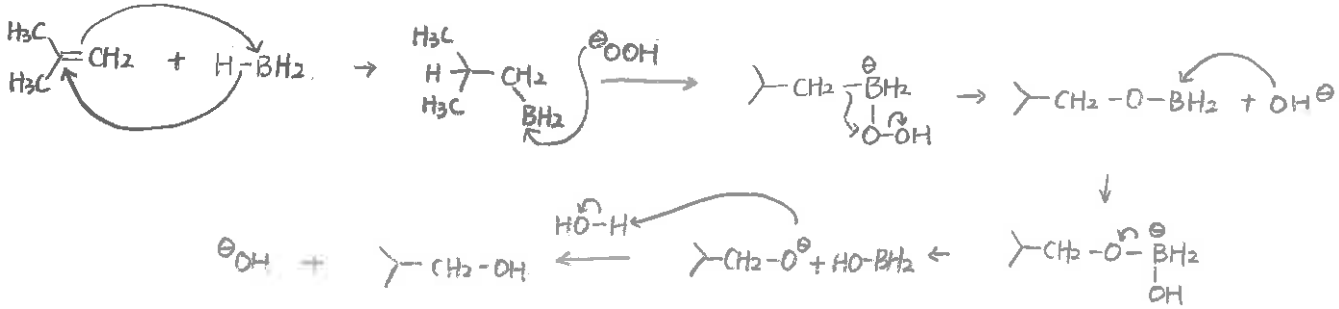
3a) Draw the product and detailed electron pushing mechanism (3 points)



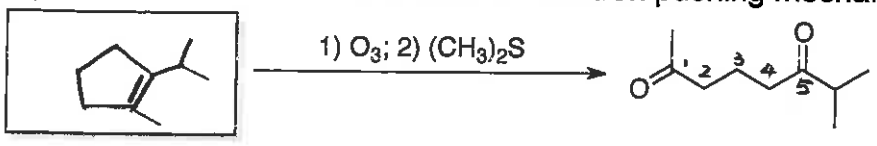


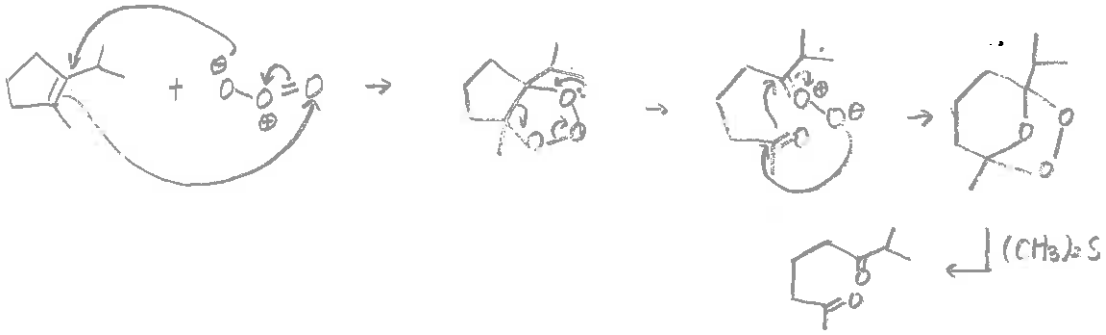
3b) Provide the reaction condition and detailed electron pushing mechanism (4 points)



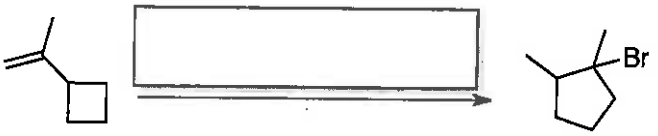


3c) Provide the reactant and detailed electron pushing mechanism (4 points)



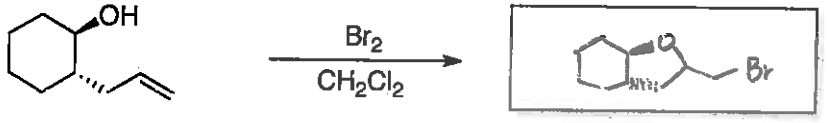


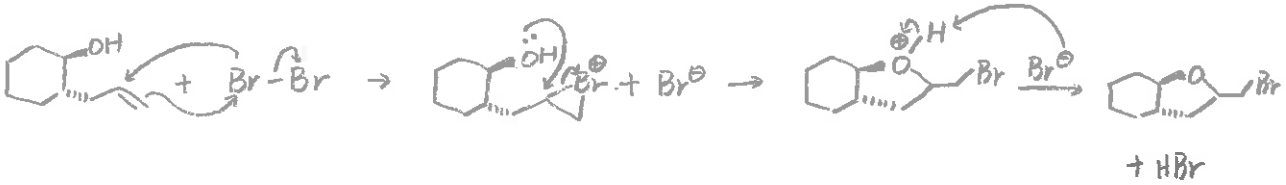
3d) Provide the reaction condition and detailed electron pushing mechanism (5 points)



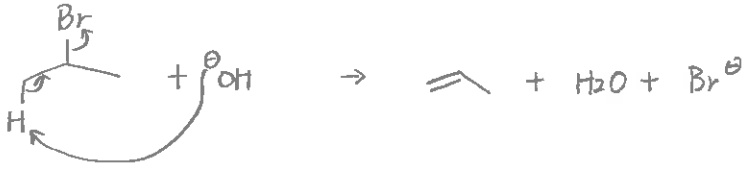
See Problem set Ch.6 100.

3e) Draw the product and detailed electron pushing mechanism (5 points)



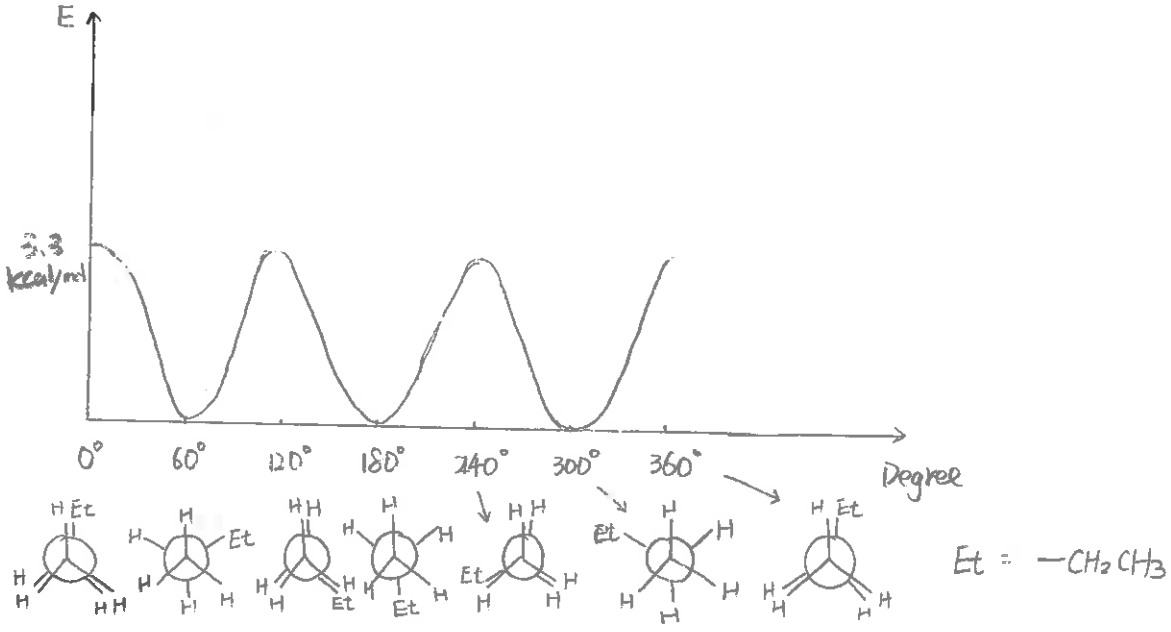


3f) Draw the product and detailed electron pushing mechanism (4 points)

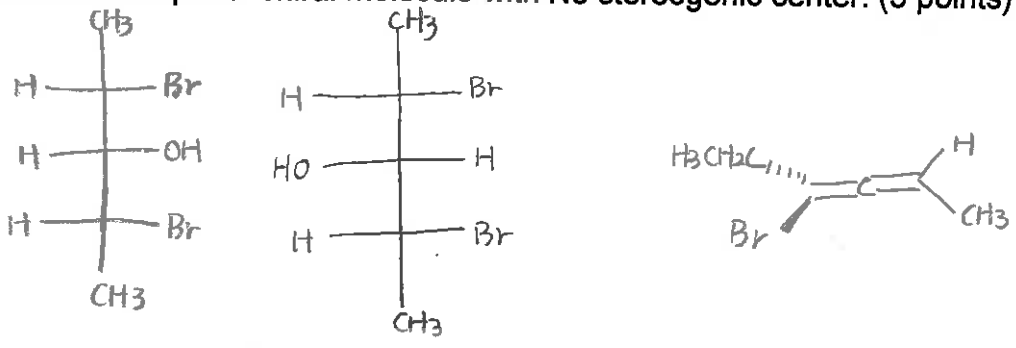


Question IV. Conformation and stereochemistry (25 points)

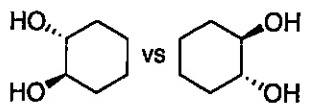
4a) Please draw detailed energetic profile for the C1-C2 rotation in n-butane (not C2-C3!). Make sure draw the energy and corresponding Newman projection. (5 points)



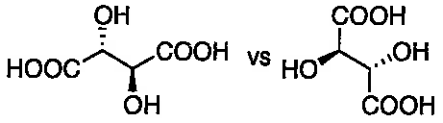
4b) Provide two examples of achiral molecules with more than two stereogenic centers and one example of chiral molecule with No stereogenic center. (3 points)



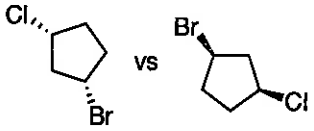
4c) Relationship: enantiomer, diastereomer, identical? (6 points)



Identical

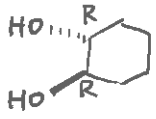


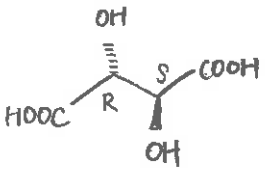
Identical

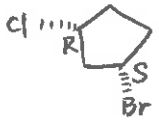


Enantiomers

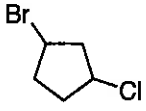
4d) Label R or S for the first molecule of each group? (3 points)



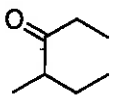




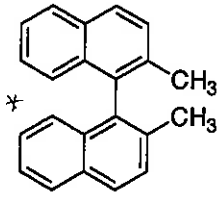
4e) Chiral or achiral? (5 points)



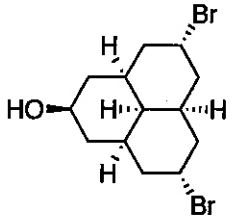
Chiral



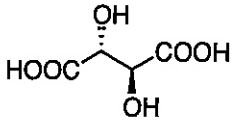
Chiral



Chiral

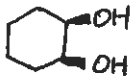


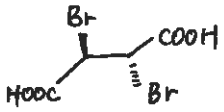
Achiral

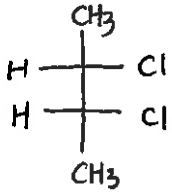


Achiral

4f) Three examples of meso compounds? (3 points)

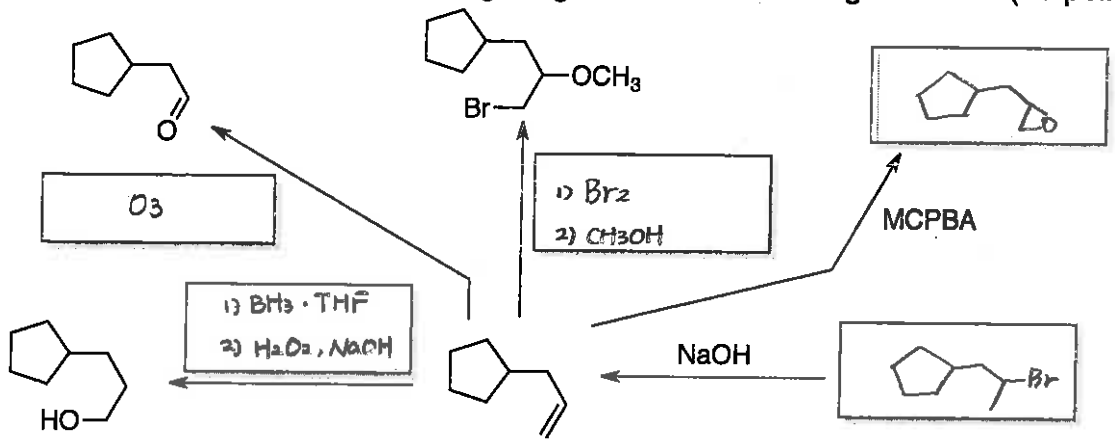




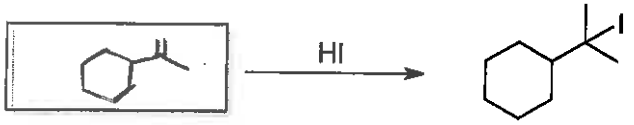


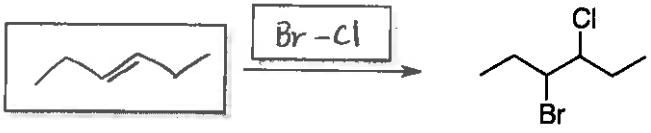
Question V. Reactions (20 points)

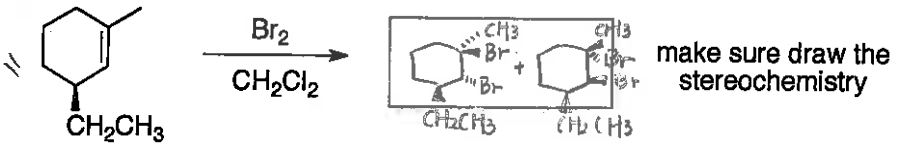
5a) Provide the product or missing reagents fro the following reactions (10 points)



5b) Starting material, product or reaction conditions (2 points each, 10 points)



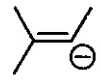




make sure draw the stereochemistry

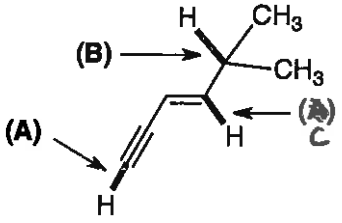
Question VI. Stability and rank (26 points)

6a) Rank the stability of the following ions and explain why (4 points)

A)  B)  C) 

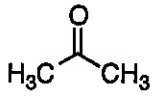
See exam I 3c)

6b) Rank the length of the following labeled bonds and explain why you (4 points).

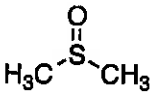


See exam I 3d

6c) DMSO and acetone are both commonly used solvents. The oxygen has electro negativity 3.8 while O is 2.5 and S is 2.5. Based on this number, the C-O and S=O should have similar polarity. However, DMSO is much more polar than acetone. Explain why? (4 points)



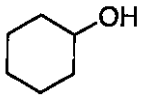
acetone

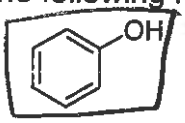


DMSO

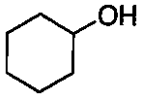
See examI 4d)

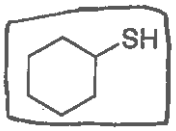
6d) Which one of the following molecule is more acidic and ***why*** (2 points, 6 point total)

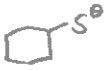


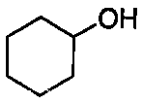


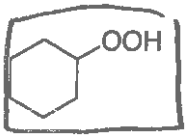
See exam I 5b) A)





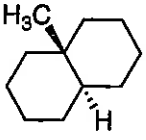
Because S is bigger than O, which can hold the negative charge more stable compared to O. Therefore  is more stable than  making it a stronger acid.

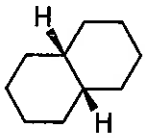


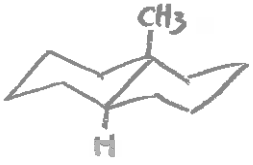


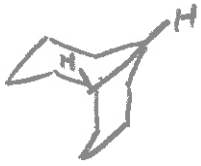
Because compared to this structure  the  has an extra oxygen which can further stablize the negative charge due to the high electronegativity of O. making  a stronger acid

6e) Draw the most stable chair structure of the following two molecules (4 points)

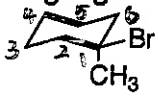


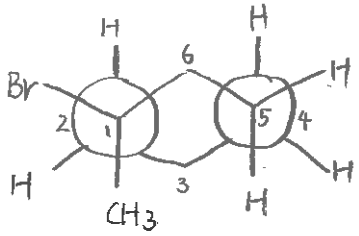






6f) Draw the double-Newman projection of the following molecule through the two highlighted bonds. Make sure pay good attention to the a and e bonds (4 points)





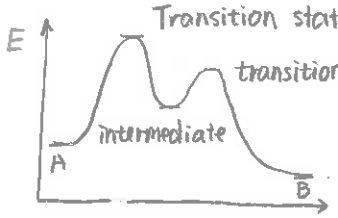
Question VII. Explanation, make sure clear and complete (33 points)

7a) What is "ee" (3 points)

"ee" means enantiomeric excess. also called the optical purity. tells us how much of an excess of one enantiomer is in the mixture.

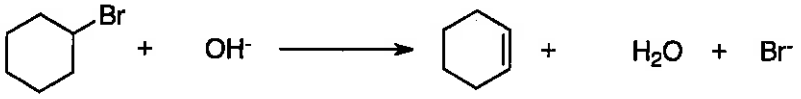
$$\text{Enantiomeric excess} = \frac{\text{observed specific rotation}}{\text{specific rotation of the pure enantiomer}} \times 100\%$$

7b) Using energetic profile to explain what is transition state, what is intermediate (3 points)



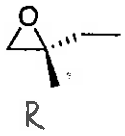
A → B

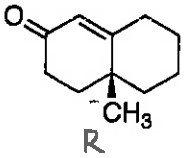
7c) Will the ΔS° value be positive or negative for the following reaction and why? (4 points)

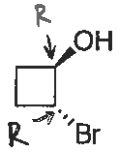


ΔS° should be positive because the entropy of the reaction increase. (Two molecules in reactant and three in product)

7d) What is the configuration of each of the asymmetric centers in the following compounds (6 points).





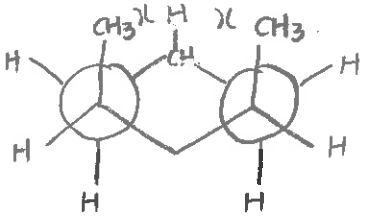


7e) Explain why CH_3Cl has a greater dipole moment than CH_3F even though F is more electronegative that Cl. (3 points).

Because Cl is bigger than F. making the C-Cl bond more polar than C-F bond. Therefore CH_3Cl has a greater dipole moment than CH_3F.

7f) One of the chair conformers of cis-1,3-dimethylcyclohexane is 5.4 kcal/mol less stable than the other. Draw the more stable one and explain how much steric strain does a 1,3-diazial interaction between two methyl group introduced into the conformer. (4 points).

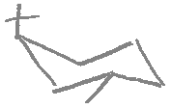
more stable



Two 1,3-dioxial interactions between H and CH_3 which introduces 1.8 kcal/mol (0.9×2).

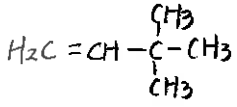
Therefore, the two methyl group introduced 5.4 − 1.8 = 3.6 kcal/mol into the conformer.

7g) Draw the two chair conformers for each of the stereoisomers of trans-1-tert-butyl-3-methylcyclohexane. Indicate which one is more stable (3 points).



more stable

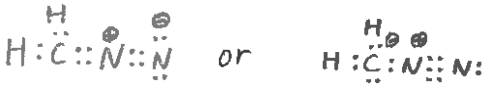
7h) Draw the structure of a hydrocarbon that has 6 carbon and three vinylic hydrogens and no allylic hydrogens. (3 points).



7i) I-Br and Br-Br which bond is stronger, why? (2 points).

Br-Br is stronger because it is shorter due to the size of Br compared to I

7j) Lewis structure of CH_2N_2 (2 points).



or

The end!