Dr. Steven Pedersen July 13, 2010

Chemistry 3A
Midterm 1

Student name: Answer Key

Student signature: _____

TA's name or section number: _____

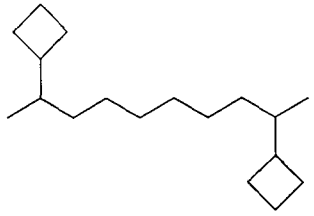
Problem 1	_____	(24 pts)
Problem 2	_____	(16 pts)
Problem 3	_____	(20 pts)
Problem 4	_____	(20 pts)
Problem 5	_____	(20 pts)
Problem 6	_____	(30 pts)
Problem 7	_____	(20 pts)
Total Points	_____	(150 pts)

No Calculators Allowed
No Molecular Models Allowed
Be Sure Your Exam has 8 Pages

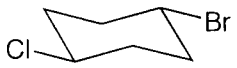
1 H							2 He
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca					35 Br	36 Kr
						53 I	54 Xe

1. There will be NO partial credit for this problem. Avoid careless errors by checking over your answers. (24 pts)

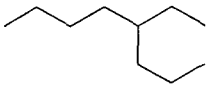
A. Provide a systematic name for each of the following compounds. Use common nomenclature for any branched substituents.



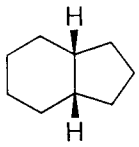
2,9-dicyclobutyldecane



trans 1-bromo-4-chlorocyclohexane or
trans 1-chloro-4-bromocyclohexane
Different alphabetizing ok



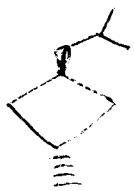
4-ethyloctane or
5-ethyloctane



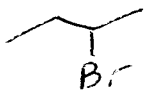
cis bicyclo[4.3.0]nonane
any order of these numbers is OK

B. Draw a structure for each of the following names. For cycloalkanes use flat rings. For all others use bond-line notation.

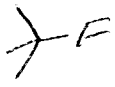
- *trans* - 1-isobutyl-3-methylcyclobutane



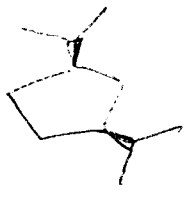
- *sec*-butylbromide



- *tert*-butylfluoride



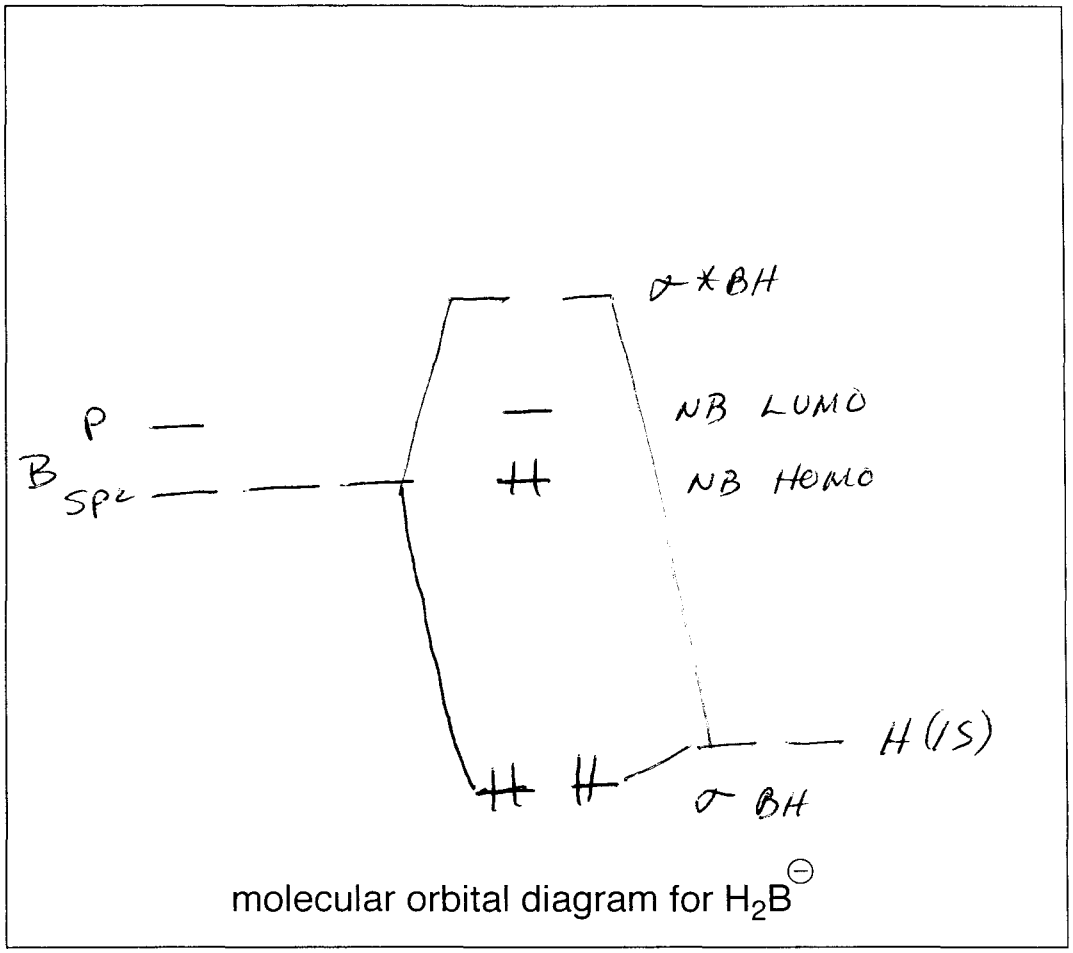
- *cis* - 1,3-diisopropylcyclopentane



2. (16 pts)

A. Construct a molecular orbital diagram for H_2B^- using the following guidelines and labeling schemes. BE SURE TO INCLUDE EVERYTHING ASKED FOR BELOW.

- Indicate the relative energy levels of any atomic and hybrid orbitals from which you constructed the MO diagram.
- Clearly indicate which orbitals are being combined to make molecular bonding orbitals.
- Label all the levels as σ, π, nb (non-bonding) etc.
- Fill in all of the electrons.
- Label the HOMO and LUMO



molecular orbital diagram for $H_2B^{\ominus}$

Do not write in this box! For grading only.

RE:

CO:

L:

E:

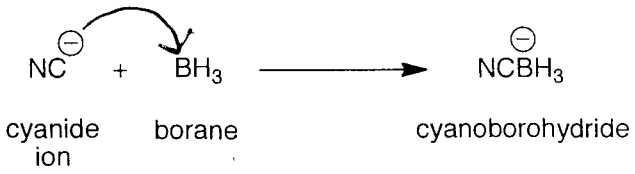
HL:

OA:

B. Sketch what H_2B^- would look like. Make sure your bond angles accurately represent the structure. Any bonds can be represented in bond line notation. Any non-bonding orbital's, filled or unfilled, need to be drawn as an orbital.

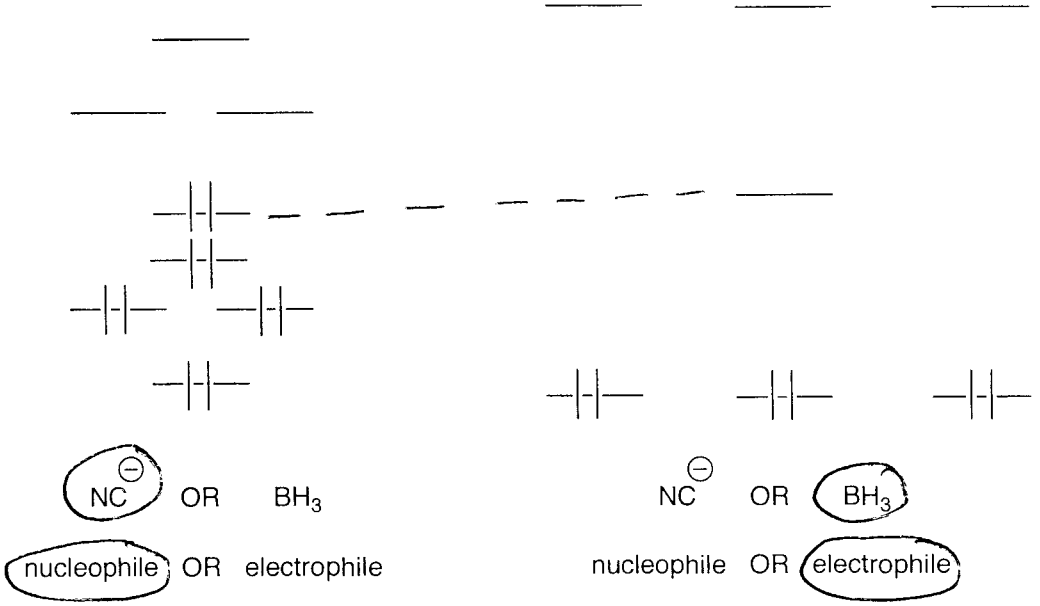
3. (20 pts)

A. Borane reacts with cyanide ion to give cyanoborohydride as shown below. Provide relevant arrows to indicate electron movement in this reaction. Note that there are no radicals involved in this reaction.



B. There are two molecular orbital diagrams shown below. Indicate which one belongs to cyanide ion and which one belongs to borane by circling the correct term under each diagram.

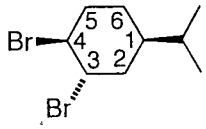
C. Identify which of these two molecules is the nucleophile and which is the electrophile in the reaction shown in part A by circling the correct term under each molecular orbital diagram.

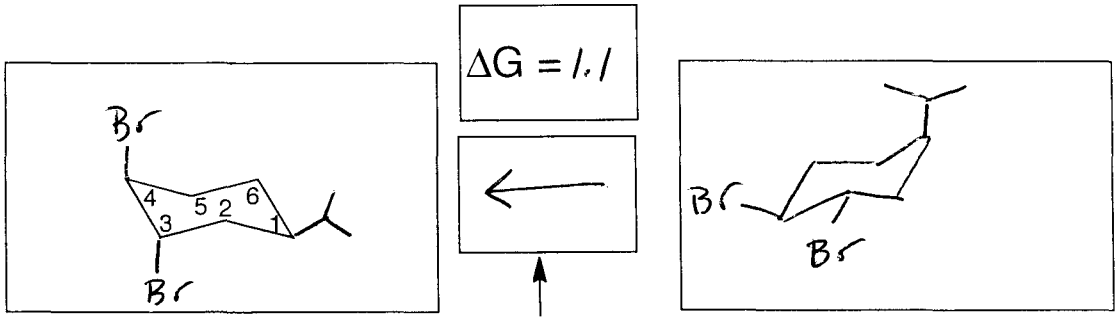


D. Using the main premise behind Frontier Molecular Orbital Theory, connect with a dashed line, the two orbital's in the above diagram that interact with each other in the reaction between cyanide ion and borane.

4. (20 pts)

A. Convert the flat cyclohexane structure shown below to a chair conformation in the box on the left. Make sure you use the numbering scheme given in both compounds (the flat and chair structures). Then draw the ring flipped chair structure of this compound in the far right box.





chair conformer of the flat cyclohexane structure shown above

express the direction of K here

ring-flipped chair structure

B. Using the values on the handout calculate ΔG for this equilibrium and place your answer in the box provided (you do not need to show your work).

2 Br$_{ax}$ → 2 Br$_{eq}$ = 2 x -0.55 = -1.1

i-Pr$_{eq}$ → i-Pr$_{ax}$ = +2.2

+1.1

C. Based on your calculated ΔG, use an arrow to express which side the equilibrium (K) would favor.

D. Do you expect the calculated value for ΔG to be the same, or at least very close to, the experimental value? Circle one.

Yes (No)

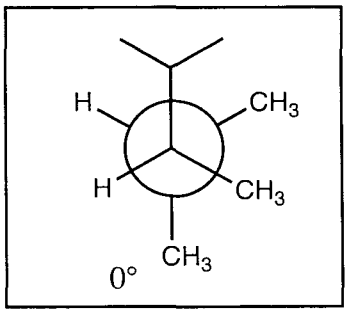
If you circled No, indicate whether the experimental value would increase or decrease relative to your calculated ΔG value and offer a brief explanation as to why this would be the case using terms you have learned in lecture.

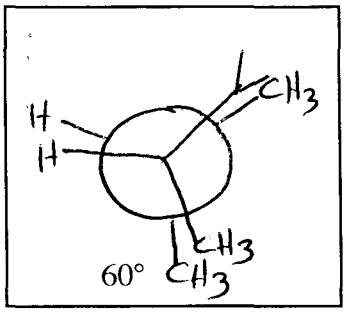
It would increase due to the extra gauche interaction found between the two equatorial bromo groups.

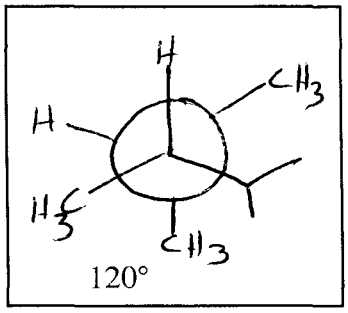
5. (20 points)

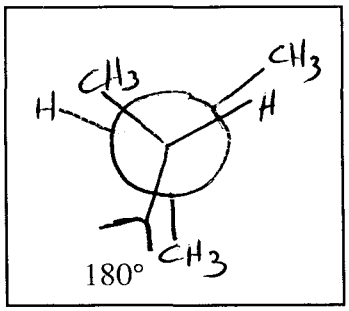
A. In the boxes below draw Newman projections that represent conformers of the molecule shown in the first box. The degrees of rotation are shown in each box.

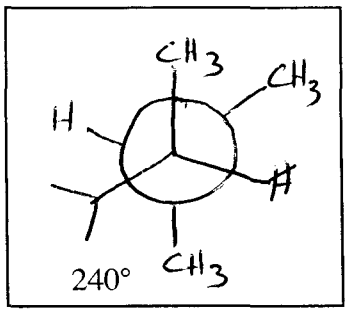
For each conformer hold the back atom constant and rotate the front atom clockwise.

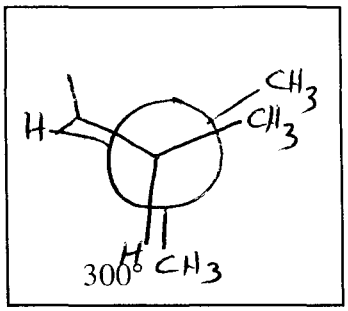












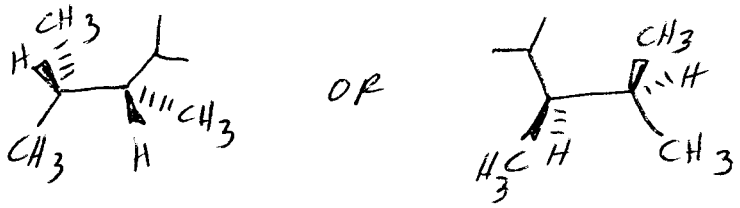
Lowest E Staggered

Lowest E Eclipsed

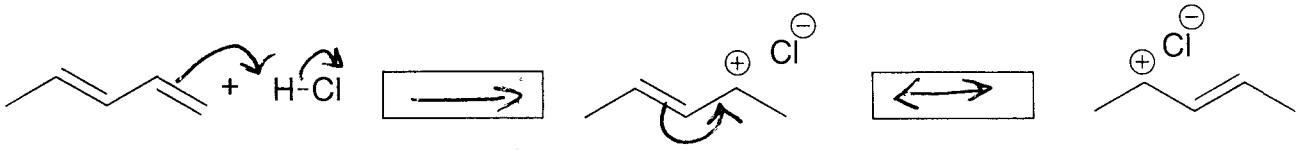
B. Identify the **LOWEST ENERGY STAGGERED** conformation by writing the phrase "Lowest E Staggered" in the box underneath the correct conformer.

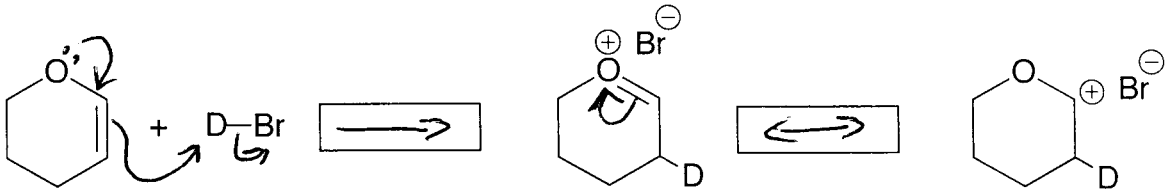
C. Identify the **LOWEST ENERGY ECLIPSED** conformation by writing the phrase "Lowest E Eclipsed" in the box underneath the correct conformer.

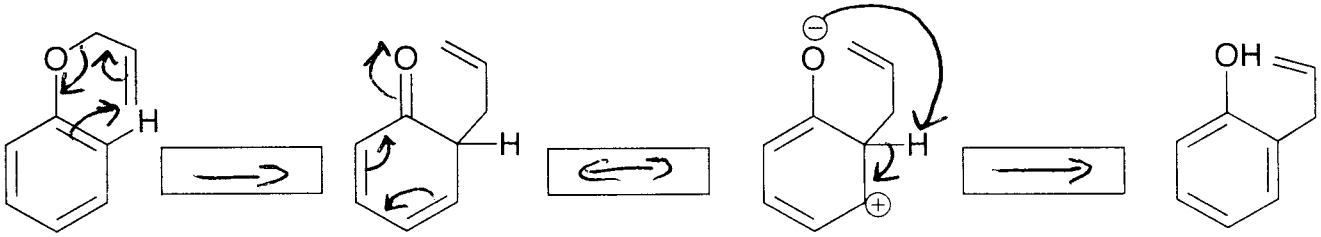
D. Draw a bond-line structure that exactly depicts the conformer shown in Part A in the box labeled 0°.

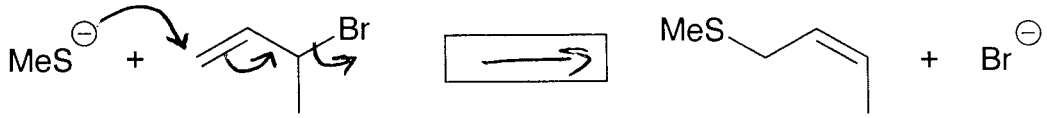


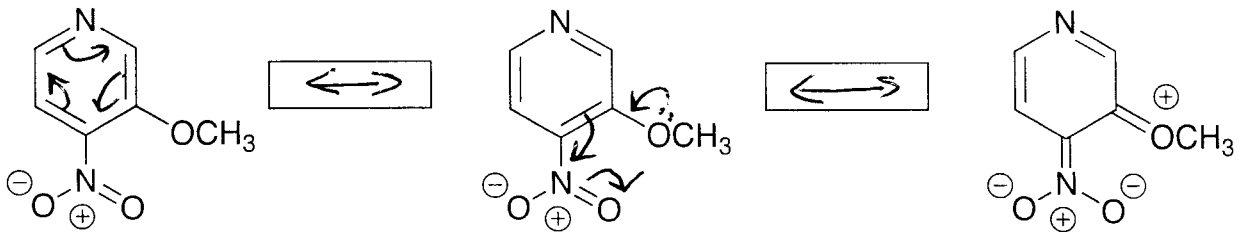
6. In the following problems it is up to you to add all relevant arrows. When showing electron movement in reactions or leading to resonance structures use curved arrows. Please note that none of these reactions involve radicals (that is, no single electron movement)! Between each structure(s) there is a blank box. In this box, use the appropriate arrow to indicate whether a reaction took place or if the structures are related by resonance. (30 pts)





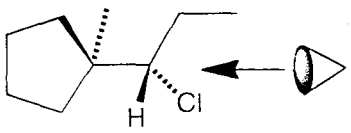


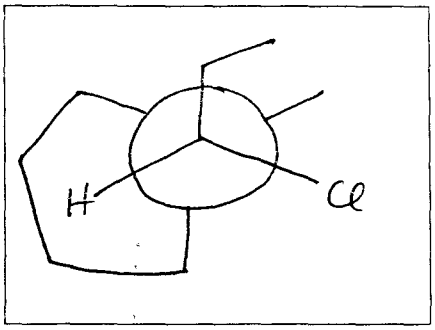




7. (20 pts)

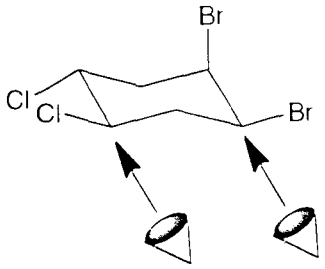
A. Draw a Newman projection looking down the bond that is indicated.

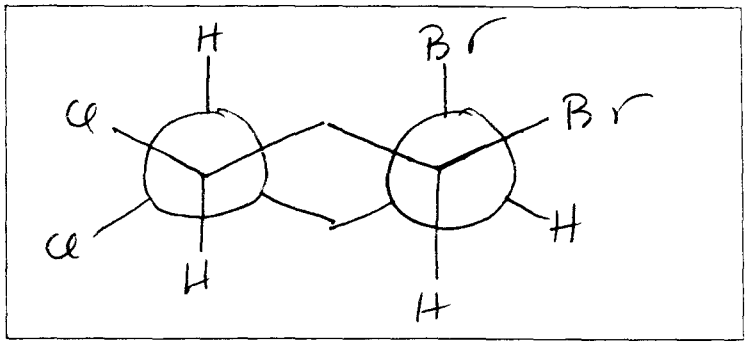




Newman Projection

B. Draw the "double barrel" Newman projection looking down the two bonds that are indicated.



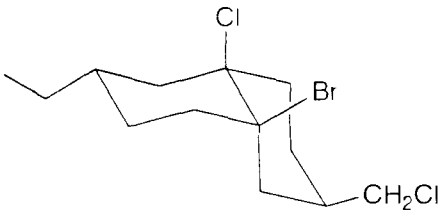


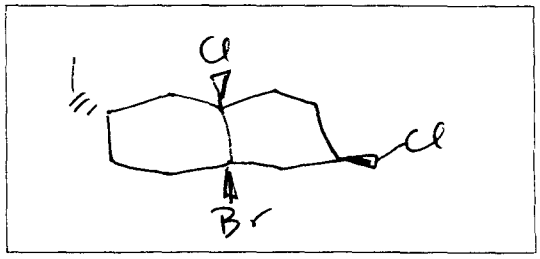
"Double barrel" Newman projection looking down both of the indicated bonds

C. Are the two bromine atoms in the structure in part B considered (circle one):

(cis) trans stereoisomeric hyperconjugative

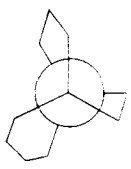
D. Draw the flat ring representation of the compound shown.

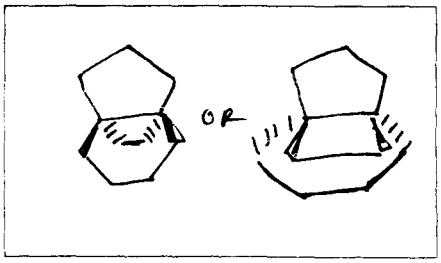




flat ring structure

E. Draw a bond-line structure that exactly represents what is depicted in the Newman projection.





bond-line structure