Dr. Steven Pedersen November 10, 2014

Chemistry 3A
Midterm 2

Student name: Answer Key

Student signature: ____

Problem 1	_________	(18 pts)
Problem 2(a-d)	_________	(14 pts)
Problem 2(e-g)	_________	(24 pts)
Problem 3(a-b)	_________	(16 pts)
Problem 3(c-d)	_________	(16 pts)
Problem 4	_________	(18 pts)
Problem 5	_________	(14 pts)
Problem 6	_________	(10 pts)
Problem 7	_________	(20 pts)
Total Points	__________	(150 pts)

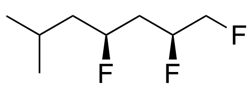
No Calculators Allowed
No Molecular Models Allowed
Be Sure Your Exam has 10 Pages

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

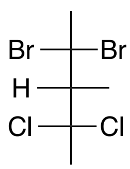
1. There will be NO partial credit for this problem. Avoid careless errors by checking over your answers. (18 pts)

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

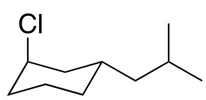
There are other possible answers based on lack of alphabetizing.



(2*S*,4*S*)-1,2,4-trifluoro-6-methylheptane
OR
(4*S*,6*S*)-4,6,7-trifluoro-2-methylheptane



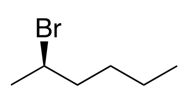
(*R*)-2,2-dibromo-4,4-dichloro-3-methylpentane
OR
(*R*)-4,4-dibromo-2,2-dichloro-3-methylpentane



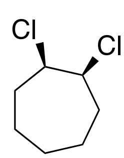
(1*R*,3*S*)-1-chloro-3-isobutylcyclohexane
OR
(1*S*,3*R*)-3-chloro-1-isobutylcyclohexane

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

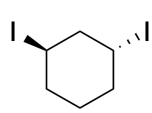
- (*R*) 2-bromohexane



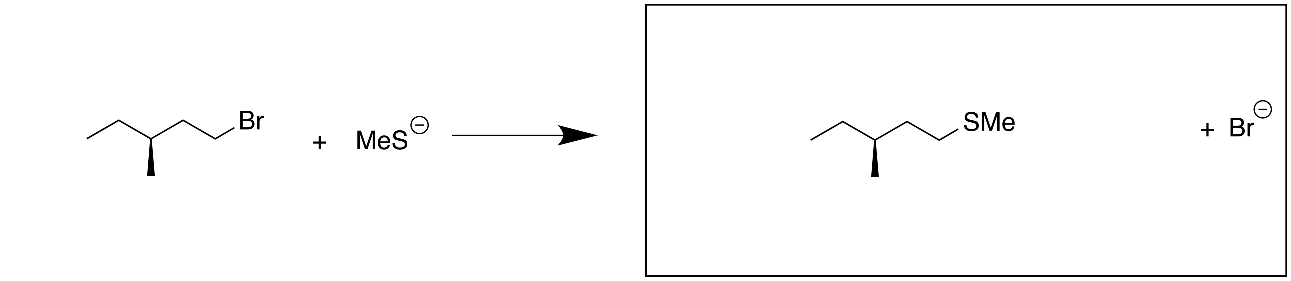
- (*meso*) 1,2-dichlorocycloheptane

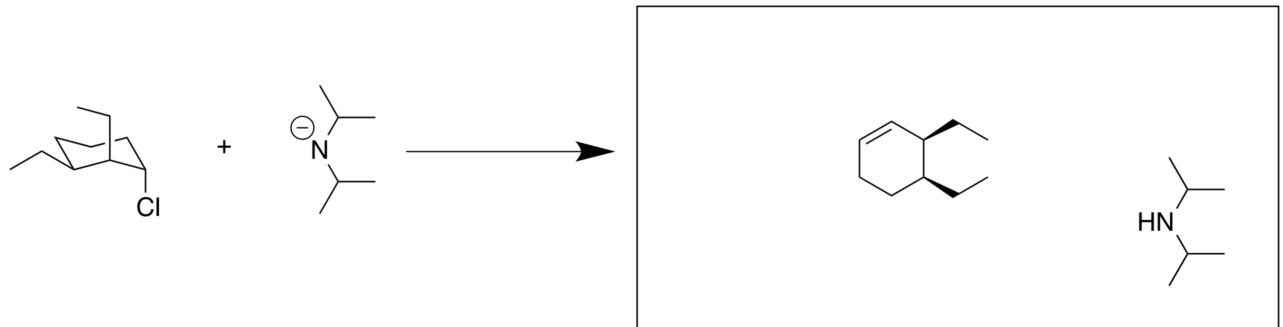


- (*1R, 3R*) 1,3-diiodocyclohexane

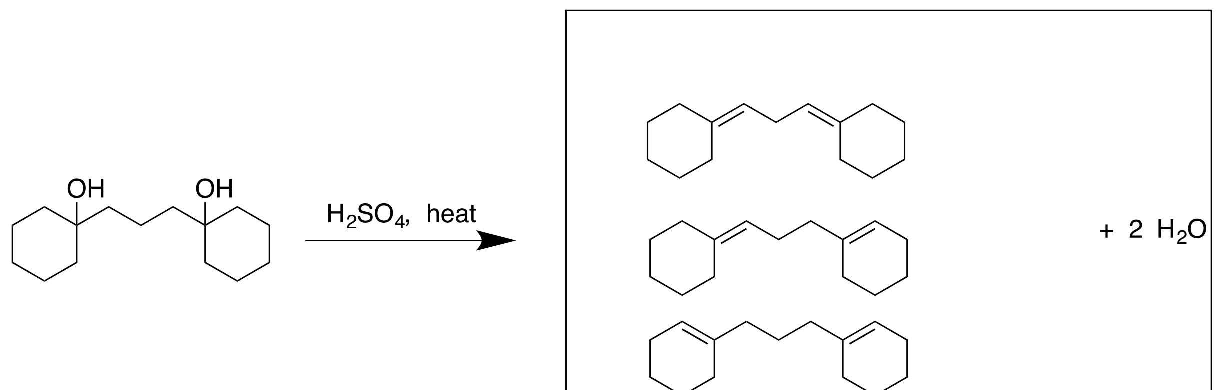


2. Predict all of the possible organic product(s) from the following reactions. Where relevant, show all stereoisomers. Pay particular attention to any information given in the product boxes. Each redundant or wrong answer within a box cancels one correct answer in the same box. (38 pts)

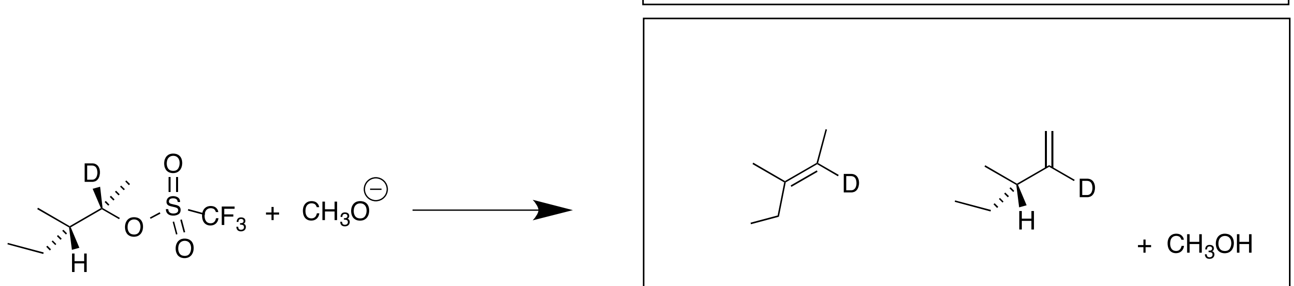




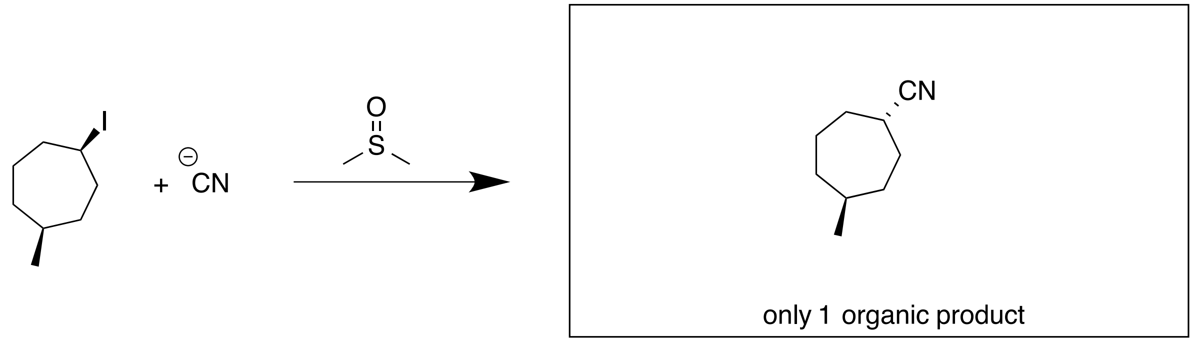
show product(s) using FLAT ring(s)

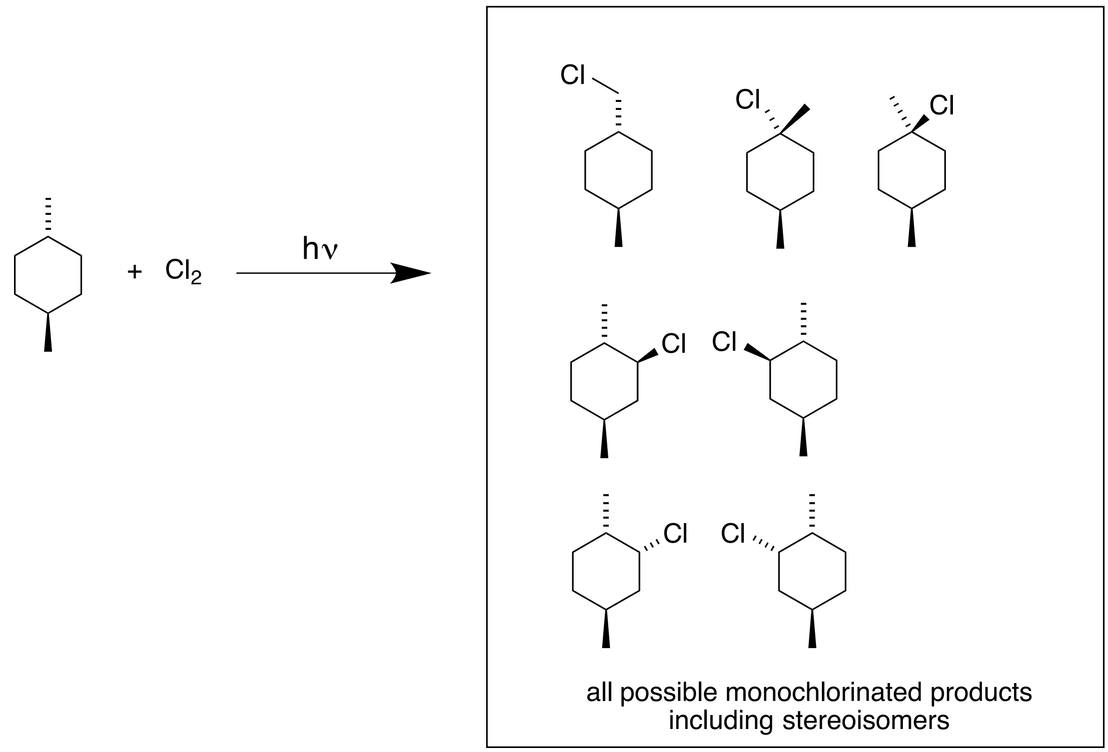


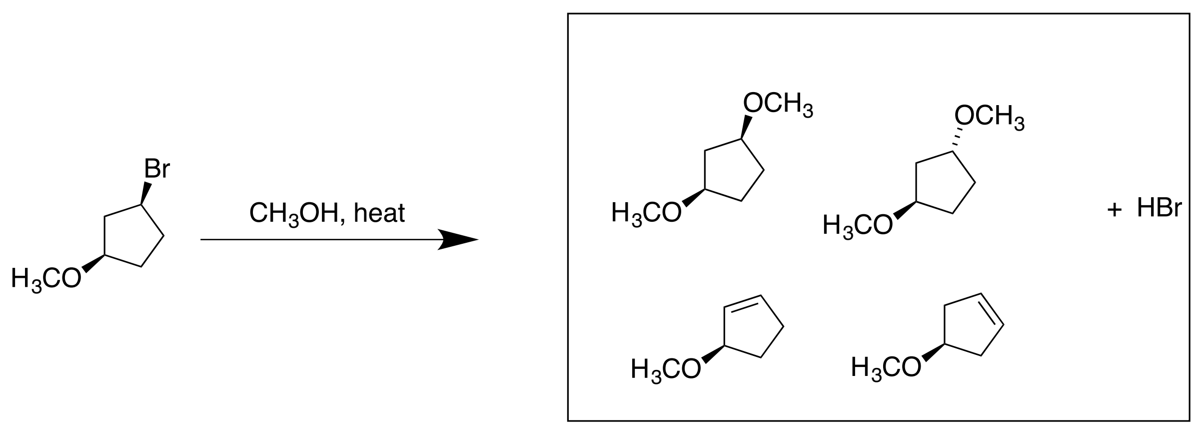
All organic products have the molecular forumla: $C_{15}H_{24}$



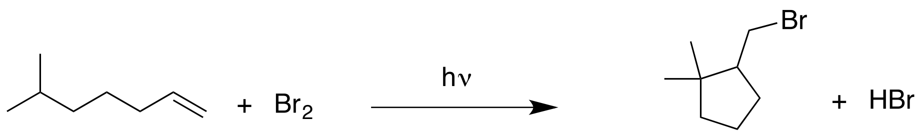
2 alkenes


I
CN
O
S
CN
only 1 organic product

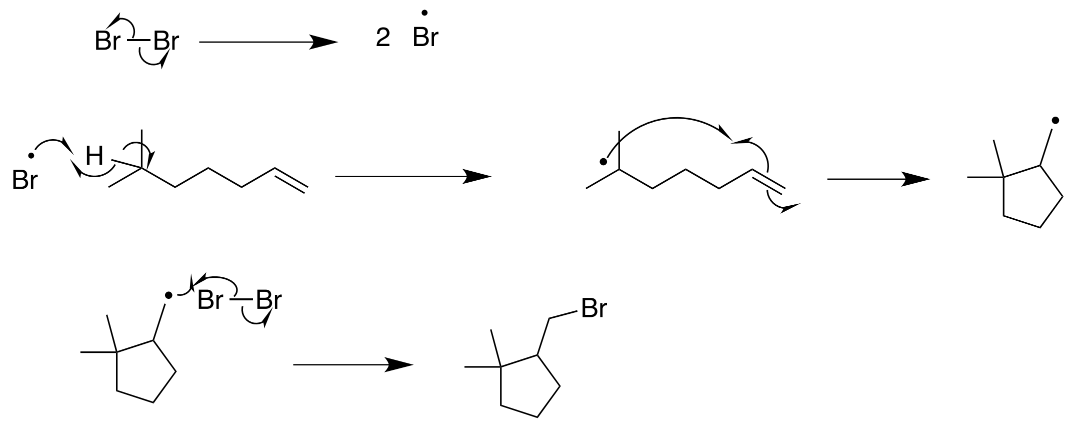

Cl₂
hν
Cl
all possible monochlorinated products
including stereoisomers

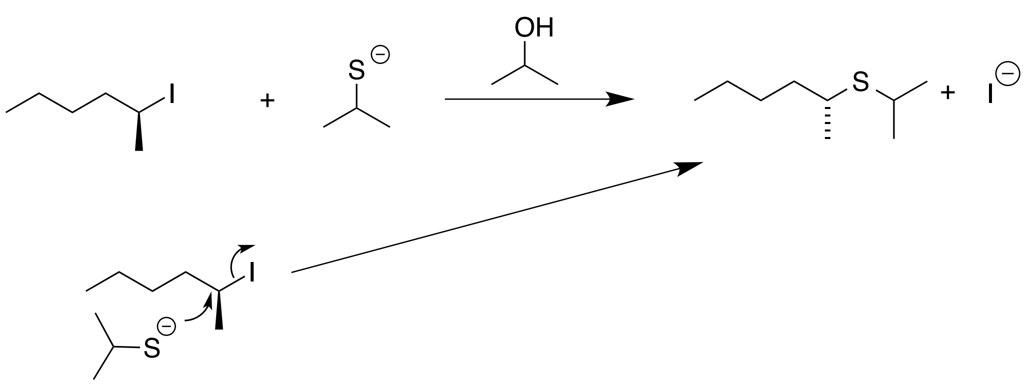

Br
H3CO
CH3OH, heat
OCH3
+ HBr

3. Write logical arrow-pushing mechanisms for the following reactions. Be sure that your mechanism accounts for all products shown. (32 pts)



Note: In this mechanism, the ring is formed before the carbon-bromine bond.





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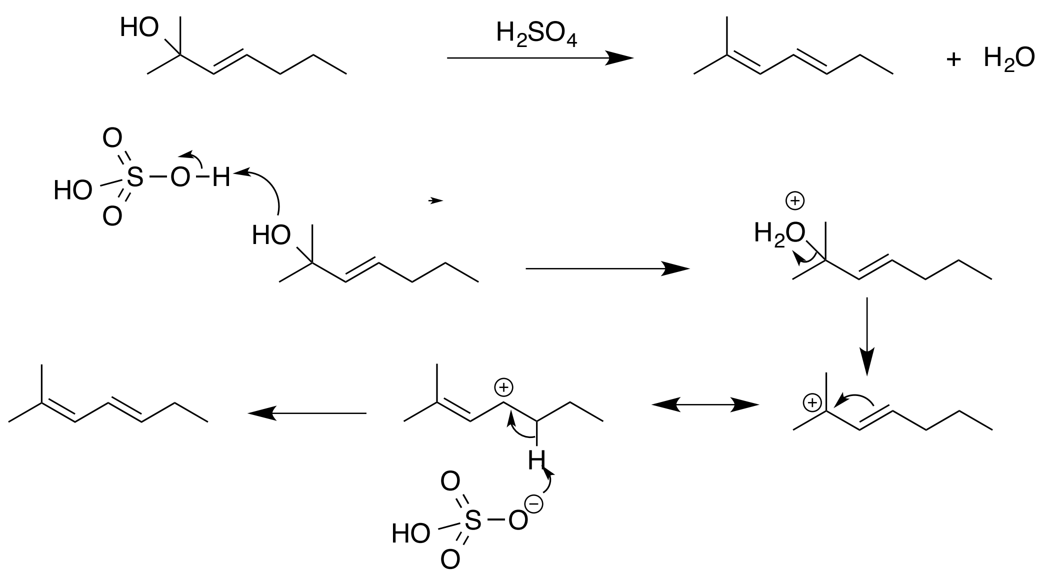
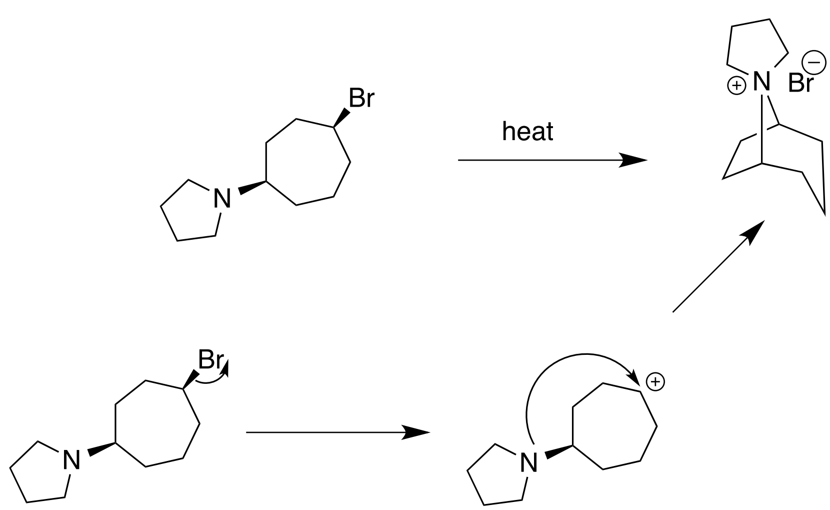
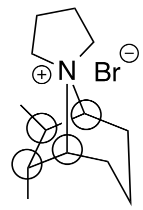

HO
H_2SO_4
+ H_2O
O
HO
S
O
H
O
HO
H_2O
H
O
HO
S
O
O

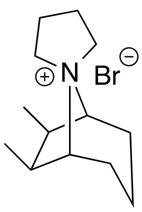

Br
N
heat
N
Br
Br
N
N

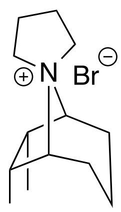
4. (18 pts)

A. Circle all stereocenters on the molecule shown below. Wrong answers cancel right answers.



B. What is the relationship between the two molecules shown below? Circle one.



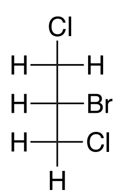


They are identical. They are diastereomers.

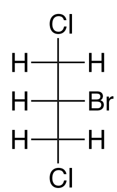
They are enantiomers. They are atropeisomers.

C. For each pair of molecules use one term, and only one, that best describes their relationship to one another. The terms to choose from are (use the abbreviations shown):

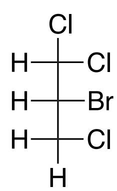
Identical(I) Enantiomers(E) Diastereomers(D) None of These(N)



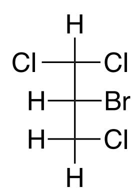
A



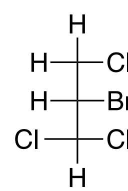
B



C



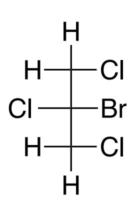
D



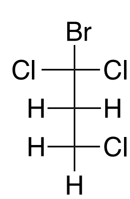
E

A and B:__***I***___
A and C:__***N***___
A and D:__***N***___
A and E:__***N***___
B and C:__***N***___
B and D:__***N***___
B and E:__***N***___
C and D:__***I***___
C and E:__***E***___
D and E:__***E***___

D. Starting with compound D in Part C (above), switch any TWO atoms in the molecule (they do not need to be on the same carbon) to generate an ACHIRAL compound. Show your answer on the Fisher projection provided.

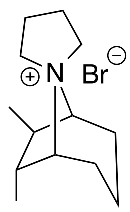


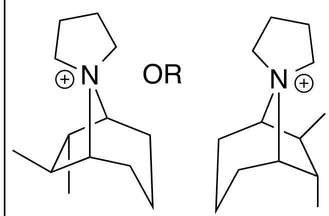
OR



5. (14 points)

A. The molecule shown below is chiral. Draw its enantiomer in the box provided.

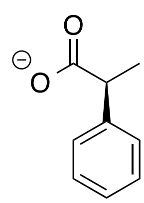




draw enantiomer here

B. Briefly explain how one could separate a mixture of the two enantiomers in Part A (keep your answer within the box). If your explanation includes using another molecule(s), you must provide a REAL example of that molecule(s). Hint: The bromide ion can be exchanged with other ions.

Enantiomers differ in how they interact (or react) with another chiral molecule. Since the bromide ion can be exchanged for another ion, then one can exchange it with a chiral anion, such as the molecule shown below. The resulting molecules are now diastereomers and have the potential for being separated.



Use this to exchange for the bromide ion in both enantiomers.

C. Assume you have determined the enantiomeric excess of a mixture of the enantiomers in Part A to be 80%, favoring the (-) isomer. What is the actual composition of the mixture? Express your answer as the percent of the (+) and (-) enantiomers present (your percentages must add up to 100%). You must show your work to receive any credit and your answers must be shown as whole numbers, not fractions.

80% ee means that the other 20% of the mixture exists as equal amounts of both enantiomers. Therefore, the total amount of each enantiomer can be determined as follows:

(-)80% + ((-)10% + (+)10%):

(-)90% and (+)10%

6. (10 pts)

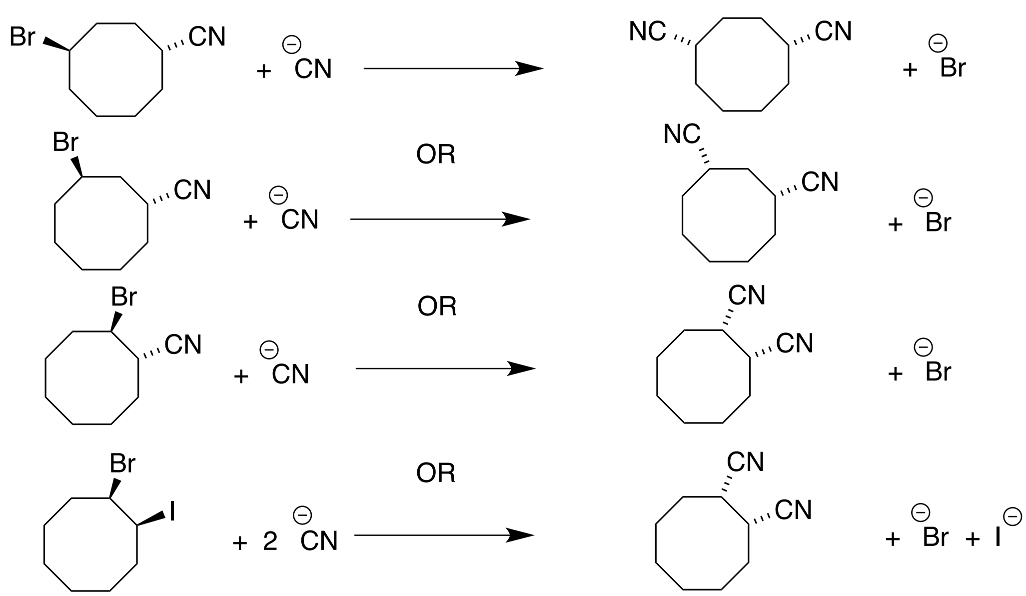
Using the constraints listed below design a reaction that would confirm the following statement:

"If you start with optical activity, you can end up with NO optical activity."

The contraints are:

- The reaction must be S_N2.
- Your electrophile must be a disubstituted cyclooctane (for full credit, you must be sure to take into account what makes a good electrophile).
- The nucleophile must be the cyanide ion (NC^-).

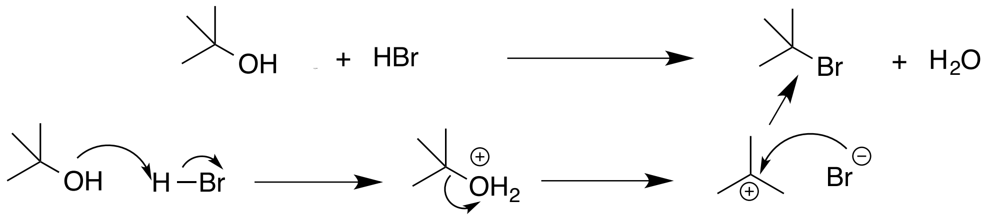
Write your reaction showing all starting materials and all products in the box below.



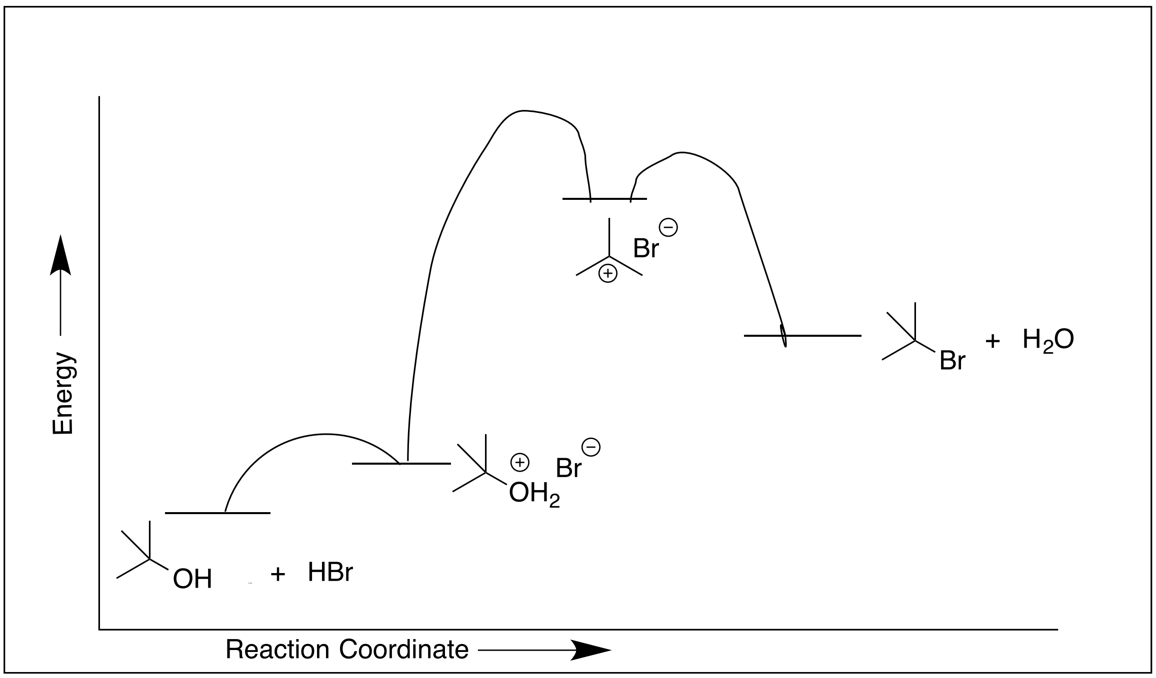
For an example like the last one, the two leaving groups have to be different.

7. (20 points)

A. Write a logical arrow-pushing mechanism for the following reaction. Be sure that your mechanism accounts for all products shown.



B. Based on the mechanism you wrote in Part A, draw a reaction coordinate diagram for the overall reaction. Label all energy levels with the relevant molecules. Assume the OVERALL reaction is ENDOTHERMIC.



C. Based on your reaction coordinate diagram in Part B, will the transition state for the FIRST step in the reaction be considered: (circle one) EARLY or $\boxed{\text{LATE}}$.

D. Draw a picture of the transition state you identified in Part C using dotted lines (i.e. ··········) to represent bond-breaking and/or bond-making. The relative "length" of these dotted lines should be consistent with your answer in Part C.