Dr. Steven Pedersen November 9, 2016

# Chemistry 3A

## Midterm 2

Student name: ANSWER KEY

Student ID: _________________ (Also include your SID in the top left corner of each page)

Student signature: ____________________________________________

| | | |
|---|---|---|
| Problem 1 | _________ | (18 pts) |
| Problem 2 | _________ | (30 pts) |
| Problem 3 | _________ | (48 pts) |
| Problem 4 | _________ | (12 pts) |
| Problem 5 | _________ | (26 pts) |
| Problem 6 | _________ | (16 pts) |
| Total Points | __________ | (150 pts) |

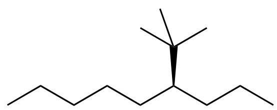
No Calculators Allowed
No Molecular Models Allowed
Be Sure Your Exam has 11 Pages

**ALL ANSWERS MUST BE ON THE FRONT OF EACH PAGE. ANY ANSWERS ON THE BACK OF A PAGE WILL NOT BE CONSIDERED FOR GRADING.**

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

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

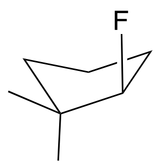
A. Provide a systematic name for the following compounds (include R/S when appropriate). Use common nomenclature for any branched substituents.



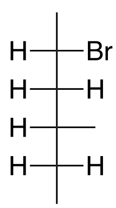
(*S*)-4-*tert*-butylnonane

or

(*S*)-6-*tert*-butylnonane



(*R*)-2-fluoro-1,1-dimethylcyclopentane



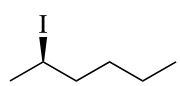
(2*S*,4*R*)-2-bromo-4-methylhexane

or

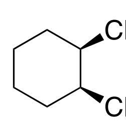
(3*R*,5*S*)-5-bromo-3-methylhexane

B. Draw a structure for each of the following names. For cycloalkanes use flat rings.

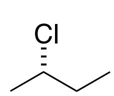
- *(R)*-2-iodohexane



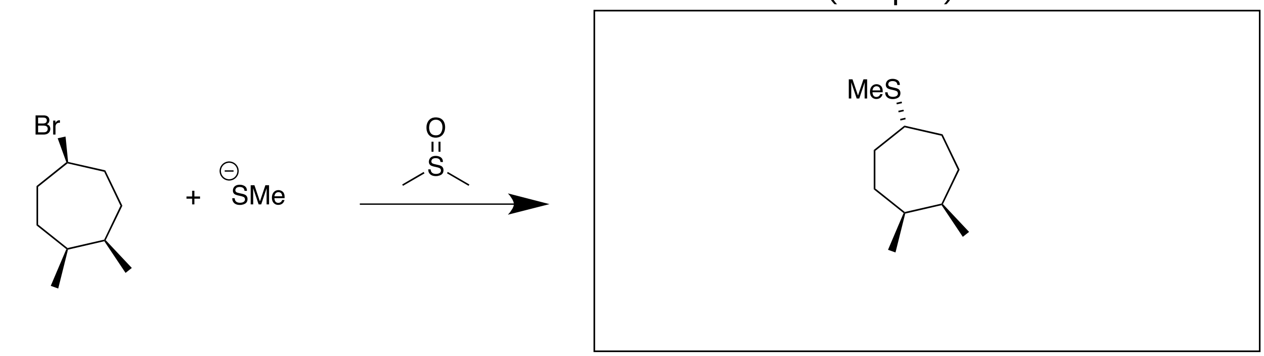
- *meso*-1,2-dichlorocyclohexane

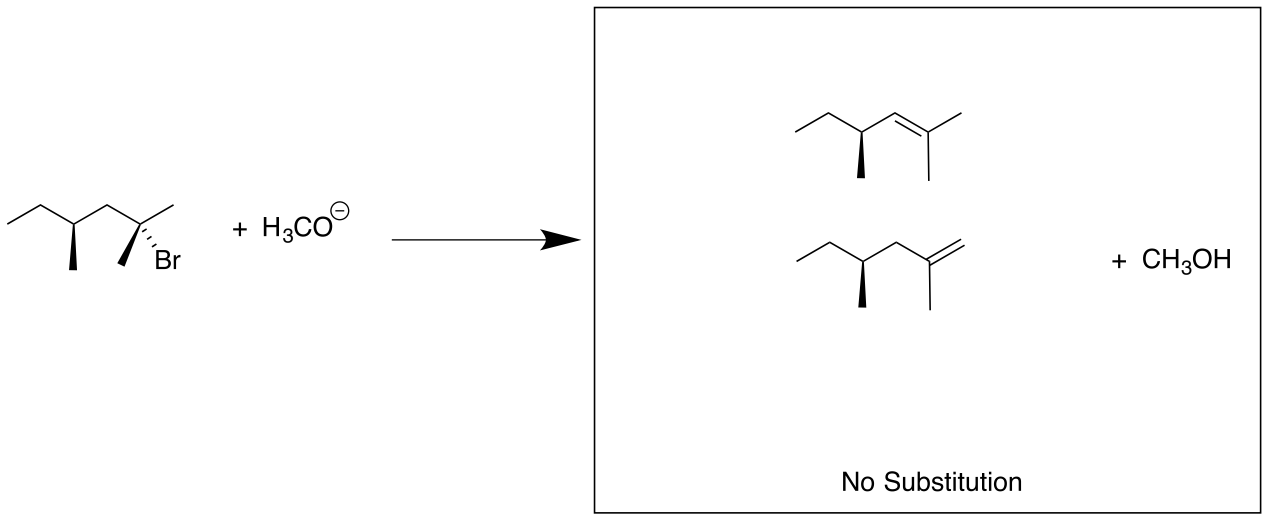


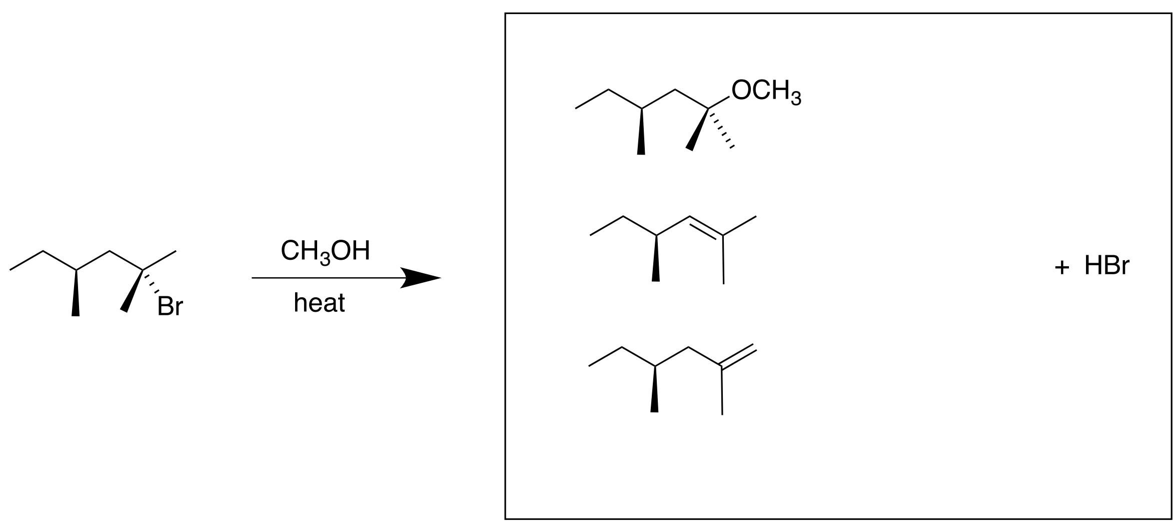
- *(S)*-sec-butylchloride



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 in the same box. (30 pts)

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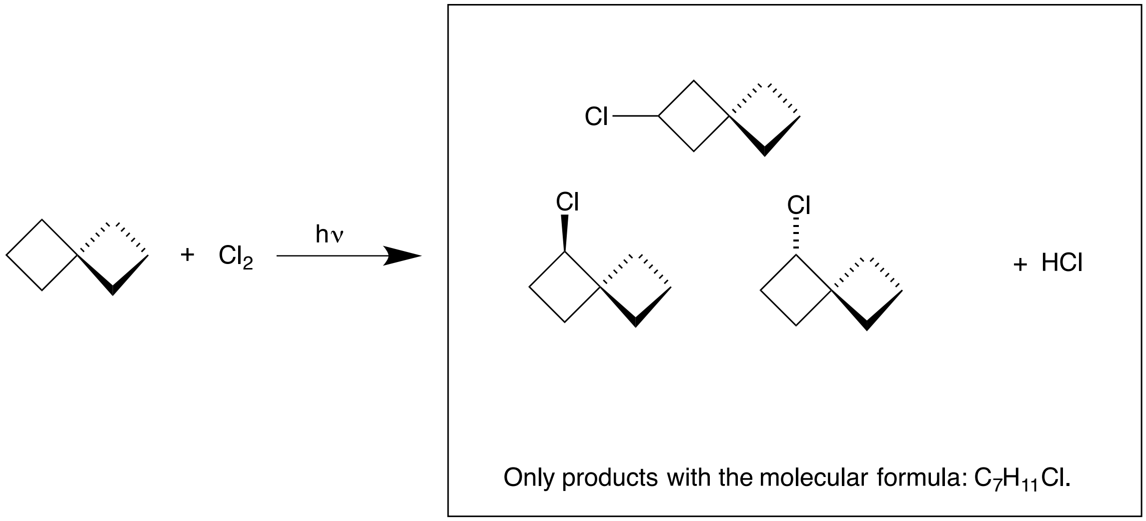
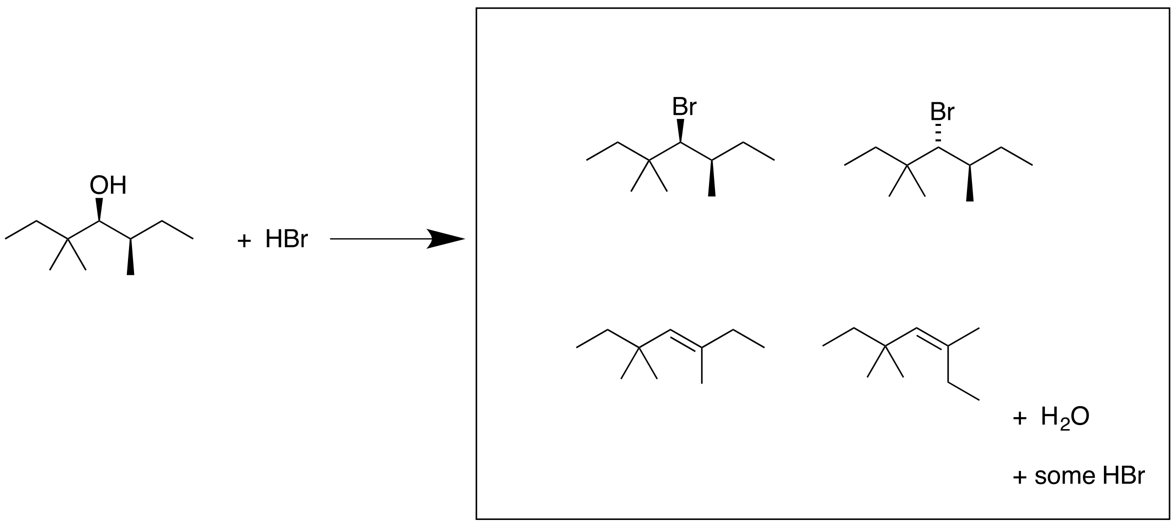
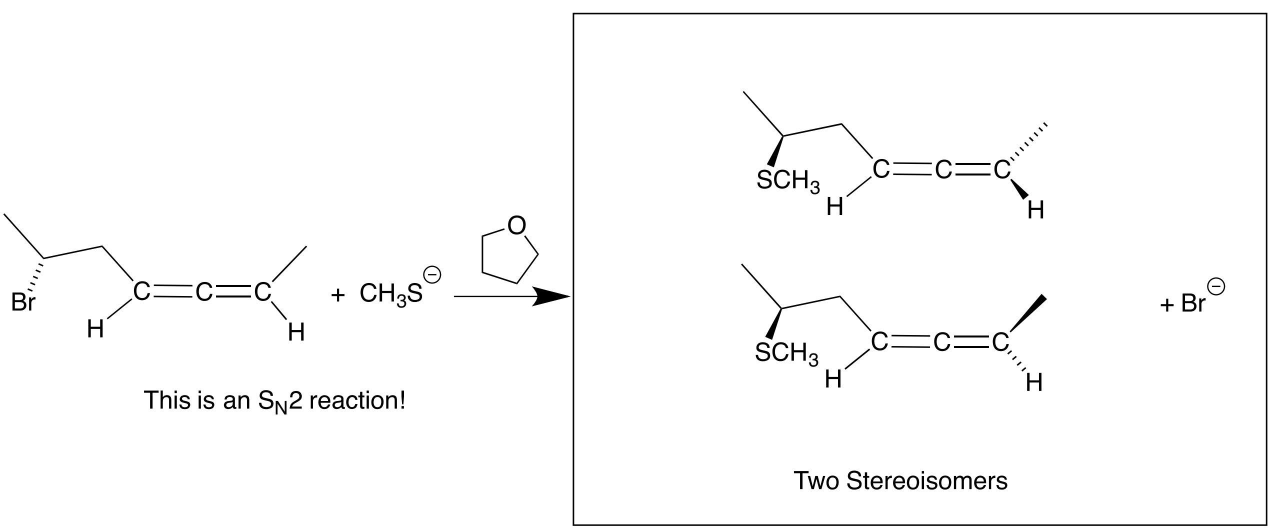



Only products with the molecular formula: $C_7H_{11}Cl$.

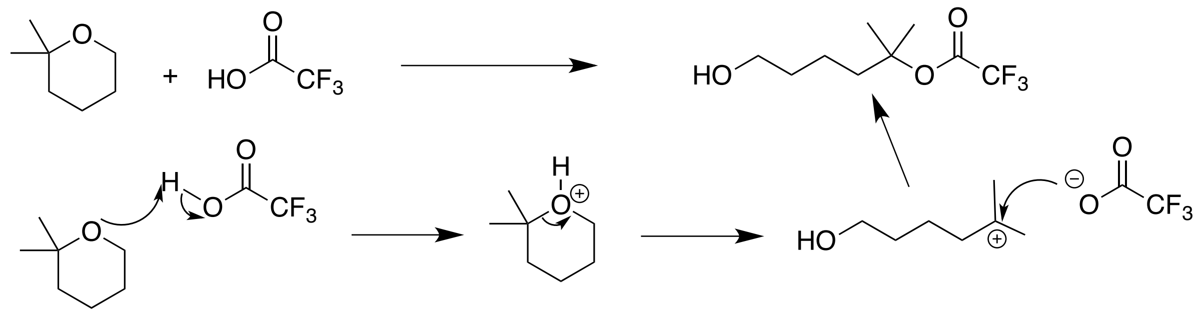


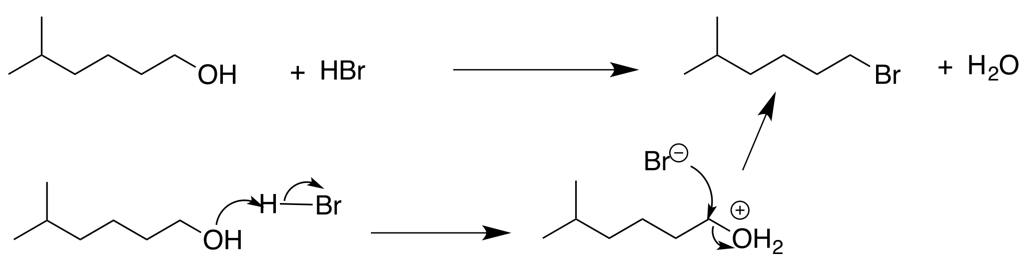




This is an $S_N2$ reaction!

Two Stereoisomers

3. Write logical arrow-pushing mechanisms for the following reactions. Be sure that your mechanism accounts for all products shown. (48 pts)

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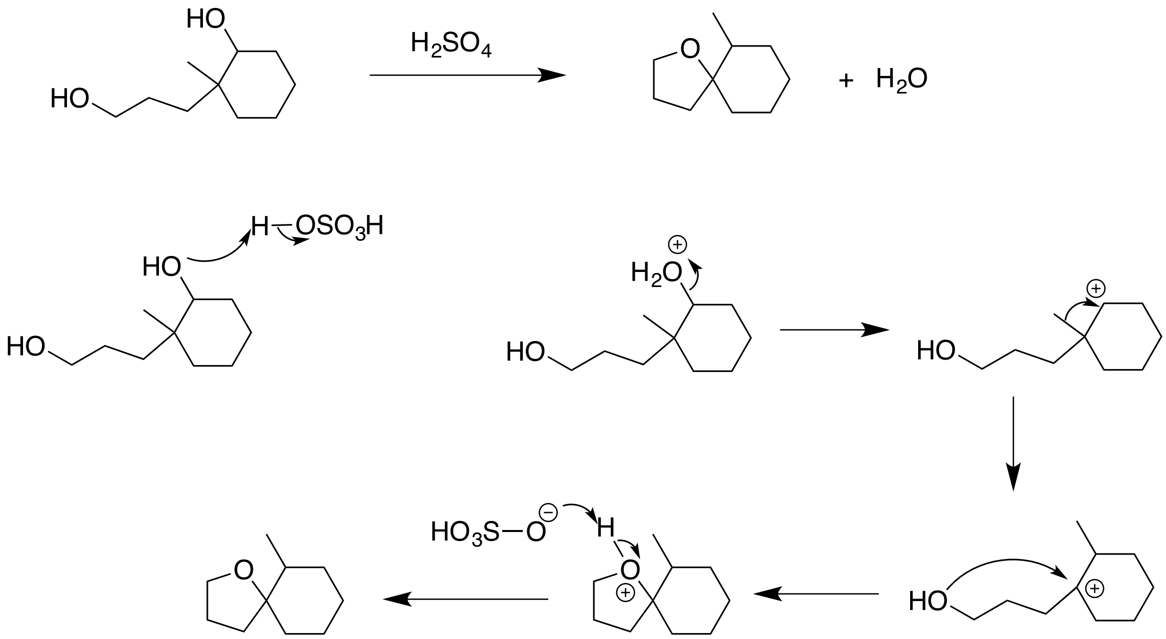


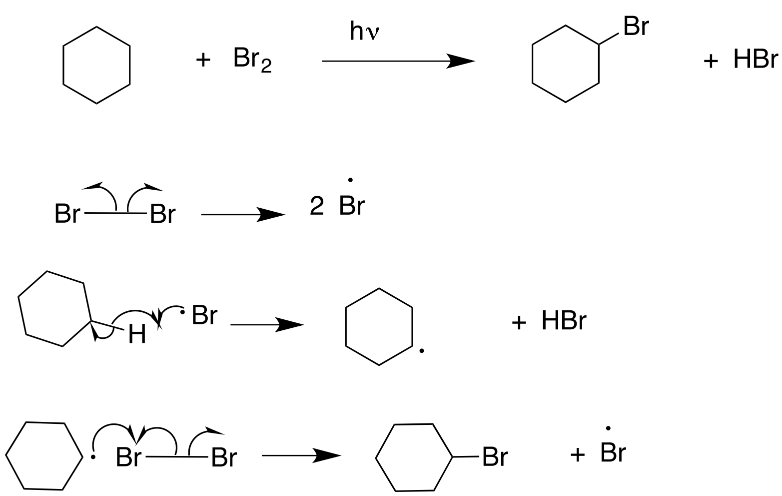


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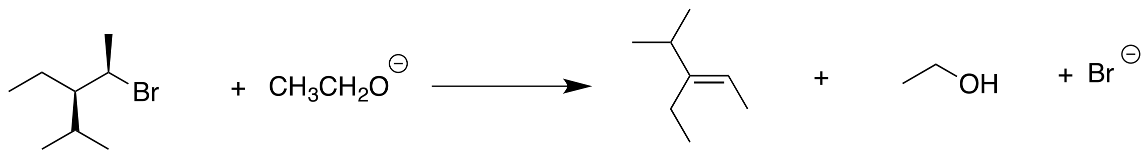
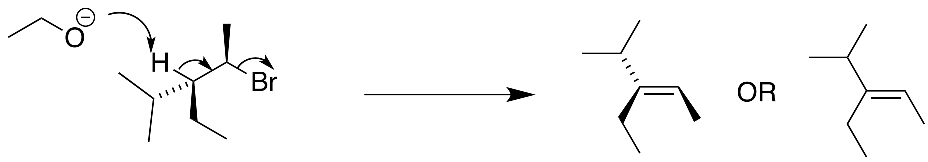
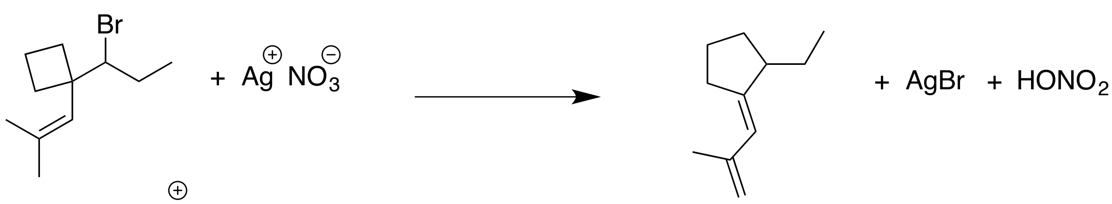
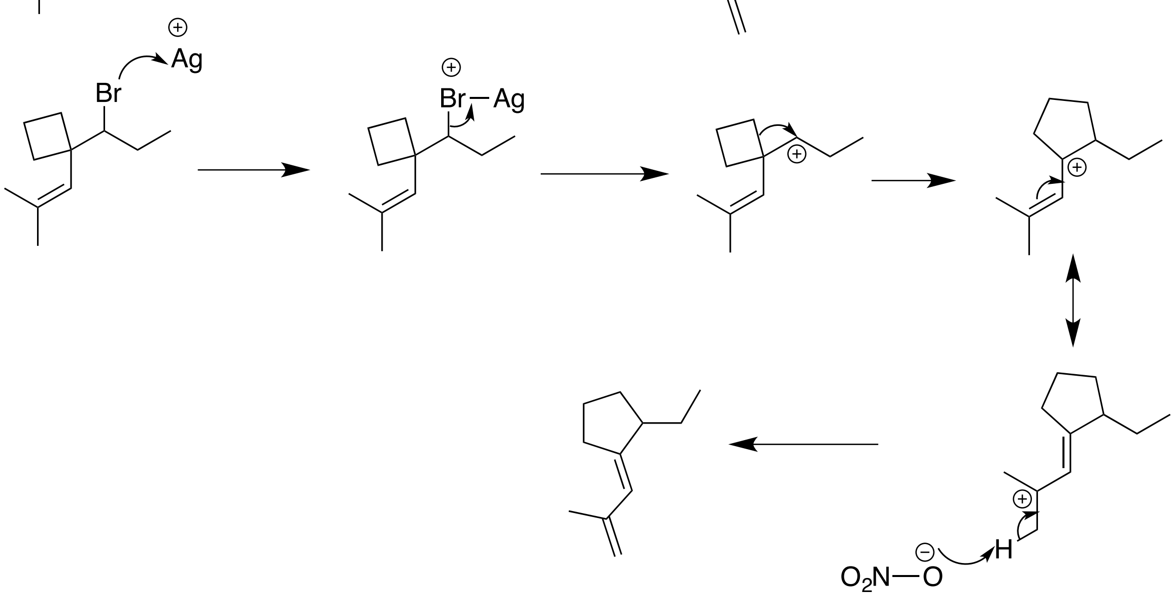



Hint: Note that only one of two possible alkenes is formed in this reaction.
In addition to arrow-pushing, you must show the correct conformation of the starting material that leads to this product.

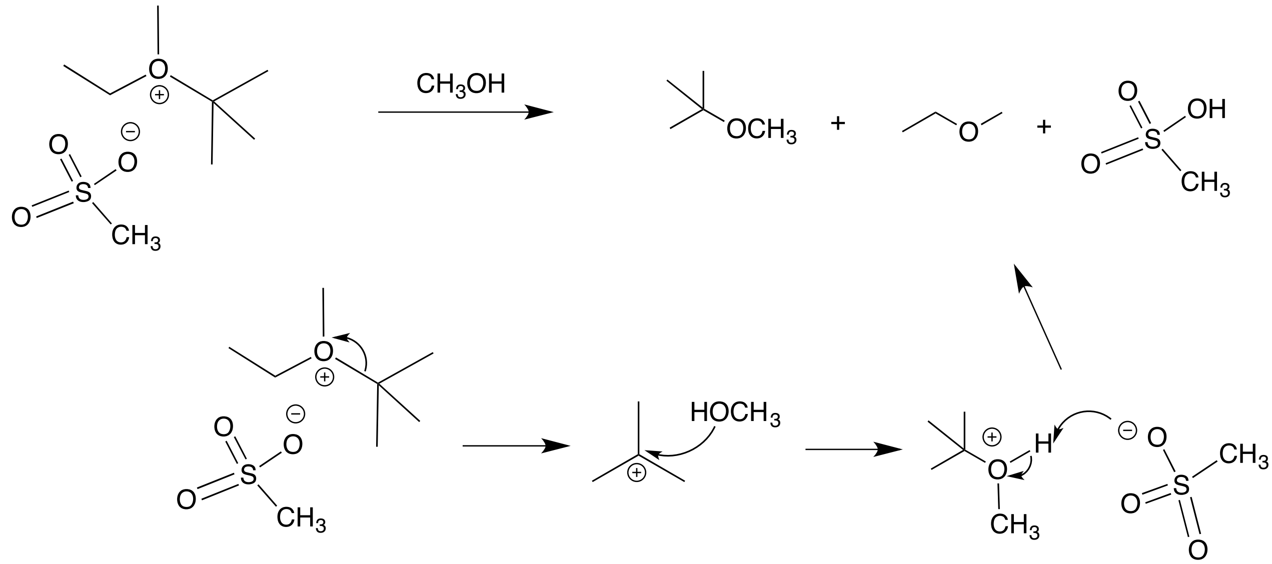


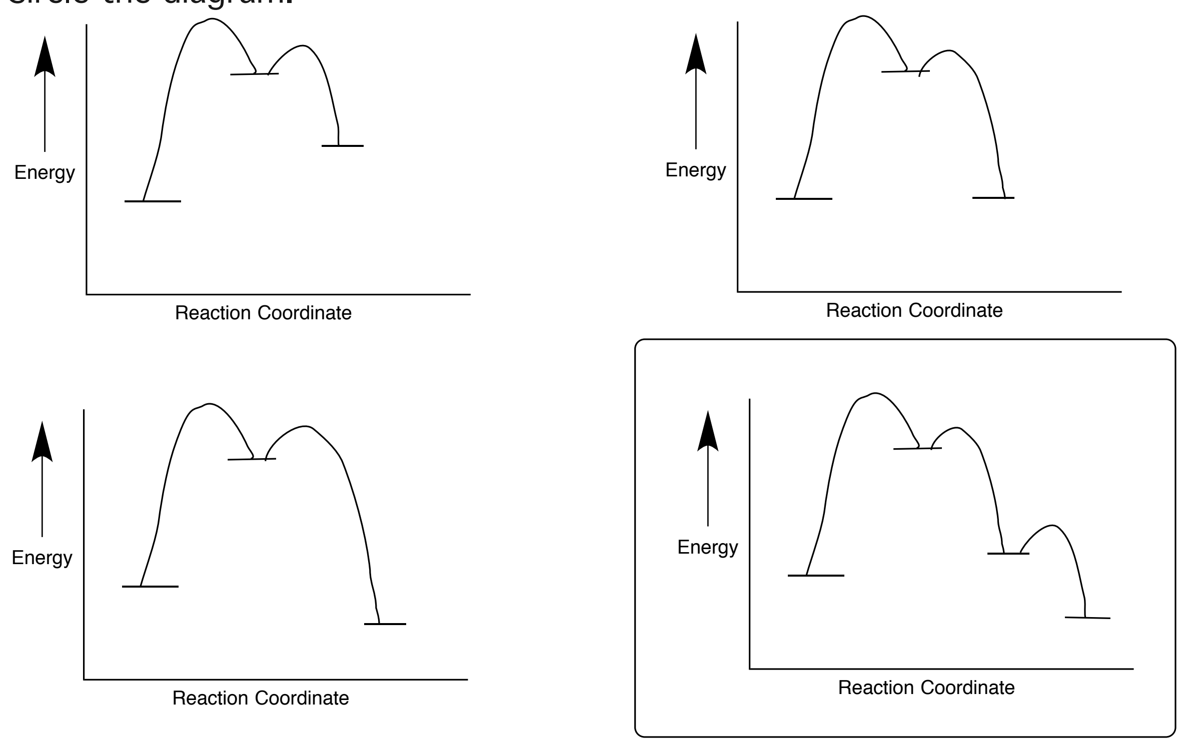



4. (12 pts)

A. Write a rational arrow-pushing mechanism for this exothermic reaction.



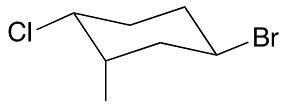

B. Which reaction-coordinate diagram below best matches the mechanism you wrote for Part A AND takes into account that the overall reaction is EXOTHERMIC? Circle the diagram.



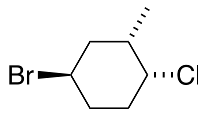
5. (26 pts)

A. For each pair of molecules use one term that best describes their relationship to one another. Use the abbreviations for the terms shown below.

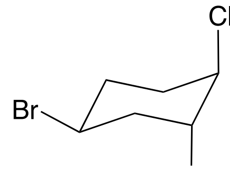
The terms are: Identical (I), Diastereomer (D), Enantiomer (E), None of These (N)



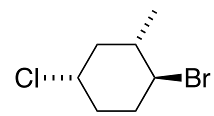
**A**



**B**



**C**



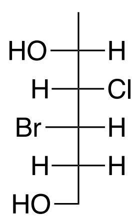
**D**

A and B:___***I***____ A and D:____***N***___

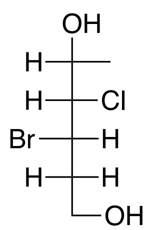
A and C:____***D***___ B and D:____***N***__

B. For each pair of molecules use one term that best describes their relationship to one another. Use the abbreviations for the terms shown below.

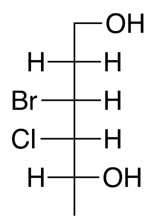
The terms are: Identical (I), Diastereomer (D), Enantiomer (E), None of These (N)



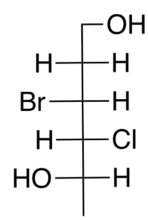
**A**



**B**



**C**



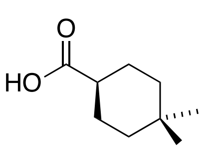
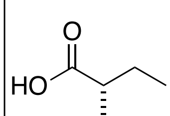
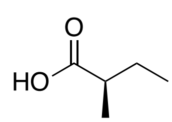
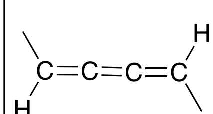
**D**

A and B:____***I***_____ B and C:____***D***______

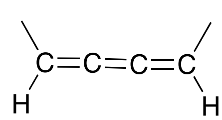
A and C:____***D***____ B and D:____***E***______

A and D:____***E***____ C and D:____***D***______

C. Identify each compound as chiral or achiral by circling the correct term within each box. For all chiral compounds, draw the enantiomer in the box.

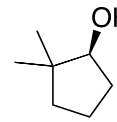
| | | |
|---|---|---|
|  |   |  |
| chiral achiral if chiral, draw the enantiomer above | chiral achiral if chiral, draw the enantiomer above | chiral achiral if chiral, draw the enantiomer above |

D. One of the compounds in Part C has a diastereomer. Draw it here.



6. (16 pts)

Dirk had gone to a lot of trouble to make Compound A optically pure. He determined the specific rotation of this compound to be +80° (c = 1.5, ethanol). He took the remainder of the sample and stored it in a small bottle that had recently been cleaned using his labs standard protocol of first washing with soap and water, then rinsing with concentrated sulfuric acid, followed by a distilled water rinse. The bottle still contained some water droplets but he felt this was of no concern because the next reaction he would be performing with Compound A was going to be carried out in 95% ethanol (the other 5% being water).



Compound A

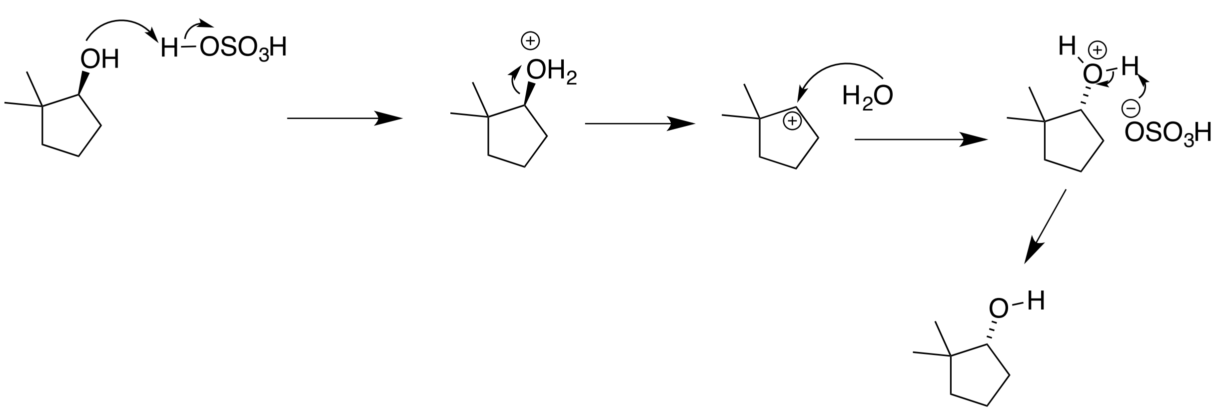
Dirk then went away on a two-week vacation and upon his return prepared to use Compound A in the next step of his synthesis. He decided to recheck the specific rotation before proceeding. Keeping all of the variables the same, including solvent and concentration, the specific rotation for Compound A was now +20°!

There are several possible explanations for the decrease in the specific rotation of his sample (none of which are due to experimental error in the specific rotation measurement).

Provide two explanations for what could have happened to his sample. Each explanation must include an arrow-pushing mechanism and show a new product. The explanation must state specifically how formation of the new product would reduce the specific rotation of the sample of Compound A Dirk started with.

**Explanation #1**

Apparently there was some residual sulfuric acid left in the bottle. This along with water could lead to formation of some of the other enantiomer as shown below. This in turn would lead to a reduction in the optical rotation since the other enantiomer rotates plane polarized light in the opposite direction.




Your answer must be kept within this box.

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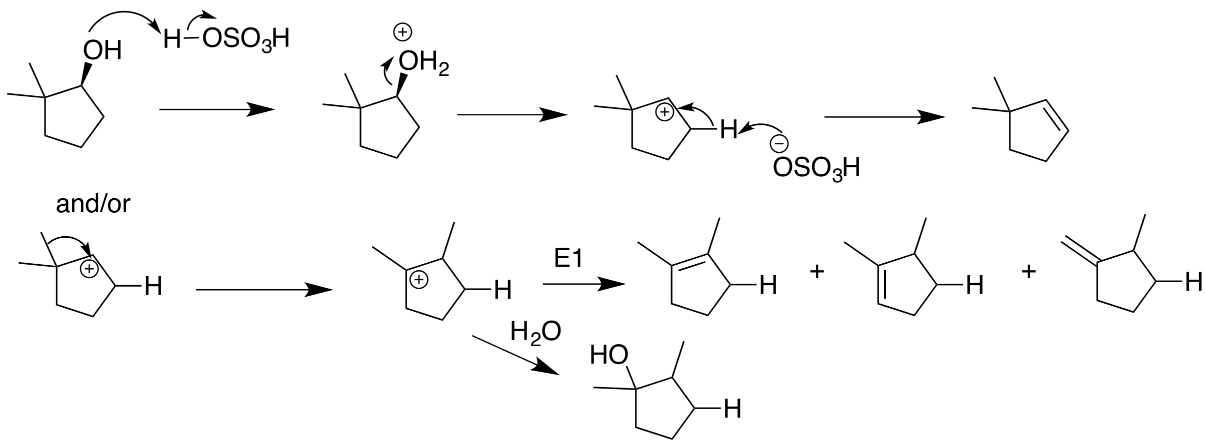
**Explanation #2**

Apparently there was some residual sulfuric acid left in the bottle. This could lead to formation of the carbocation shown below. This could under go an E1 reaction or a carbocation rearrangement which could lead to several other products. In either case the presence of these products would reduce the concentration of the original chiral alcohol.




Your answer must be kept within this box.