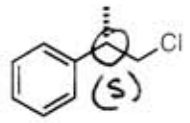
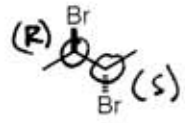
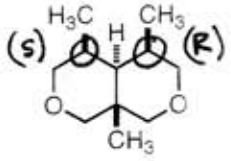
1. Circle all of the stereogenic centers in the following compounds and label them as (*R*) or (*S*). Also label each compound as "chiral" or "achiral" (2 points each):

a. 

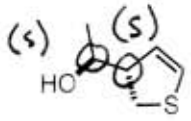
chiral

b. 

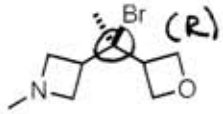
achiral (meso)

c. 

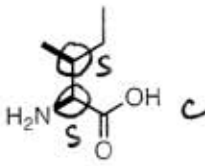
achiral (meso)

d. 

chiral

e. 

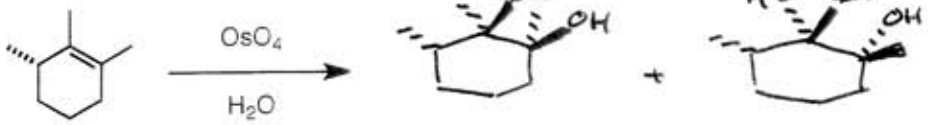
chiral

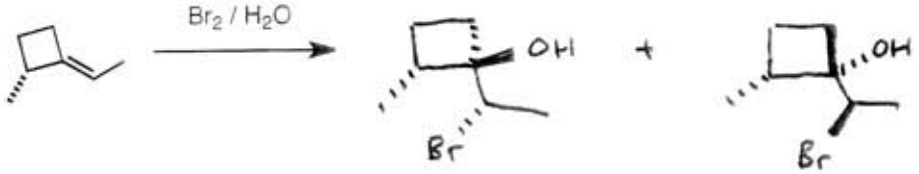
f. 

chiral

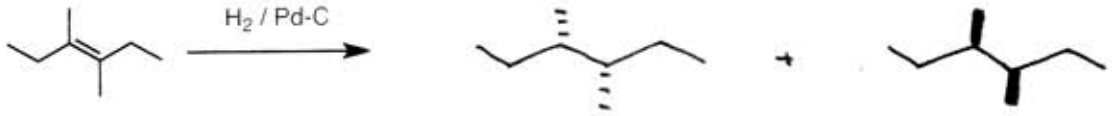
Provide the major product(s) for each of the reactions shown below, including all unique stereoisomers (3 points each).

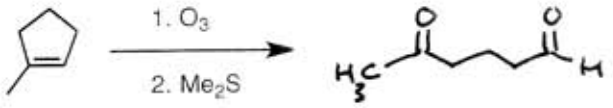
a. 

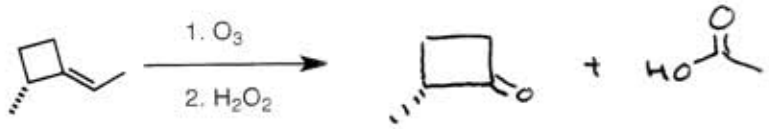
b. 

c. 

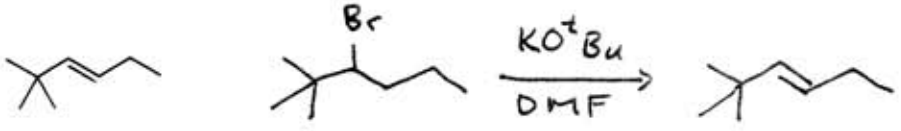
Question 2, continued:

d. 

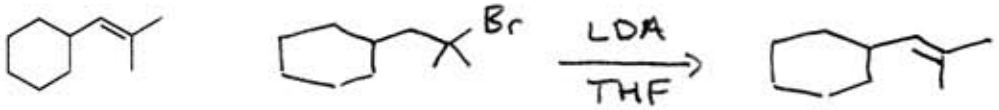
e. 

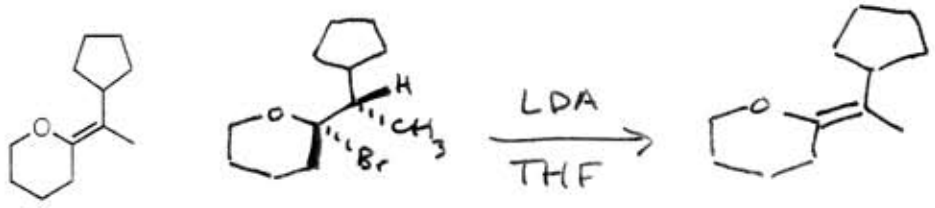
f. 

3. Provide an appropriate alkyl bromide starting material that could be used to prepare each of the following alkene products with the indicated stereochemistry. Also supply the reaction conditions that you would use to carry out your transformations. There will be more than one possible answer in some cases (4 points each).

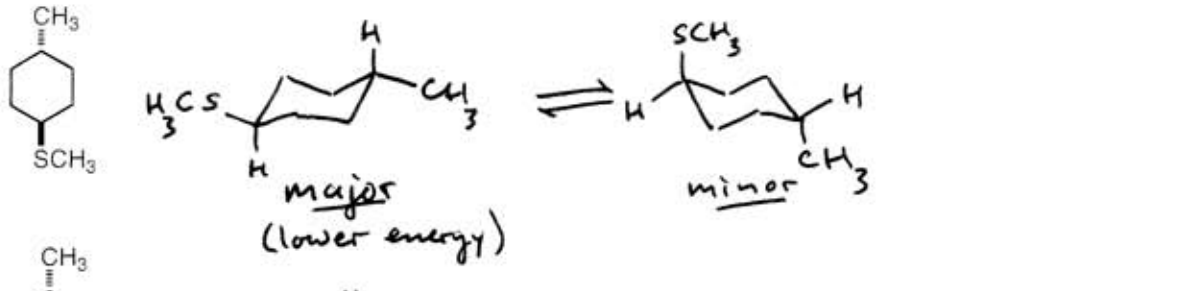
a. 

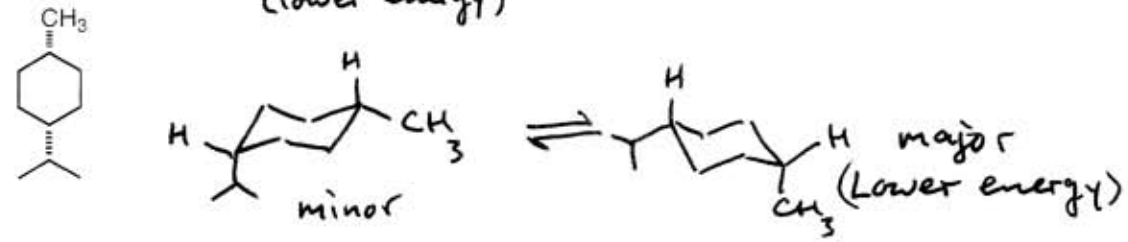
- E_2 or E_1
- trans is always major product
- no other bromide isomers

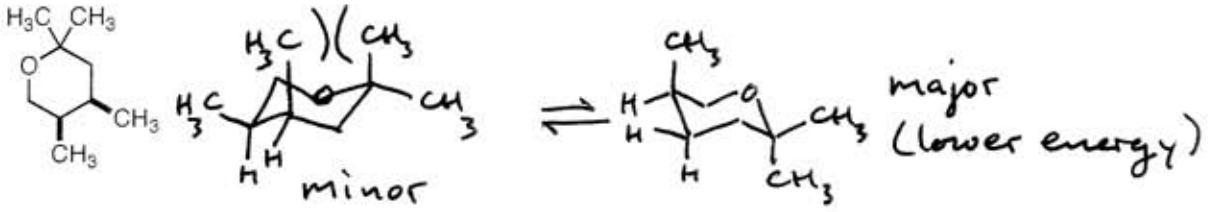
b. 

c. 

4. For each of the substituted cyclohexanes shown below, provide clear drawings for each of the two possible chair conformations. Also indicate which of the conformations you would expect to be lower in energy (4 points each).

a. 

b. 

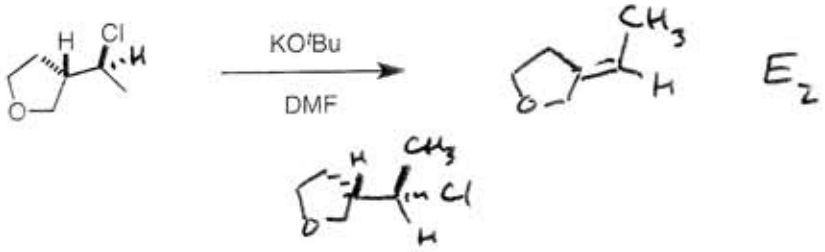
c. 

5. Predict whether each of the following reactions will proceed through an S_N2, S_N1, E_2, and/or E_1 pathway. Also provide the structures of the major product(s) that would be obtained. In some cases, more than one reaction type may occur, and in others, no reaction will occur (3 points each).

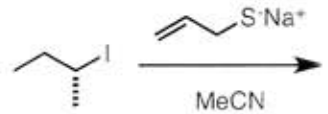
a. 

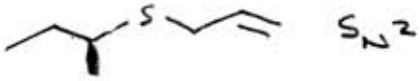
b. 

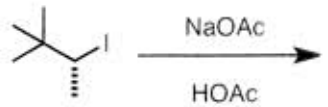
c. 

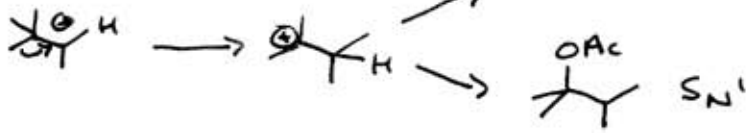
d. 

Question 5. continued:

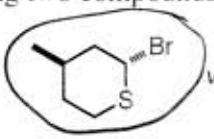
e. 

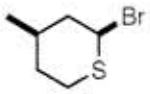


f. 



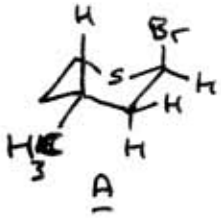
6. The following two compounds undergo E_2 elimination reactions with drastically different rates:

faster 

vs. 

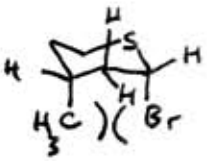
which compound eliminates faster?

Predict which substrate will eliminate faster and rationalize your choice with a clear structural drawing (6 points). Both must have axial Br groups to allow E_2 (anti):



A

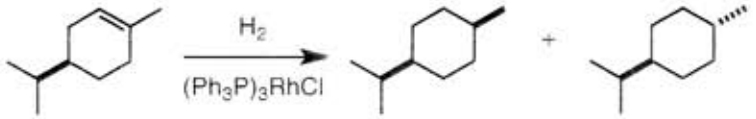
vs.

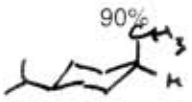


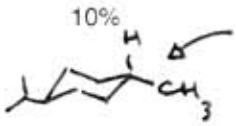
B

The 1,3 diaxial interactions in B make this conformation too high in energy to access. A therefore eliminates faster.

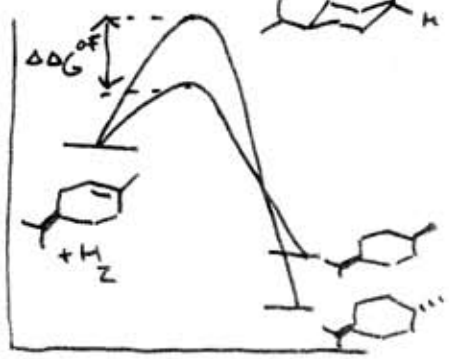
7. The following reaction produces two different products in the indicated ratio. Use this information and the product structures to generate a reaction coordinate diagram that compares the energetics leading to the formation of these two products. Also, clearly label the energy difference on the diagram that is responsible for the observed reactivity difference. For the purpose of this question, you may assume that the reaction proceeds through a single step (7 points).







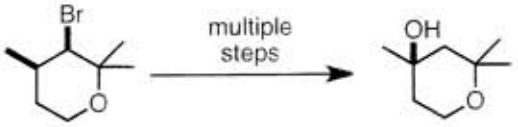
← lower in energy

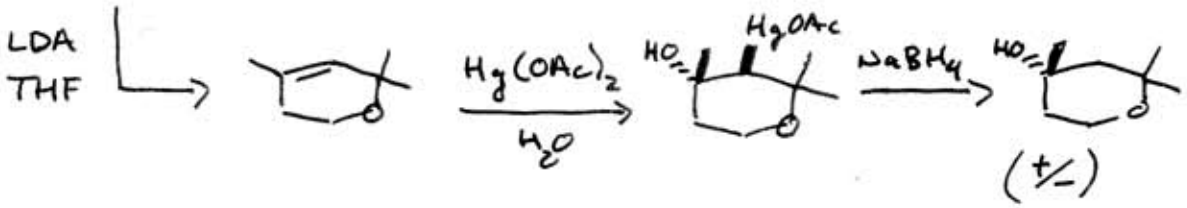


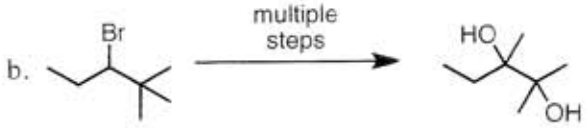
- must be kinetic control (irreversible, plus ratio)

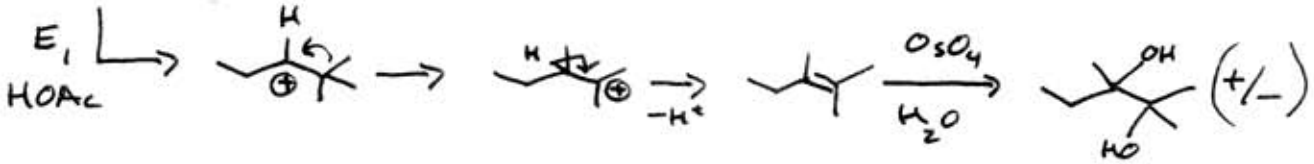
$\Delta\Delta G^{o\ddagger}$ determines product ratio

8. Each of the following overall transformations occurs through a series of multiple chemical steps. Link together the reactions you have learned in class to show how each starting compound can be converted into the indicated product. Draw all of the intermediates along the synthetic routes that you propose, and supply all reagents and reaction conditions as appropriate. No "arrow-pushing" mechanisms are required. For the compounds that are chiral, you only need to indicate how the racemic mixture can be made. There can be more than one answer in some cases (5 points each).

a. 



b. 



syn add'n, but doesn't matter here.

c.