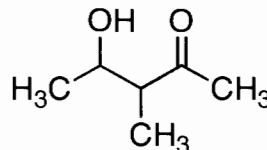
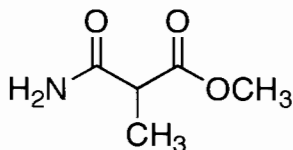
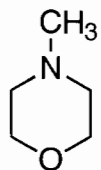




3. Name the functional groups found in each of the following molecules. (12 points)



(a) amine

(c) amide

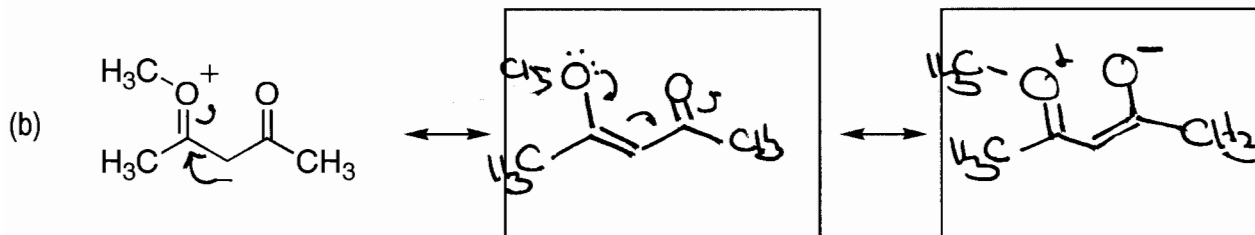
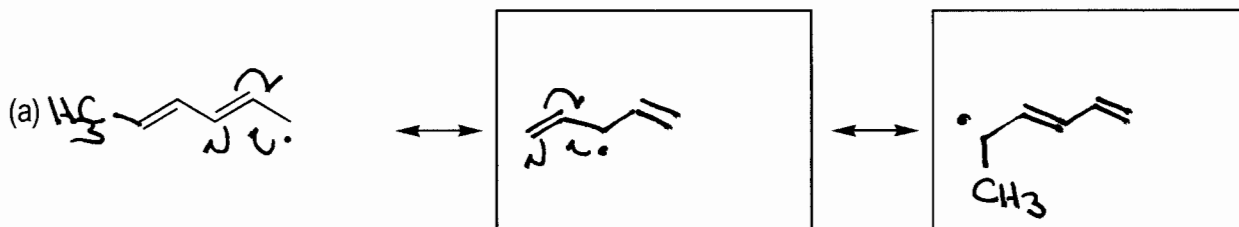
(e) alcohol

(b) ether

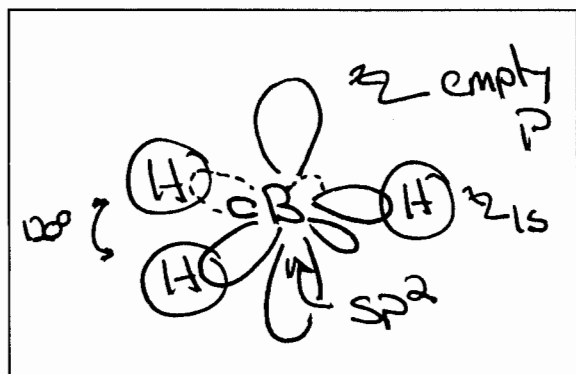
(d) ester

(f) ketone

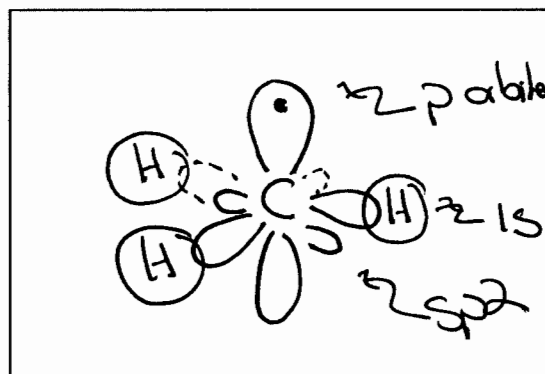
4. Draw resonance structures for the following compounds. Be sure to clearly indicate electrons, formal charges, and arrows. (8 points)



5. Draw a picture showing the orbitals, bonds, and geometry of the following molecules. Label the hybridization of the non-hydrogen atoms (8 points):



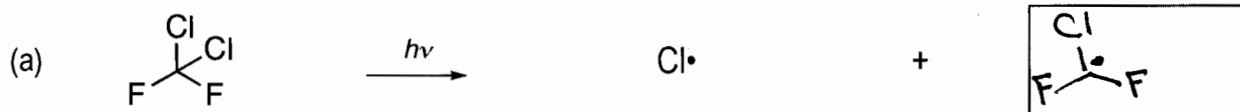
(a)  $BH_3$



(b)  $H_3C\cdot$

6. Chlorine radicals, generated from chlorofluorocarbons, destroy ozone (O<sub>3</sub>) via a radical chain reaction. A single chlorine radical can destroy 100,000 ozone molecules. Fill in the intermediates in the mechanism for the destruction of ozone by chlorine radicals (16 points):

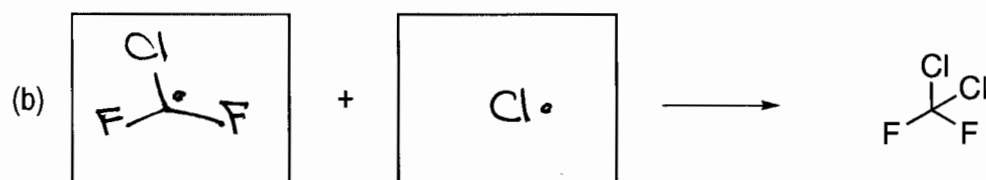
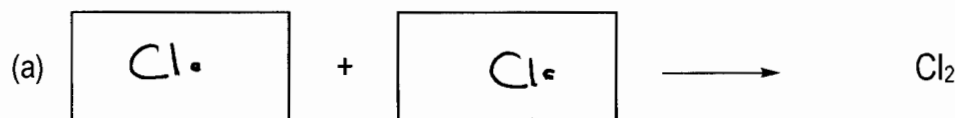
i) Initiation:



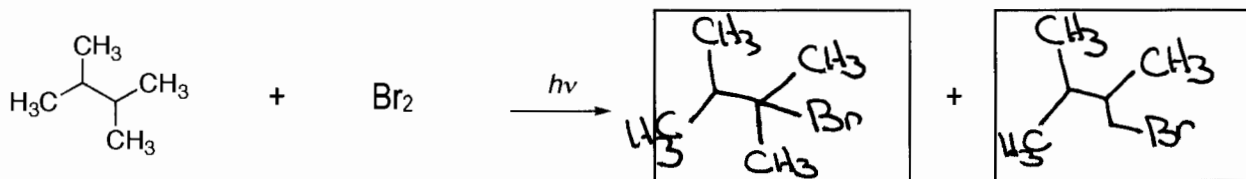
ii) Propagation



iii) Termination



7. Predict the two monobromination products and their ratio. (10 points) (4 pts) (4 pts)

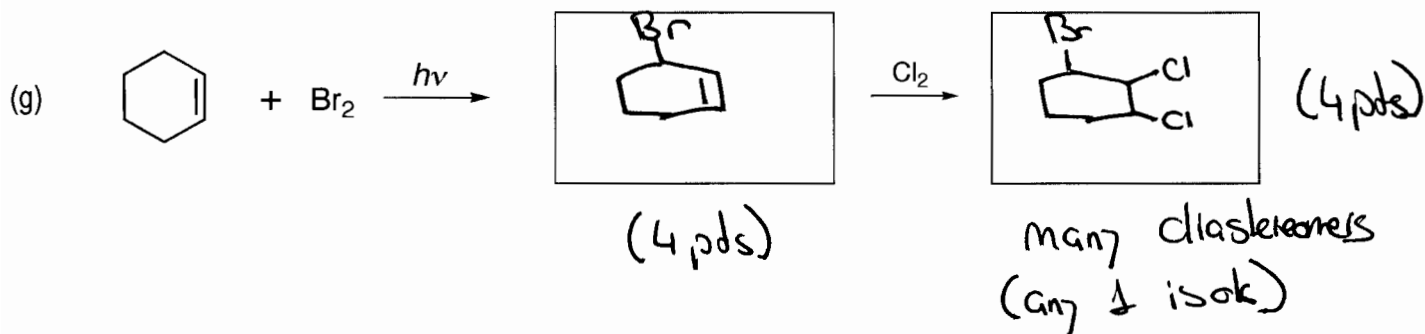
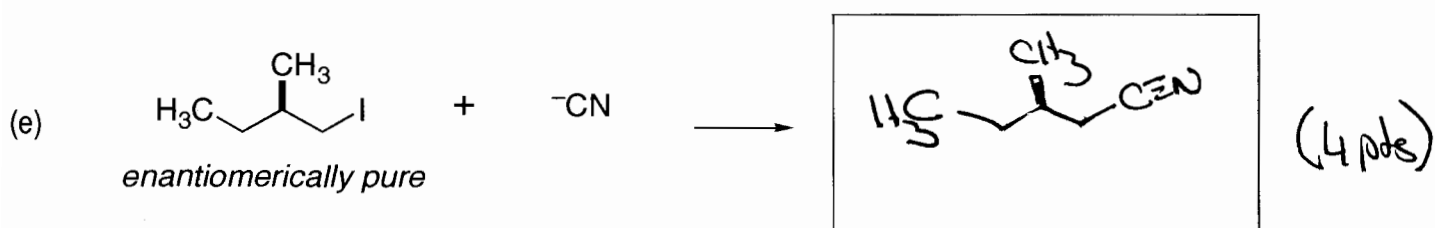
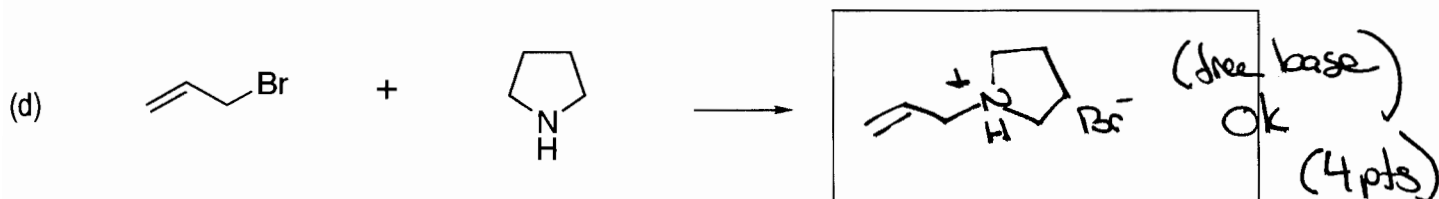
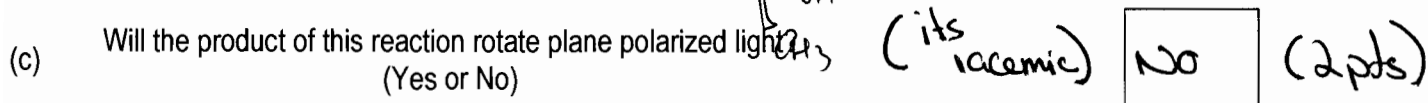
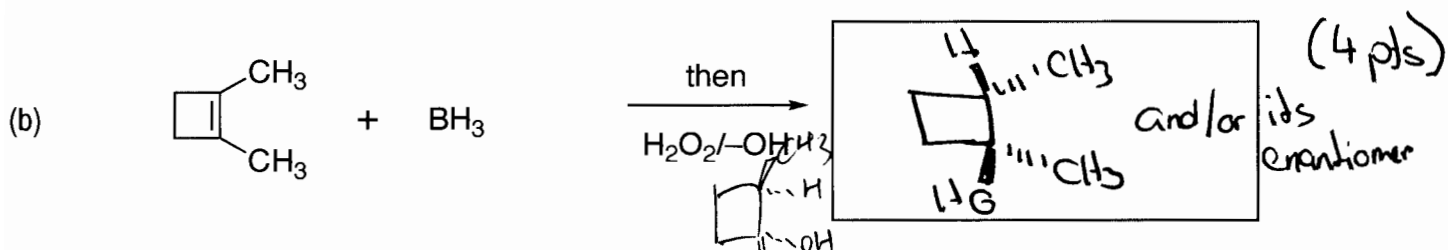
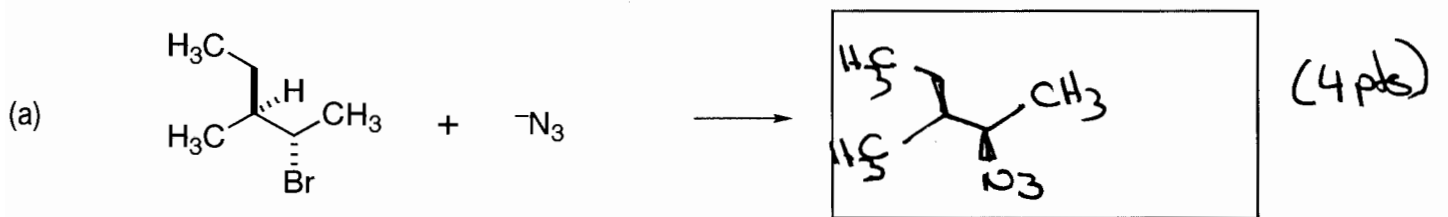


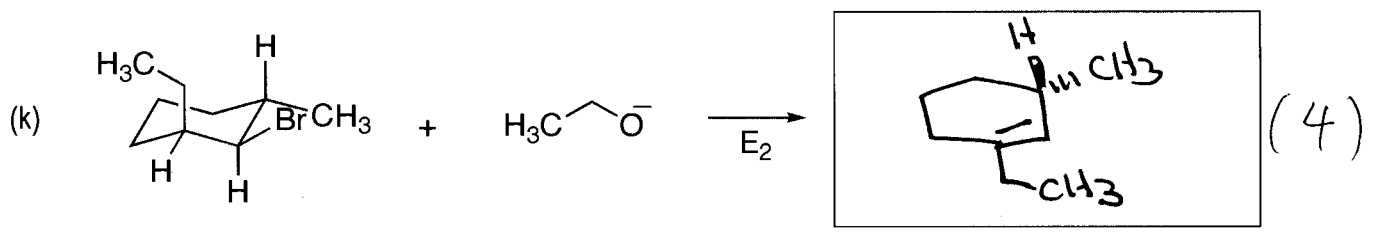
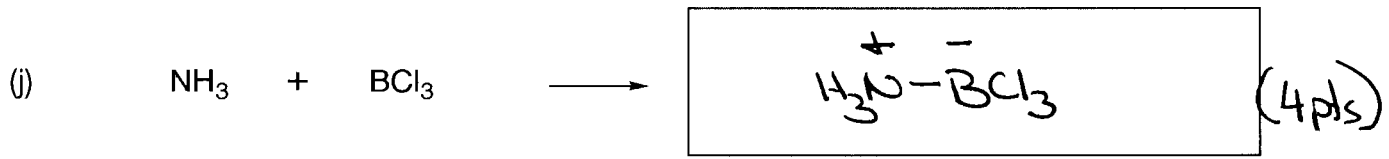
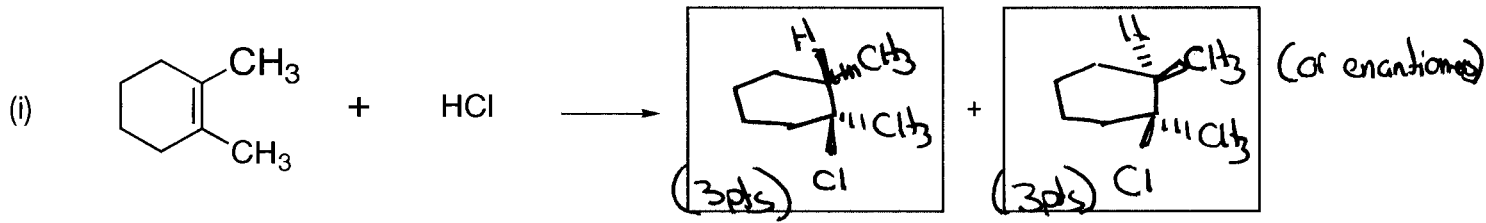
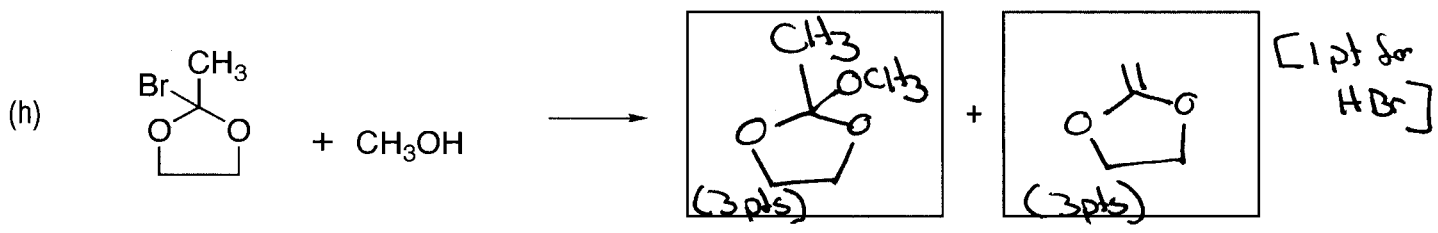
rel. rate 3°H vs 1°H  
~1600 : 1

800 : 3 (2 pts)  
3200 : 12  
99 : 1  
1600 : 1 } all OK  
3200 : 12  
99 : 1  
1600 : 1 } 2 pts

3°H's 2 × 1600 = 3200 = 1600 = 800  
1°H's 12 × 1 = 12 = 6 = 3

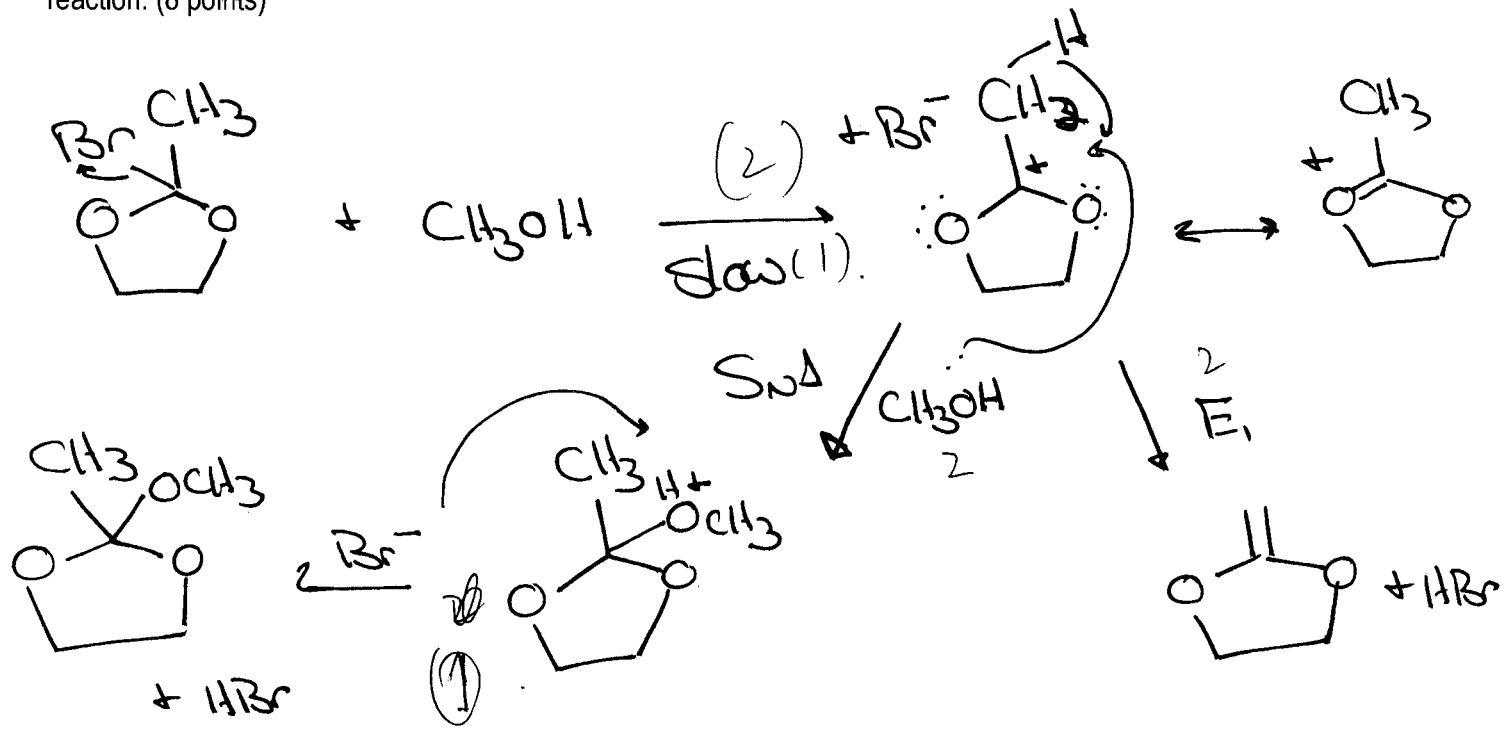
8. Draw the products of the following reactions or give answers to the questions. Pay careful attention to stereochemistry (two pages, 50 points)





(l) Assuming the starting material in (k) is enantiomerically pure, will the product be (R) or (S)? (S) (2)

9. Draw a step-by-step mechanism for the reactions in (h) above. Label the rate limiting (slowest) step in the reaction. (8 points)

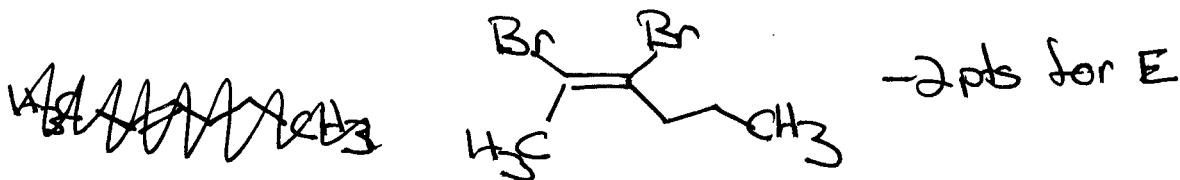


10. Give correct structures for the following compounds, showing the proper stereochemistry: (12 points)

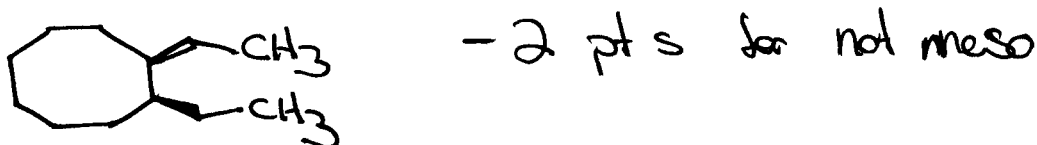
(a) (3*R*,4*S*)-3,4-dichlorocyclohexene



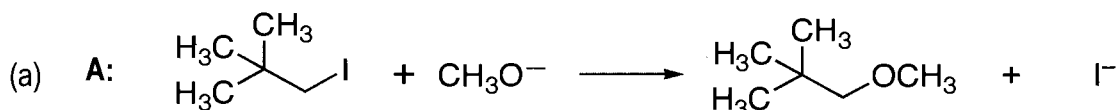
(b) (*Z*)-2,3-dibromo-2-hexene



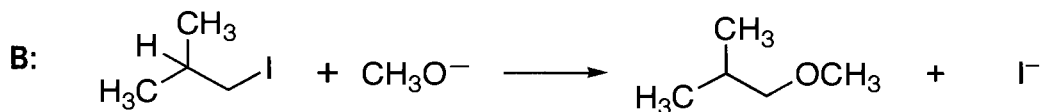
(c) *meso*-2,3-diethylcyclooctane



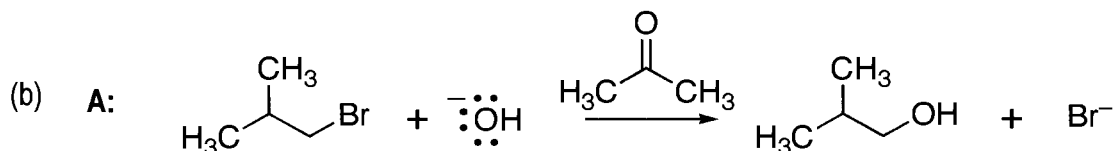
11. For each entry, which of the following  $S_N2$  reactions will be FASTER? (4 points)



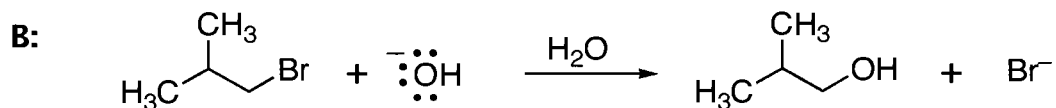
or



B

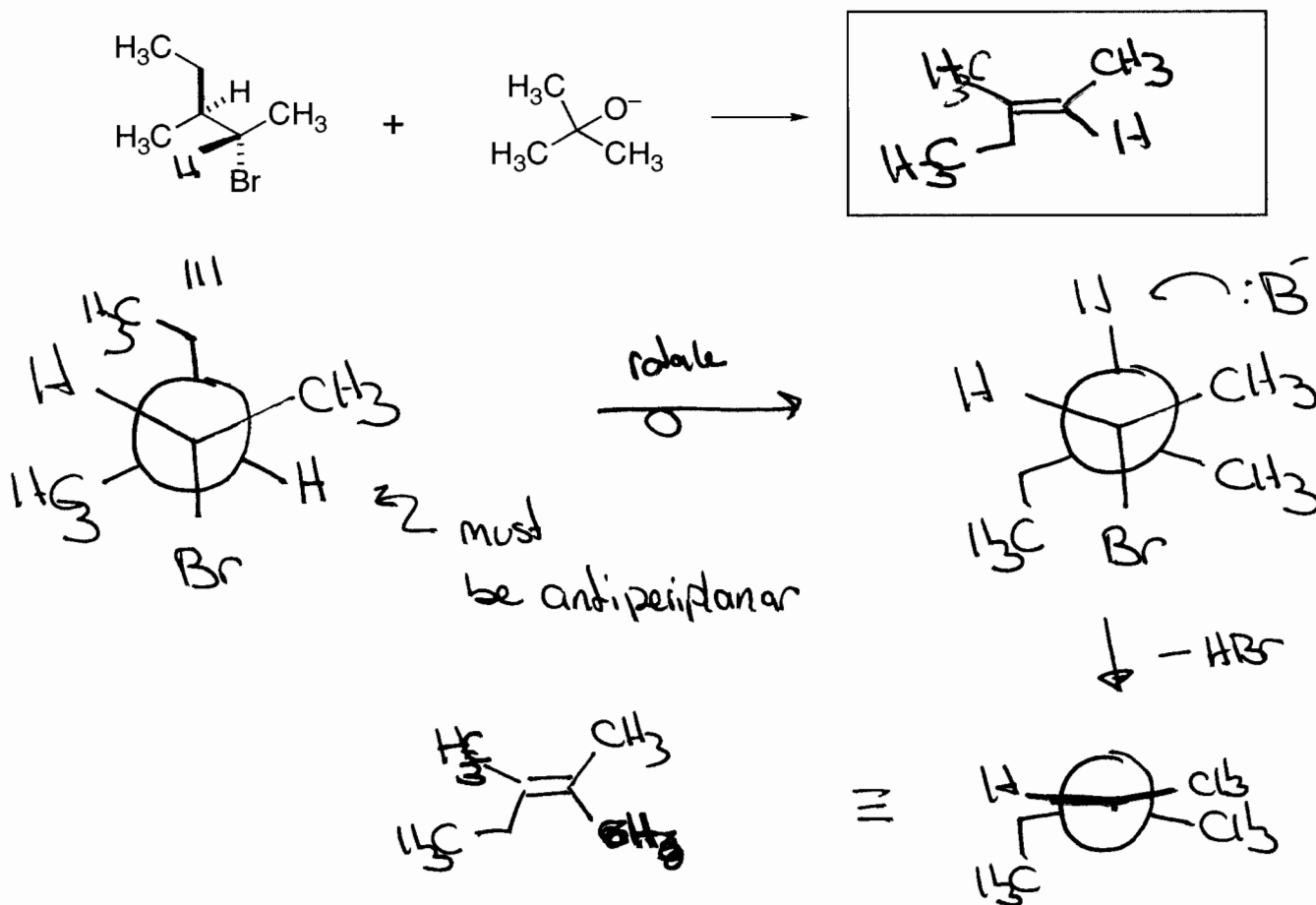


or

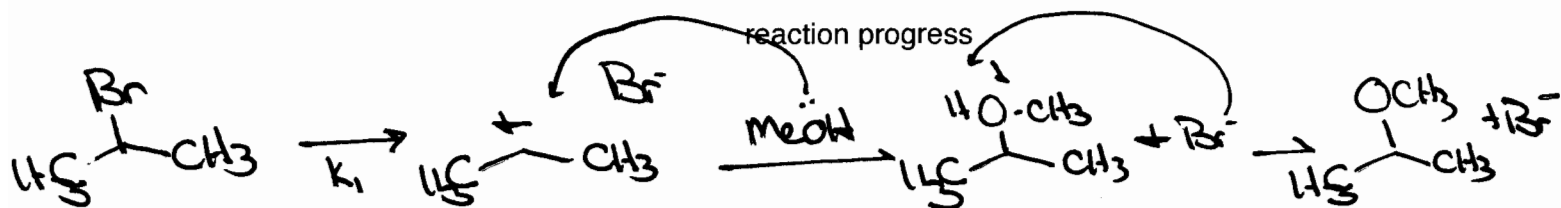
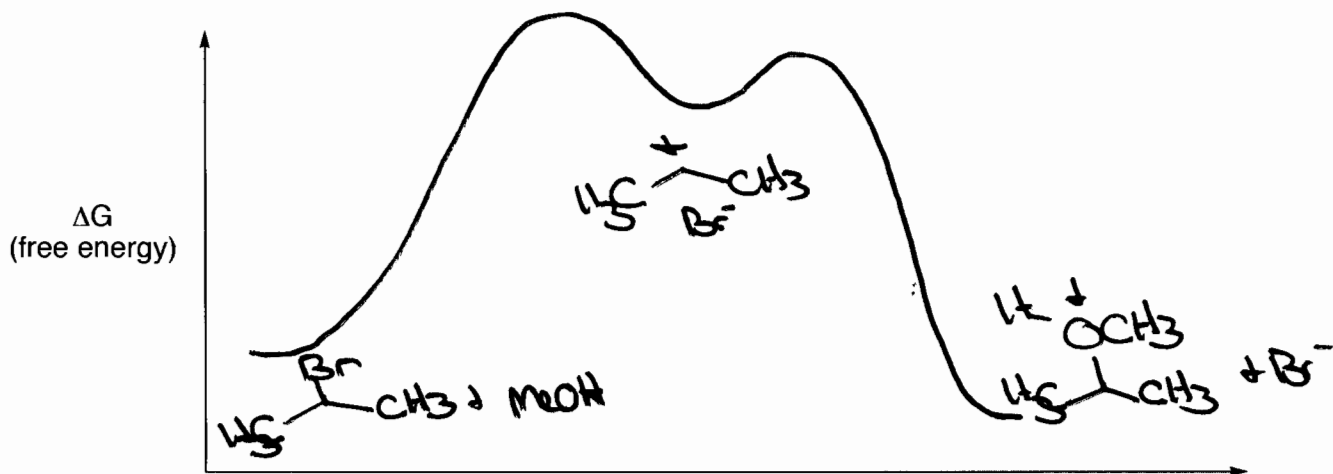


A

12. The following E2 reaction gives a single alkene stereoisomer. Predict the product and explain, using Newman projection, why it is the only one formed. (10 points)

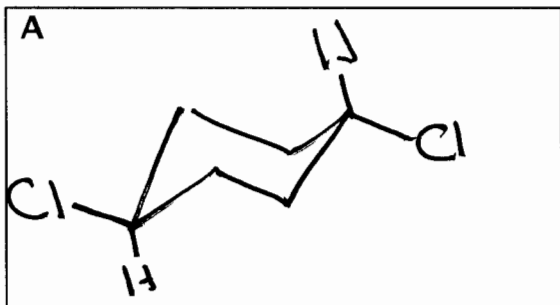


13. Draw an energy diagram for the  $\text{S}_{\text{N}}1$  reaction of 2-bromopropane with methanol. Label the key intermediates. (8 points)

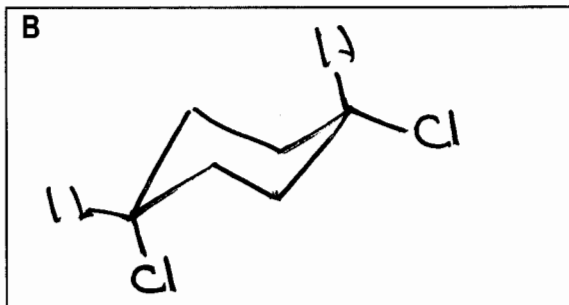


14. Draw the following representations of 1,4-dichlorocyclohexane. Write neatly! (12 points)

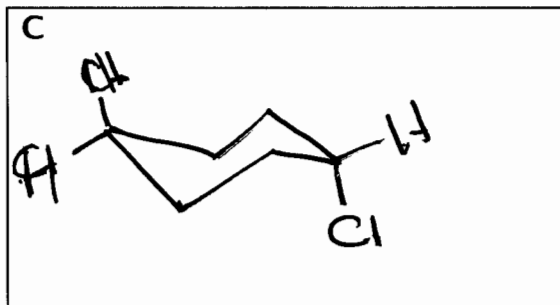
(a) The most stable conformer of the *trans*-diastereomer.



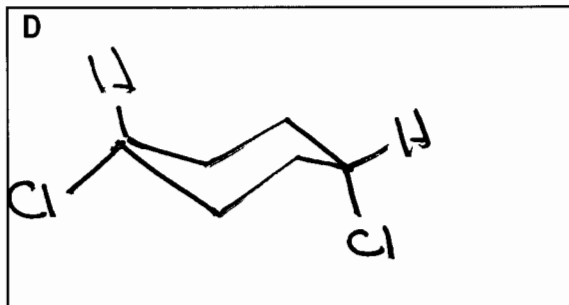
(b) The most stable conformer of the *cis*-diastereomer.



(c) The ring flipped conformer of the *trans* conformer drawn above.



(d) The ring flipped conformer of the *cis* conformer drawn above.



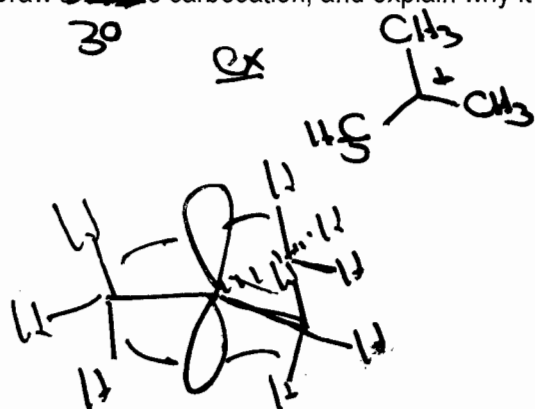
(e) Estimate the relative population of conformer **A** to conformer **C** at equilibrium.

A:  % C:  %

(f) Estimate the relative population of conformer **B** to conformer **D** at equilibrium.

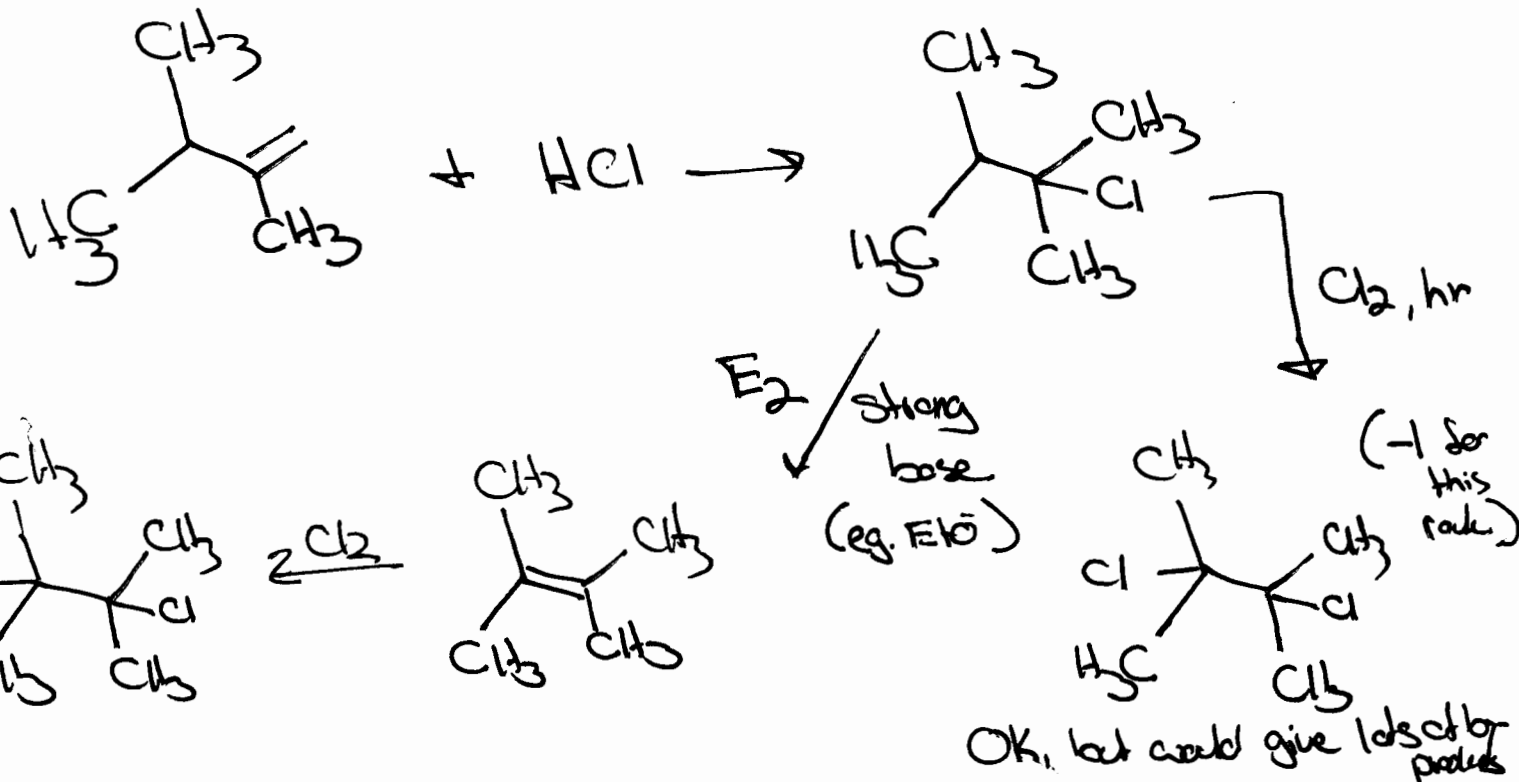
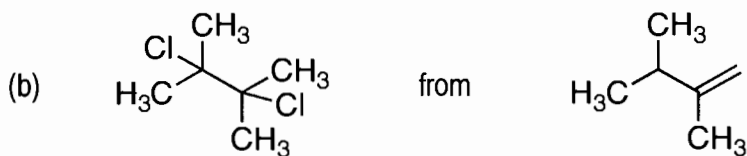
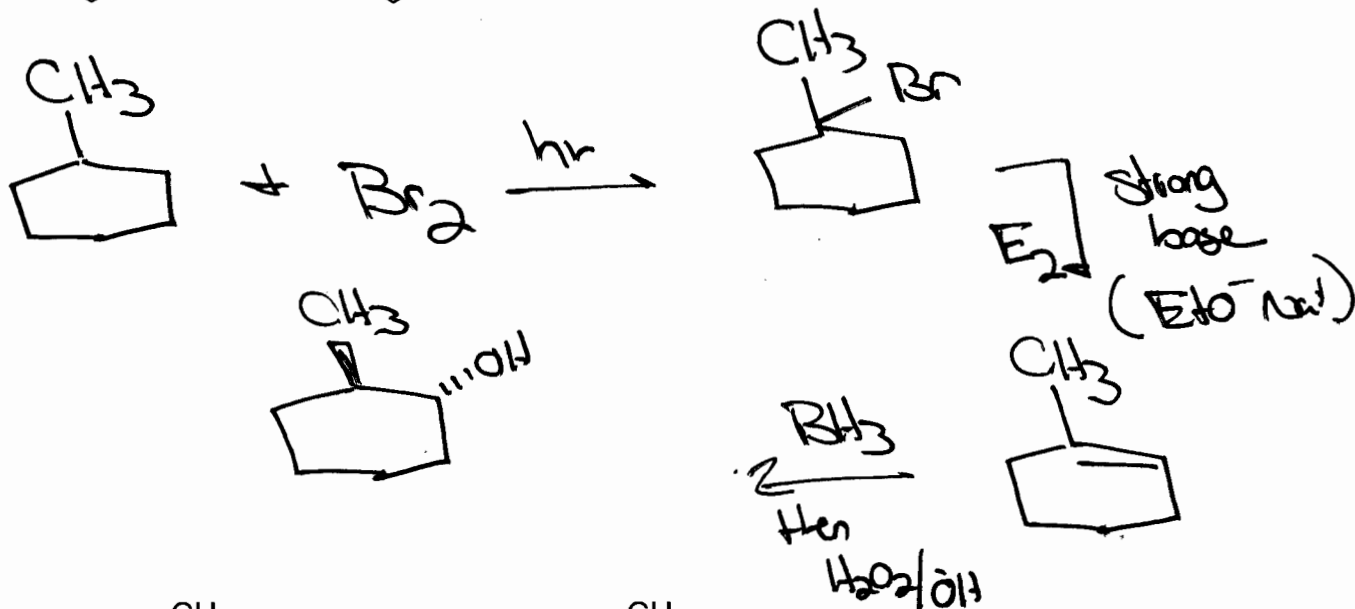
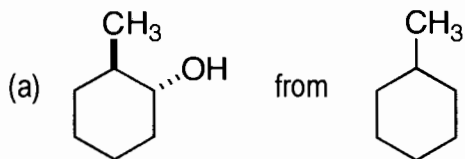
B:  % D:  %

14. Draw a ~~stable~~ carbocation, and explain why it is a relatively stable carbocation. (6 points)



empty p orbital  $\pi$  stabilized by hyperconjugation from neighboring C-H bonds (or C-C)

15. Propose multi-step synthesis of the following compounds from the given starting materials. You may use any reagents or reactions covered in this class. Each one can be prepared in three steps, however any chemically logical sequence is acceptable. (16 points)



	<b>Points</b>	<b>Possible Points</b>
<b>Page 1</b>	_____	/ 18
<b>Page 2</b>	_____	/ 28
<b>Page 3</b>	_____	/ 26
<b>Page 4</b>	_____	/ 28
<b>Page 5</b>	_____	/ 30
<b>Page 6</b>	_____	/ 16
<b>Page 7</b>	_____	/ 28
<b>Page 8</b>	_____	/ 18
<b>Page 9</b>	_____	/ 16
<b>Total</b>	<input type="text"/>	/ 208