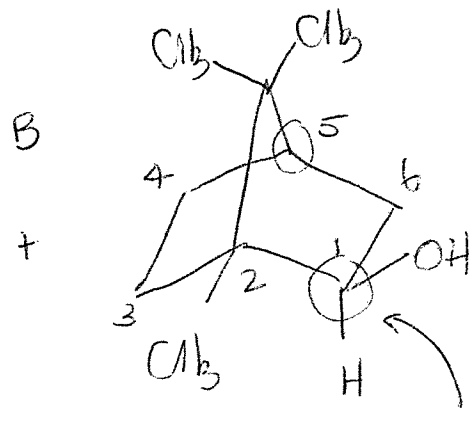
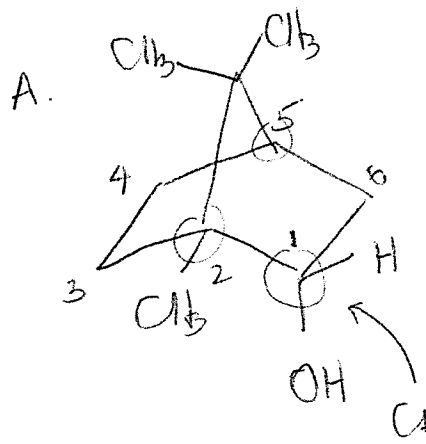


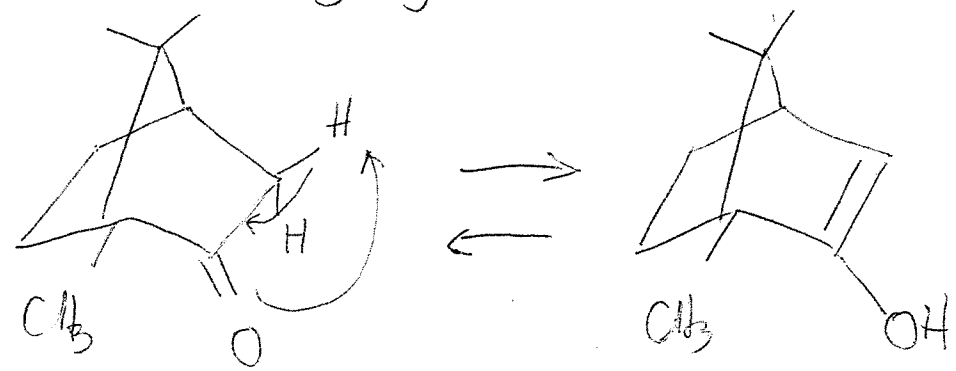
$H^{\ominus}$  (From  $NaBH_4$ )  
 (can attack from top  
 and bottom to give  
 new chiral center)

(B)



The alcohol  
 in both  
 products is  
 secondary

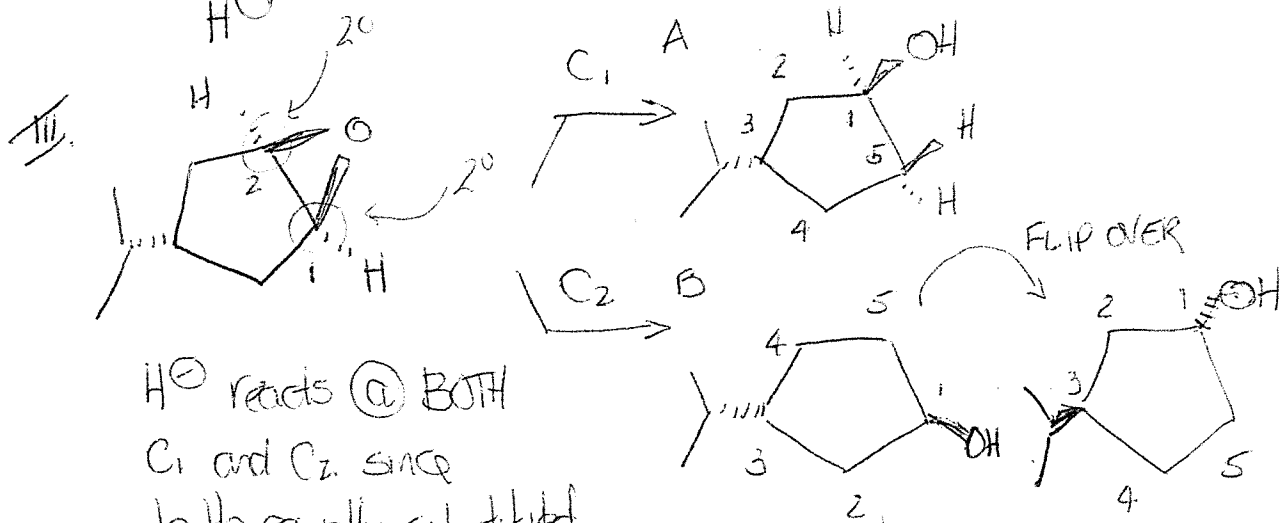
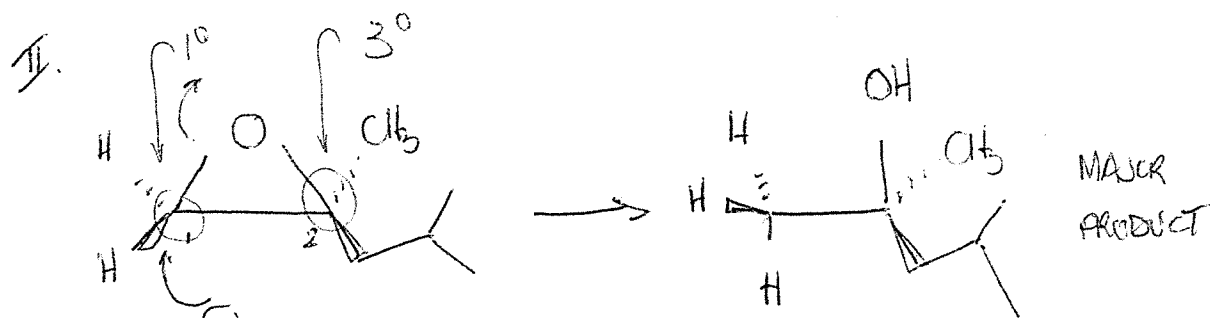
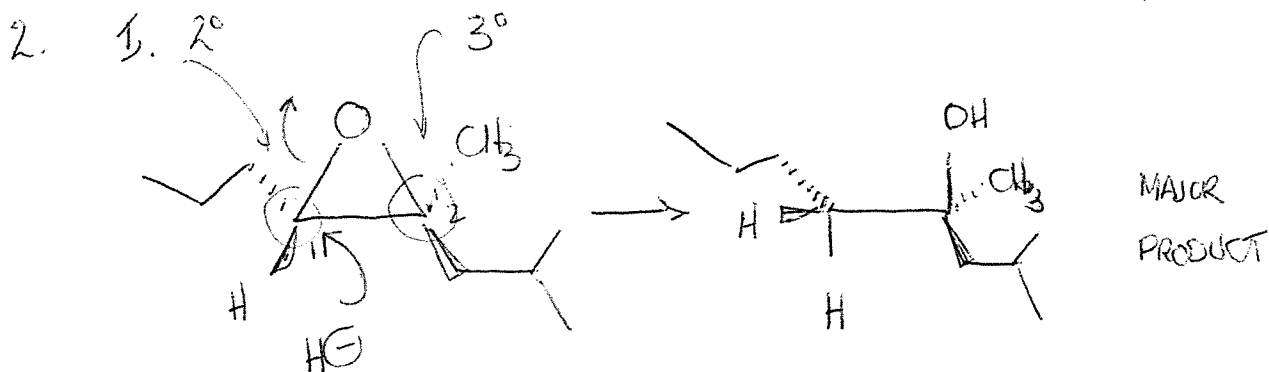
The configuration @  $C_1$  of the products is inverted going from one structure to the other.  $C_2$  and  $C_5$  are also chiral centers, but do not change between the two structures. (Some but not all chiral centers are inverted going from A to B) DIASTEREOMERS



CAMPHOR CAN FORM AN ENOL

$\text{LiAlH}_4$  reacts via  $\text{S}_\text{N}2$  w/  $\text{H}^\ominus$  serving as nucleophile

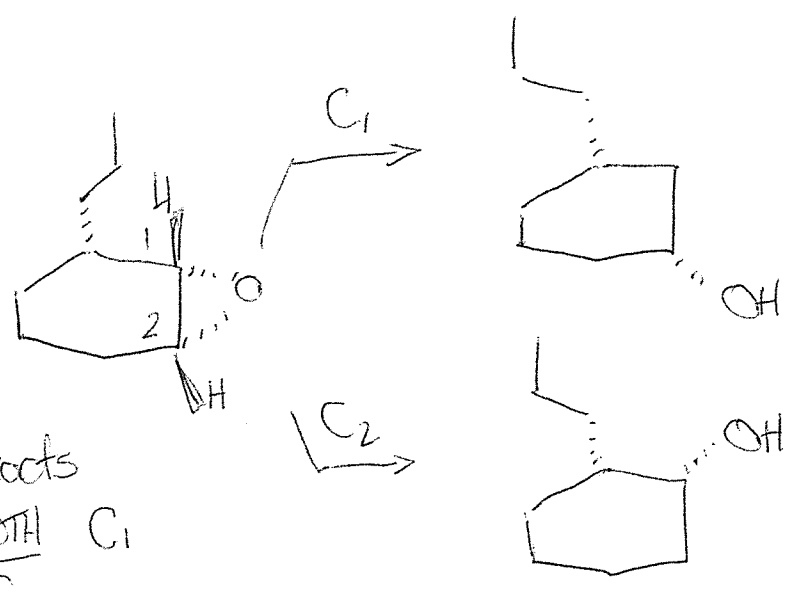
$\text{S}_\text{N}2$  occurs on the LEAST substituted carbon of the epoxide



These are NOT positional isomer. FLIP B over to see position of OH and isopropyl are still 1,3-  
 $\text{A} \neq \text{B}$  are ENANTIOMERS

2. (cont'd)

IV.



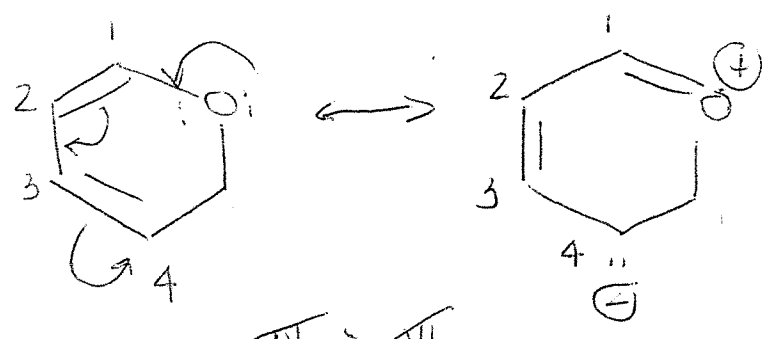
POSITIONAL ISOMERS

(D)

H<sub>2</sub>O<sub>2</sub> reacts at BOTH C<sub>1</sub> and C<sub>2</sub>

3. Reactivity of the diene in a Diels-Alder rxn is increased by ↑ negative character w/ EDG. Presence of EWG ↓ reactivity of the diene.

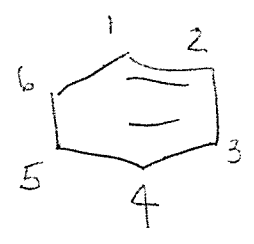
IV.



↑ ⊖ character via EDG by resonance.

IV > III

III.

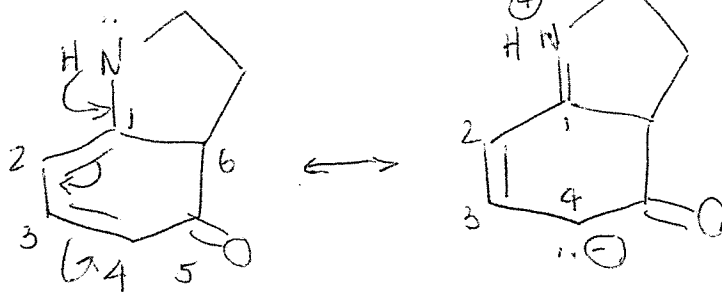


C<sub>5</sub>, C<sub>6</sub> slightly Electron-donating, no resonance;

⊖ character not ↑ as much as IV

### 3. (cont'd)

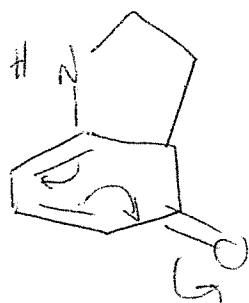
I.



One EDG + One EWG balances out. Equivalent to III.

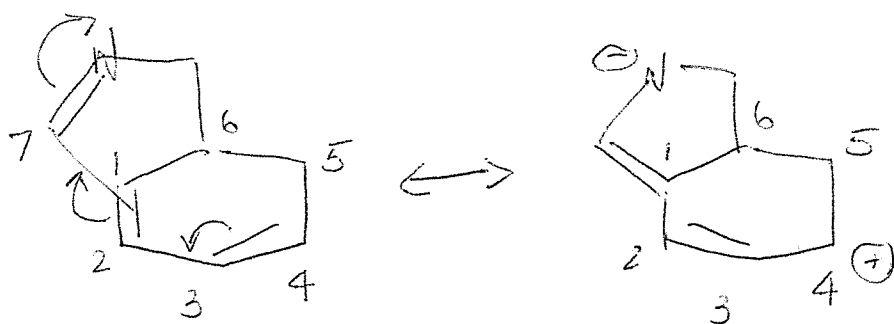
$$(I = III)$$

N atom @ C<sub>1</sub> ↑ ⊖ character as EDG by resonance but carbonyl @ C<sub>5</sub> is EWG by resonance.



$$(IV > I)$$

II.



$$(III = I)$$

C<sub>7</sub>-N (imide) is EWG by resonance ↑ ⊕, less reactive than III. and I

$$IV > III = I > II$$

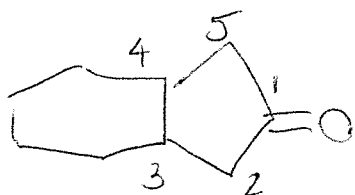
(C)

Aldehyde > ketones

4. Ketones, Aldehydes > Esters

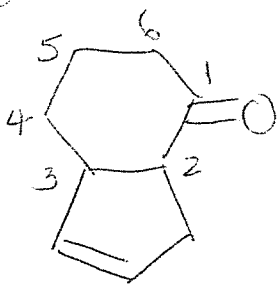
least steric crowding on  $\alpha$ -carbon > Most steric crowding on  $\alpha$ -carbon

V. Ketone, Very little steric crowding on  $\alpha$ -carbons ( $C_2, C_5$ )



Ketone

IV.

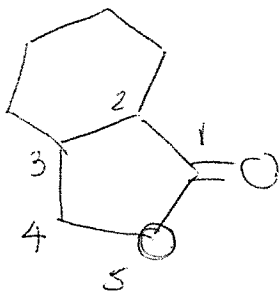


$C_2$  more crowded than  $C_2$  on V

V > IV

Ester

III.



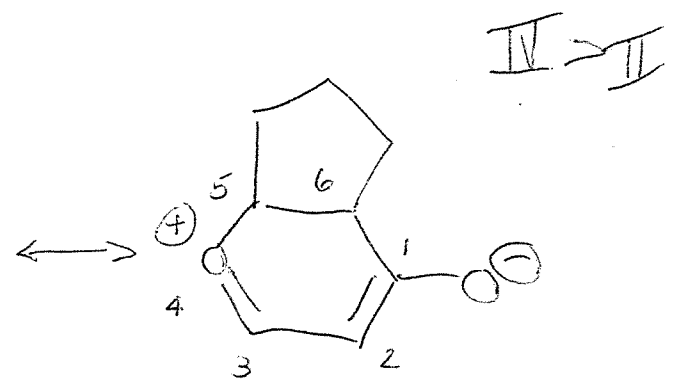
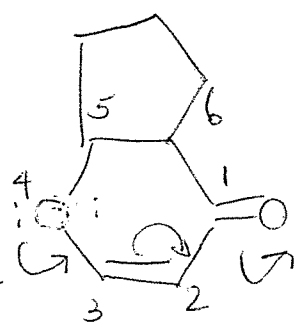
$C_2$  same crowding as  $C_2$  in IV, but ~~ESTER~~ less reactive than ketone

IV > III

4. (cont'd)

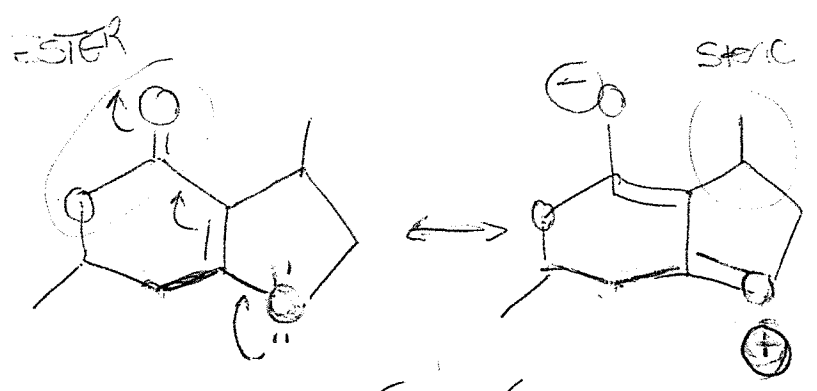
II. KETONE

w/  
RESONANCE



C<sub>4</sub> carbon equal to C<sub>6</sub> of ketone in IV but O @ position 4 and II bond of C<sub>2</sub>-C<sub>3</sub> allows for delocalization of electrons to "dilute" δ<sup>+</sup> of carbonyl carbon, making it less reactive with Nu: (δ<sup>-</sup>)

I. Ester + Resonance + Steric Crowding



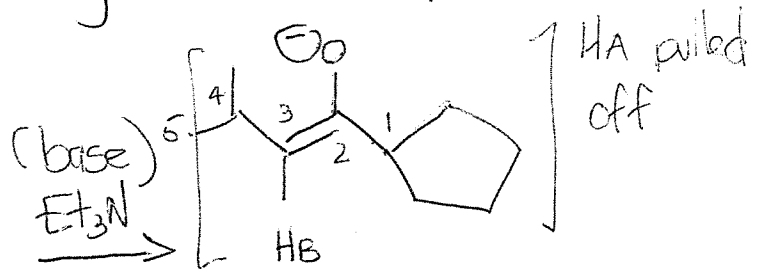
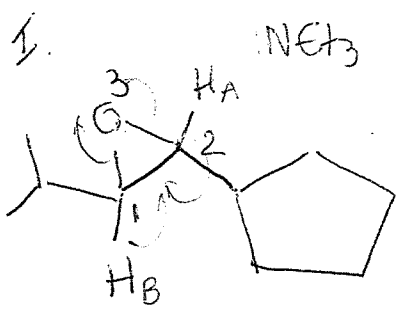
III > I

II > I

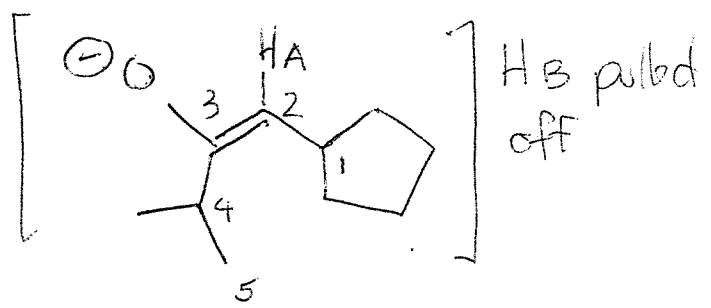
IV > IV > II > III > I

(E)

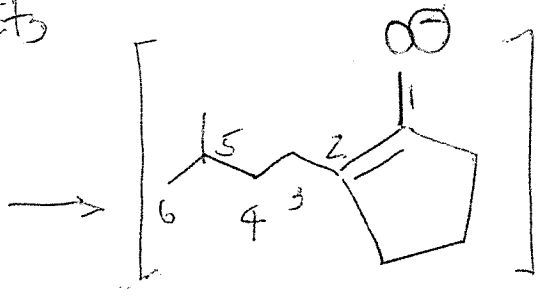
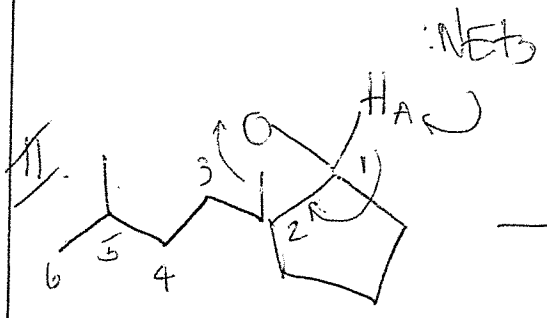
### 5. E2 ring opening of an EPOXIDE



$\text{Et}_3\text{N}$ : can pull off HA or HB of the EPOXIDE to induce ring-opening to an enolate



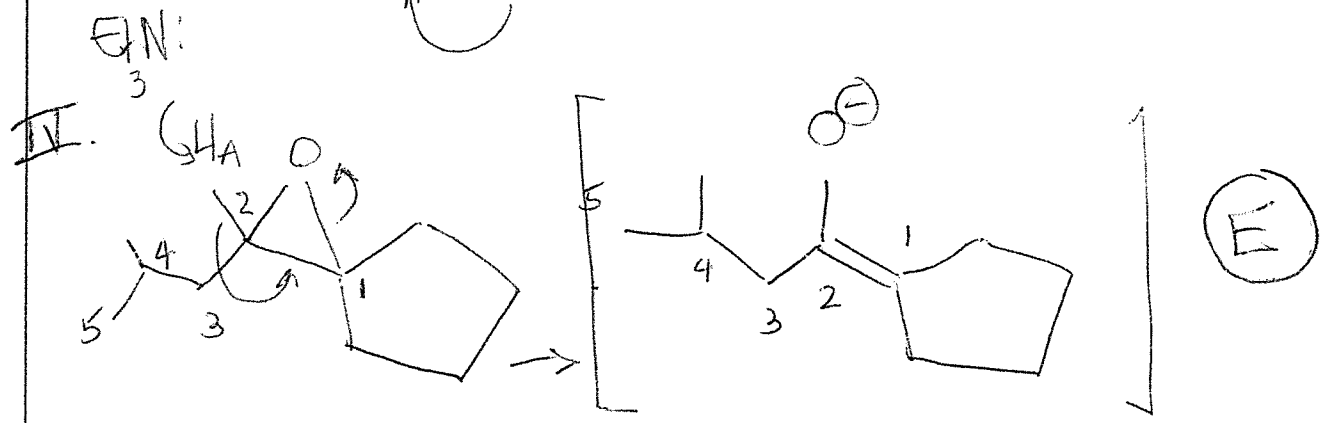
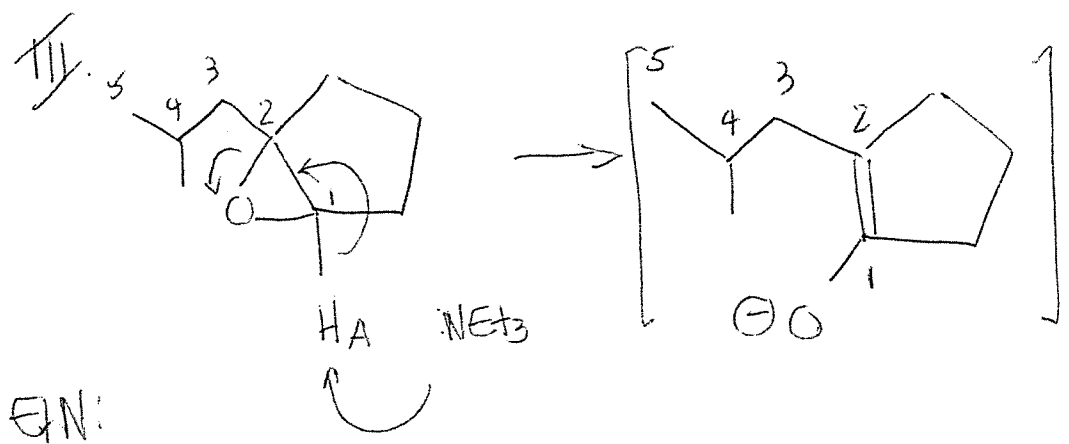
Alkene of end between C<sub>2</sub>-C<sub>3</sub> atoms



Only the HA reacting w/  $\text{Et}_3\text{N}$  can generate enolate (other H will give allylic alkoxide NOT enolate)

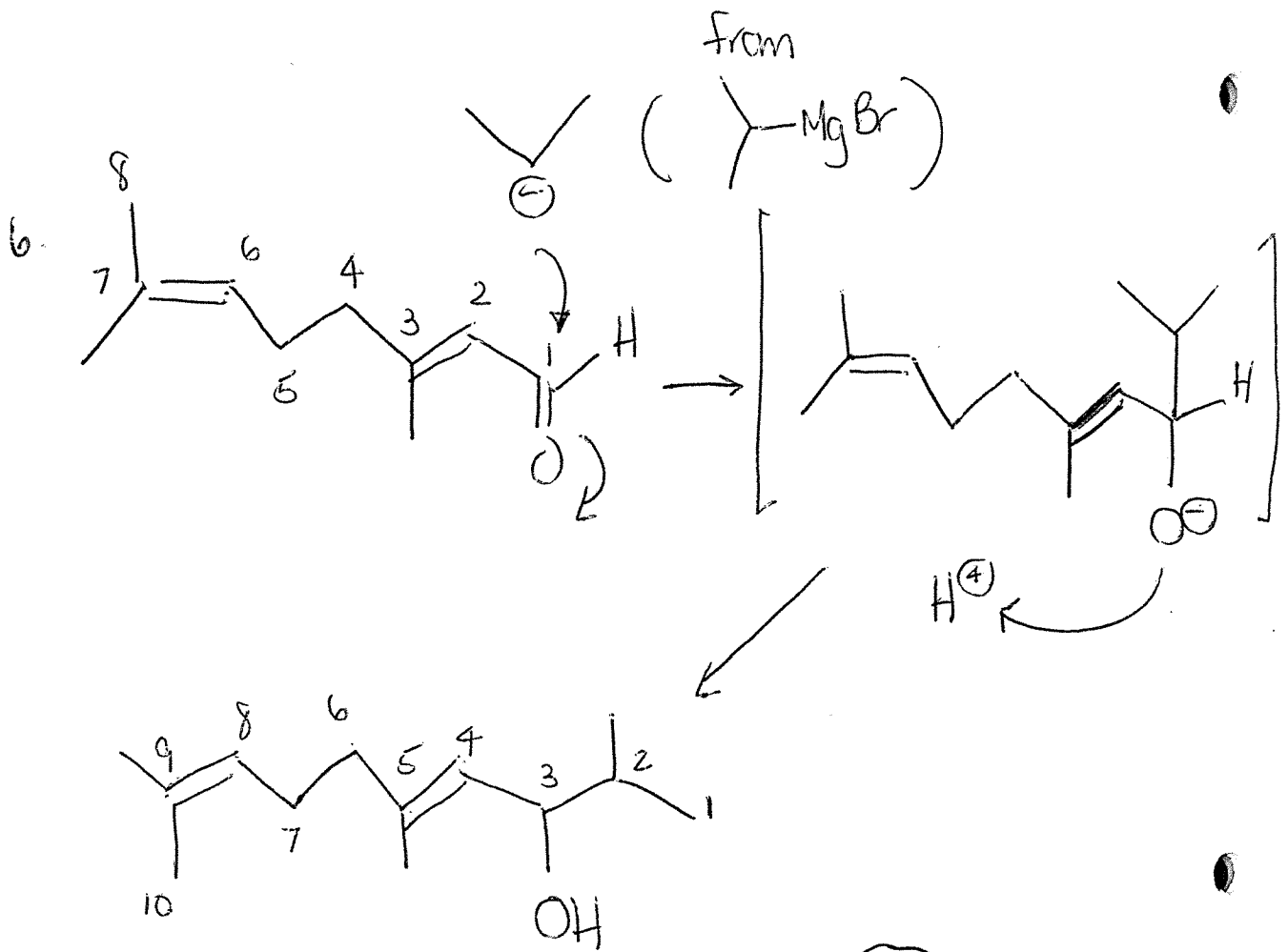
Alkene of enolate PART of ring

5. (cont'd)





-9-

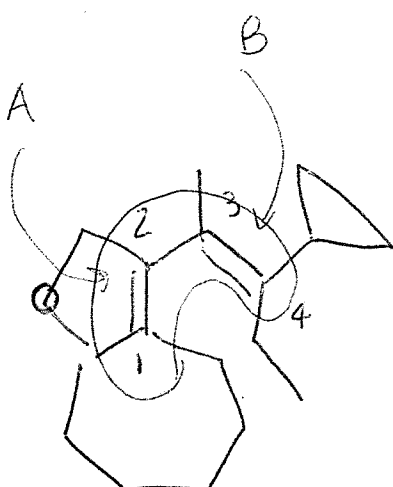


(B)

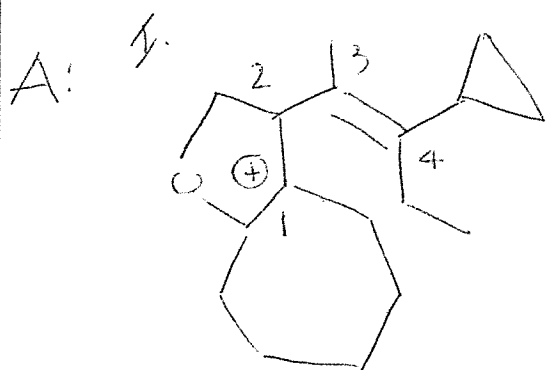
2,5,9-trimethyldeca-4,8-dien-3-ol  
or

2,5,9-trimethyl-4,8-decadiene-3-ol

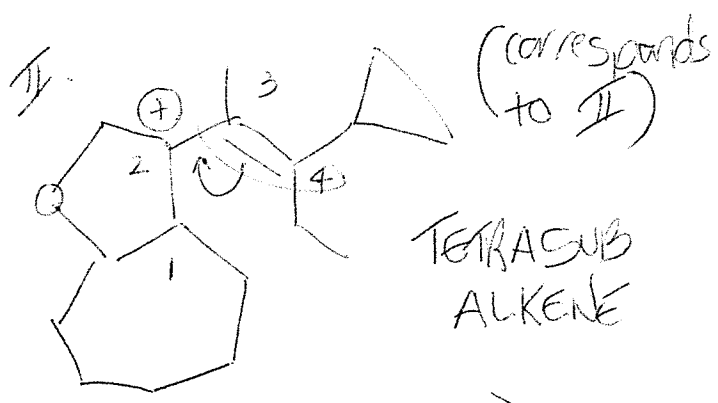
7.



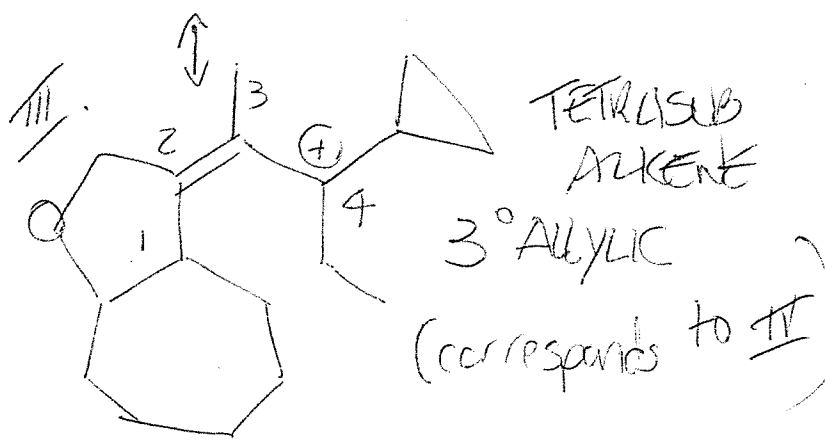
CONJUGATED DIENE  
 CIRCLED and 4 atoms  
 numbered C<sub>1</sub>-C<sub>2</sub> Alkene  
 is labeled as "A" alkene  
 C<sub>3</sub>-C<sub>4</sub> alkene labeled  
 as "B" alkene



3° ALKYL  
 (corresponds to I)

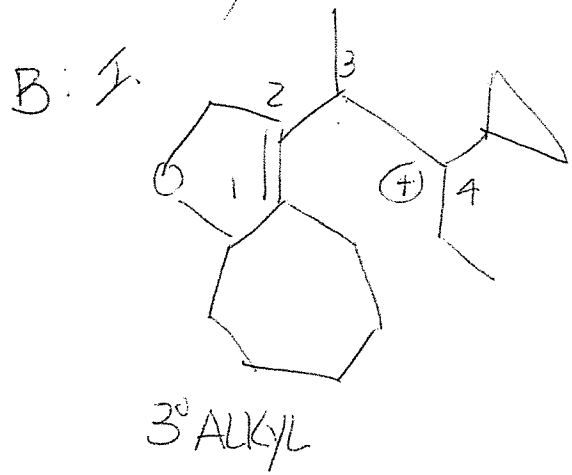


3° ALLYLIC (has resonance)

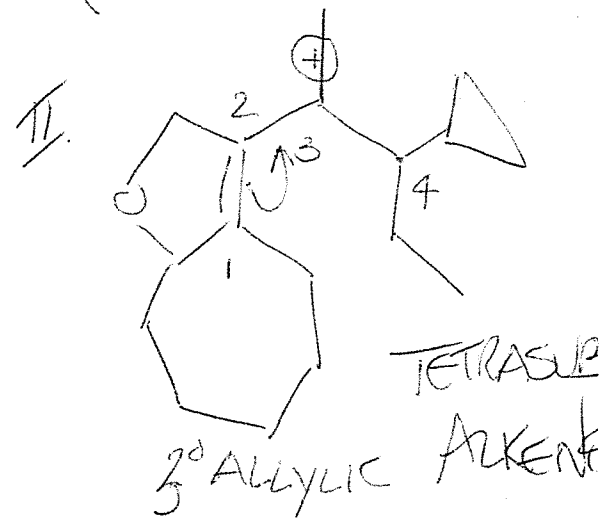


II, III, IV

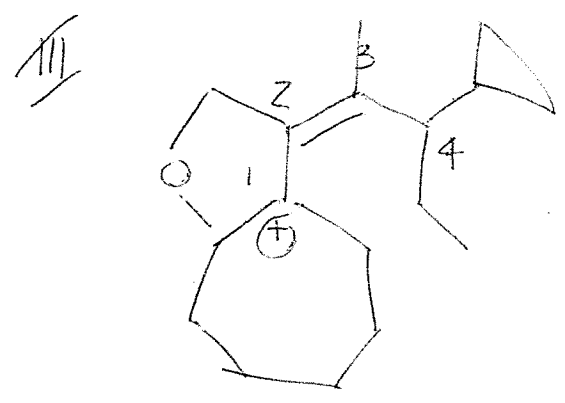
7. (CONT'D)



(corresponds to V)



The MAJOR KINETIC PRODUCT(S) are derived from the most stable carbocation intermediate(s)



Since B-II, A-III and A-III are all

3° Allylic ALL will generate major kinetic products

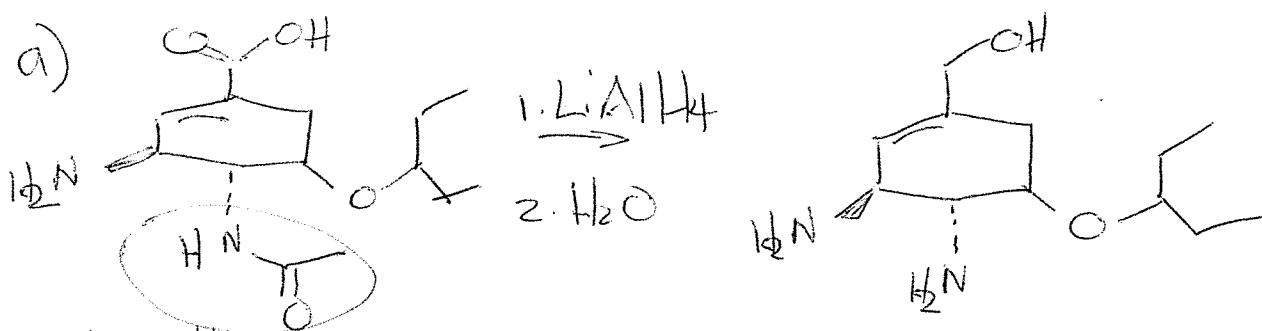
3° ALLYLIC (NOT SHOWN)

8. "Ibuprofen reacts w/  $\text{LiAlH}_4$ ."

- This indicates the compound contains an aldehyde, ketone, ester or carboxylic acid

"The product of the reaction contains both a  $1^\circ$  and  $2^\circ$  alcohol"

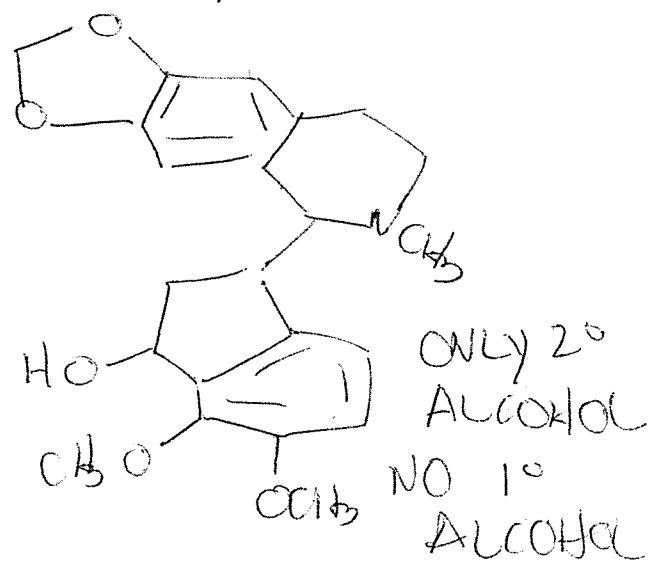
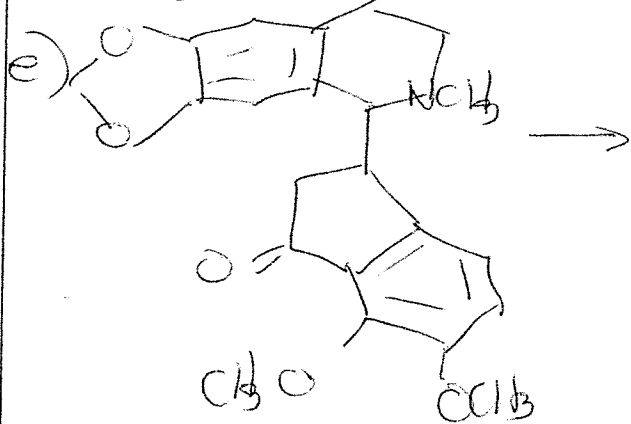
- Since rxn of choice a would only give a  $1^\circ$  alcohol, this choice can be eliminated.



$\text{LiAlH}_4$  also reduces amides

DOES NOT CONTAIN  $1^\circ$  and  $2^\circ$  alcohol only  $1^\circ$

Choice e can also be eliminated.



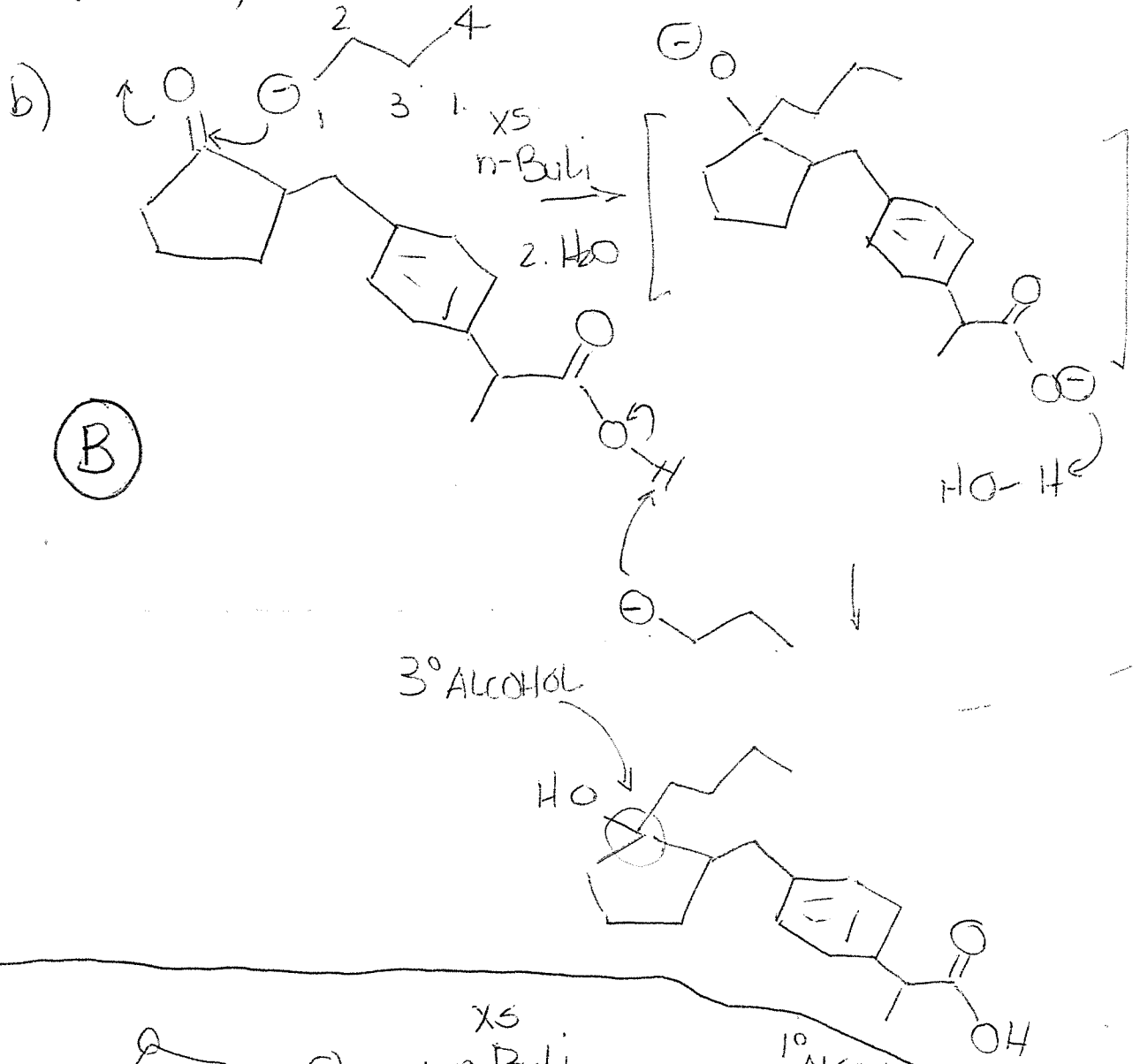
8. (cont'd)

Similarly, choice c can be eliminated since react of this compound w/ 1.  $\text{LiAlH}_4$  2.  $\text{H}_2\text{O}$  will give a product containing a  $2^\circ$  alcohol (from rxn of LAH w/ the ketone) and the  $3^\circ$  alcohol that is part of the starting material will still remain in the product. So this will give a product containing a  $2^\circ$  and  $3^\circ$  alcohol.

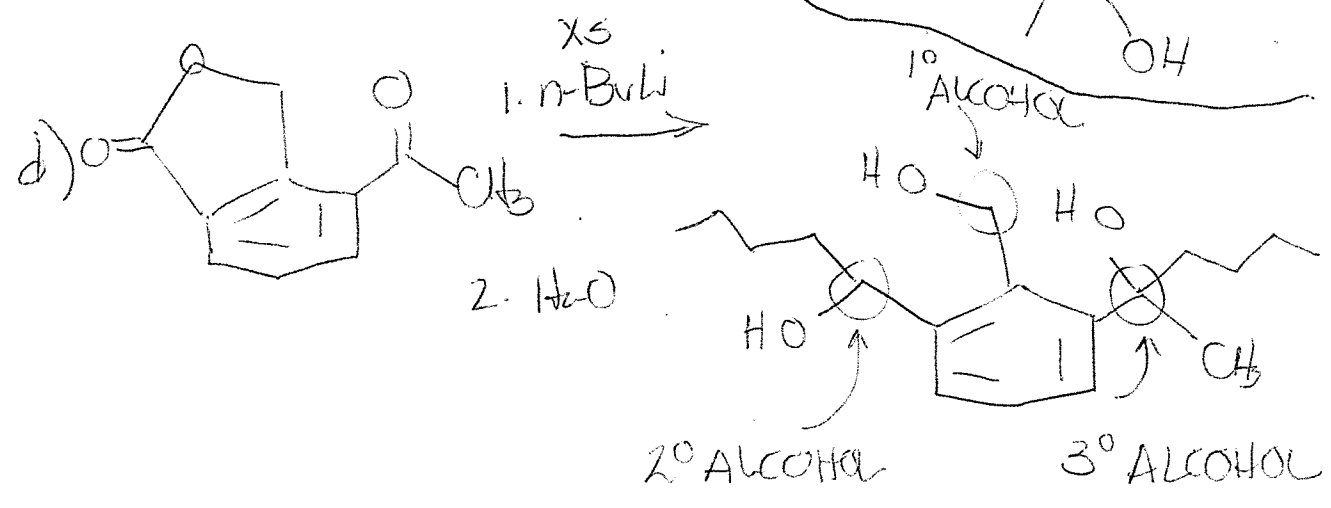
Only choices b and d remain at this stage.  $\text{NaBH}_4$  reacted w/ either b or d will only react with the ketone (to give a  $2^\circ$  alcohol) but the esters are unreactive w/  $\text{NaBH}_4$ .

Reaction of b with 2 equivalents of n-butyl lithium will give a  $3^\circ$  alcohol and a carboxylic acid in the product. No other alcohols.

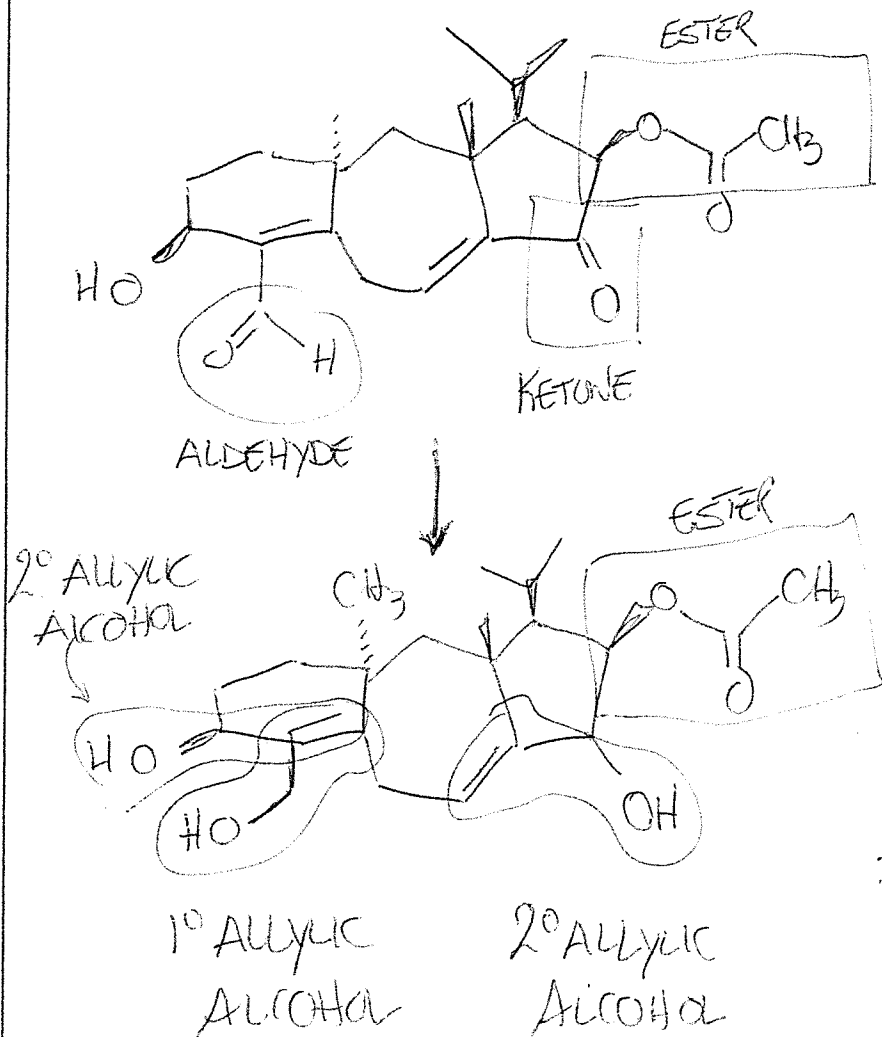
c. (cont'd)



(B)



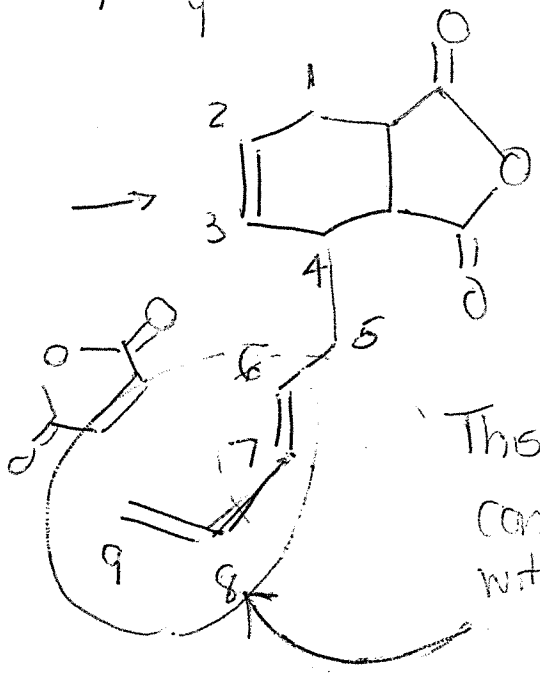
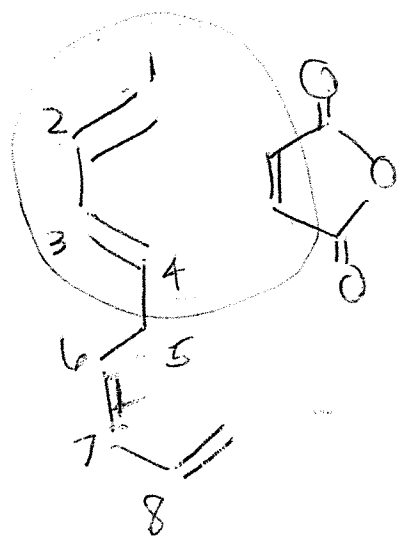
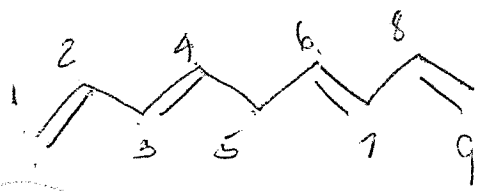
9.  $\text{NaBH}_4, \text{CH}_3\text{OH}$  will react with aldehydes and ketones but not esters and carboxylic acids.



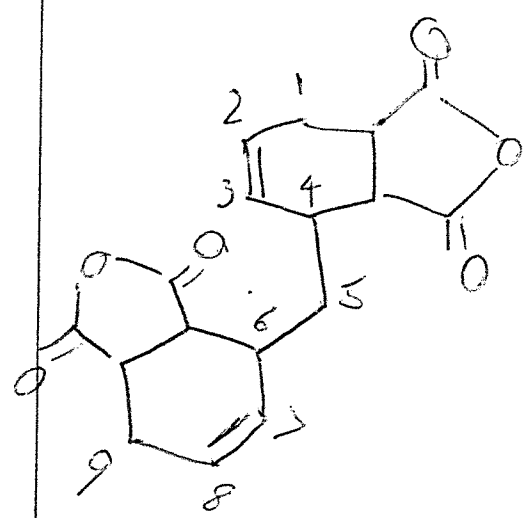
TWO  $2^\circ$  ALLYLIC ALCOHOLS  
ONE  $1^\circ$  ALLYLIC ALCOHOL  
ONE ESTER

(D)

10. 1,3,6,8-nona-tetra-ene

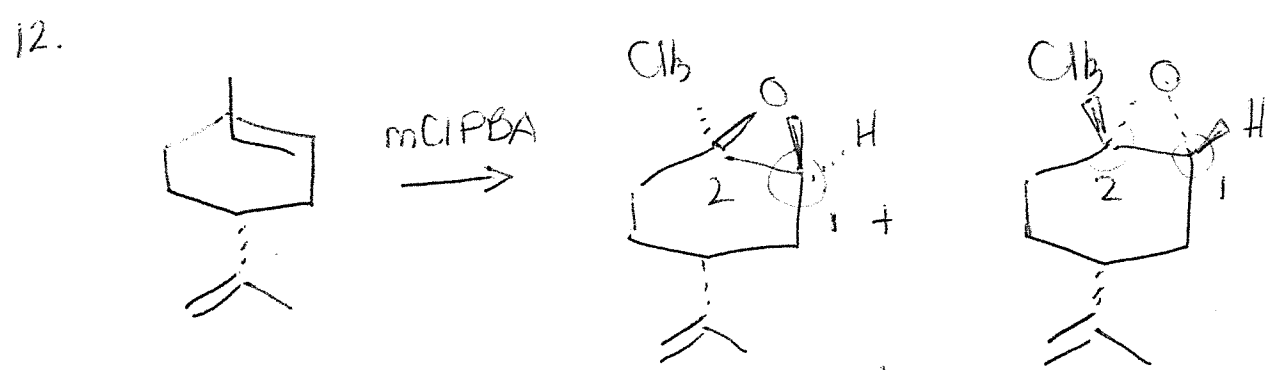
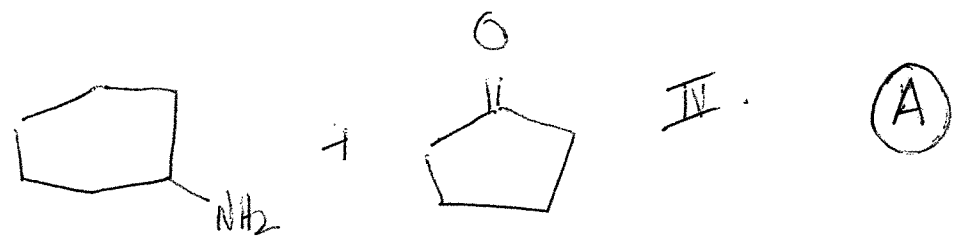
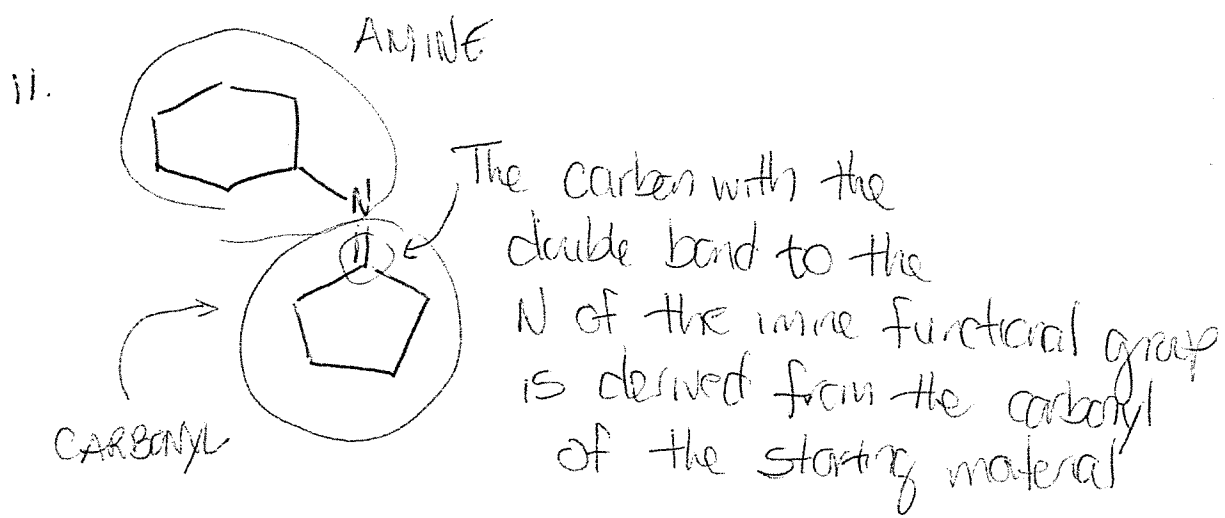


This diene can then react with the



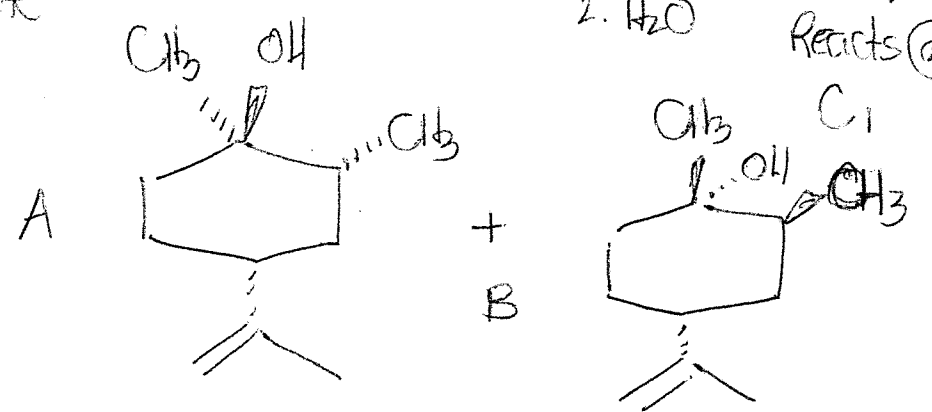
This structure corresponds to choice (C)



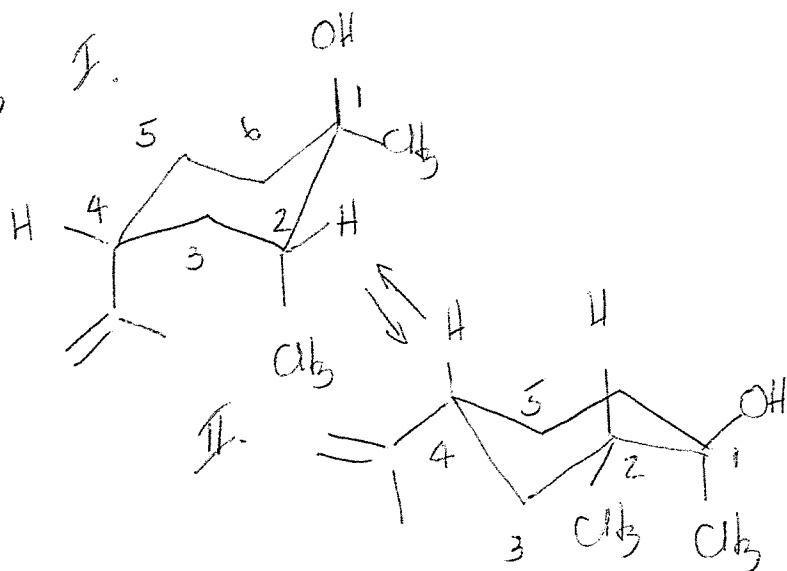
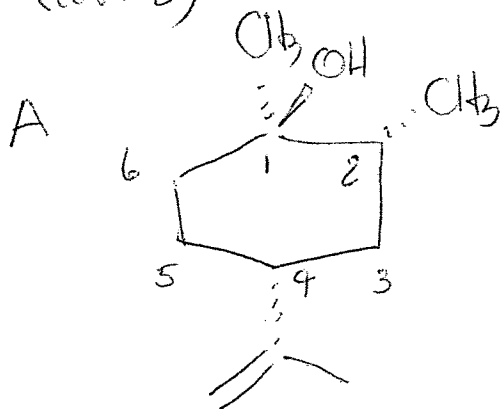


$\text{CH}_3^-$  reacts @  $\text{C}_1$  (less substituted) from opposite side of epoxide

1.  $\text{CH}_3\text{MgBr}$  ( $\text{S}_{\text{N}}2$ )  
2.  $\text{H}_2\text{O}$   
Reacts @



12. (CONT'D)



These are the two possible chair conformations of A

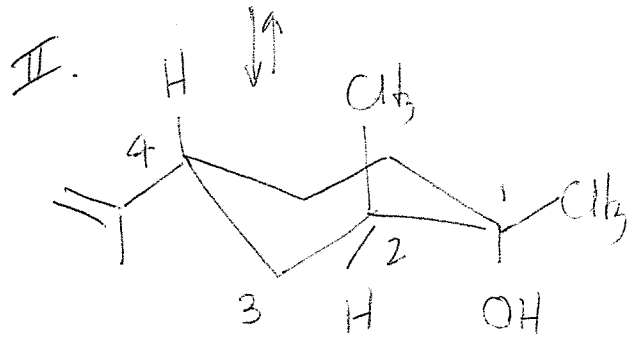
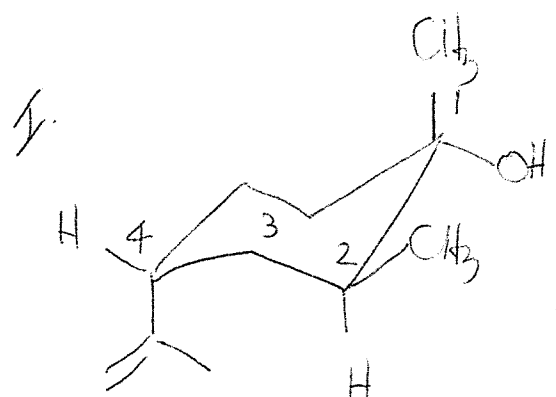
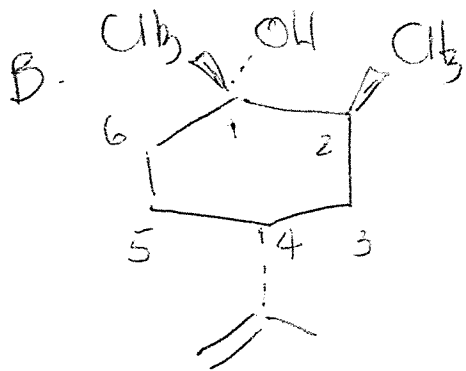
- I.
- |                       |                |
|-----------------------|----------------|
| AXIAL OH              | C <sub>1</sub> |
| EQ CH <sub>3</sub>    | C <sub>1</sub> |
| AXIAL CH <sub>3</sub> | C <sub>2</sub> |
| AXIAL ISOPROPENYL     | C <sub>4</sub> |

MORE STABLE THAN A-I

- II.
- |                       |                |
|-----------------------|----------------|
| AXIAL CH <sub>3</sub> | C <sub>1</sub> |
| EQ OH                 | C <sub>1</sub> |
| EQ CH <sub>3</sub>    | C <sub>2</sub> |
| EQ ISOPROPENYL        | C <sub>4</sub> |

Corresponds to choice d

12. (CONT'D)



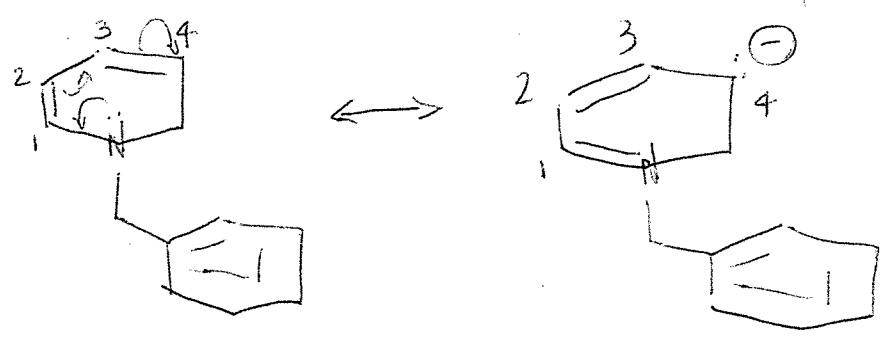
I. Ax  $\text{CH}_3$   
 Eq OH  
 Eq  $\text{CH}_3$   
 Ax ISOPROPENYL

II. Eq  $\text{CH}_3$   
 Ax OH  
 Ax  $\text{CH}_3$   
 Eq ISOPROPENYL

(D)

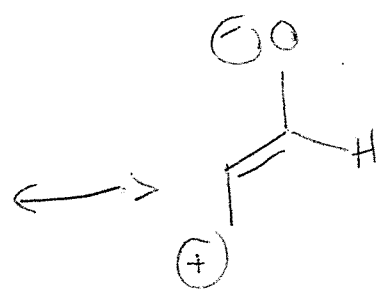
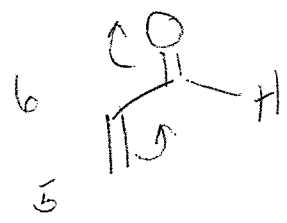
A-II has 3 Eq SUBSTITUENTS (more stable)  
 relative to B-I, B-II or A-I.

13.



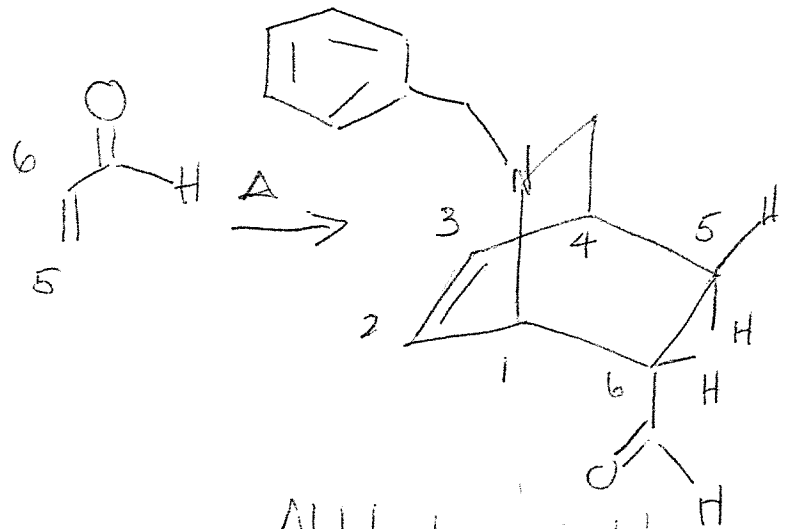
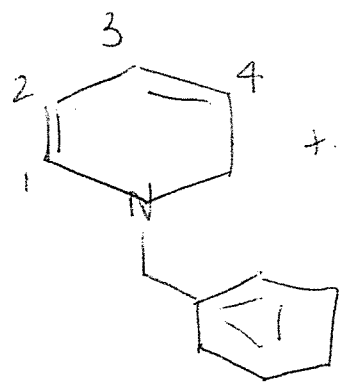
$\text{C}_4$  is most  $\ominus$  carbon on diene

B. (cont'd)



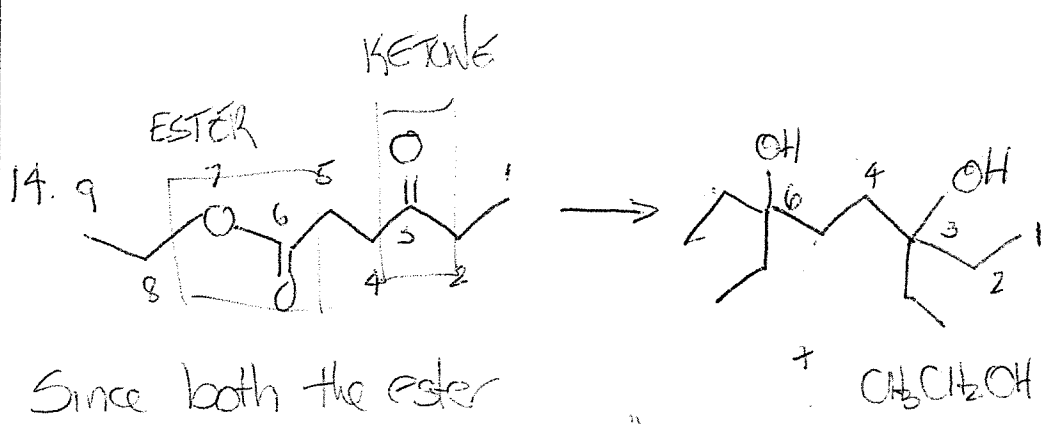
C<sub>5</sub> carbon is most  
⊕ carbon of  
dienophile

C<sub>4</sub> of d reacts  
with C<sub>5</sub> of dienophile  
to give the major  
product of the  
reaction



Aldehyde substituent  
is down (ENDO) away  
from the bridge

I. (A)

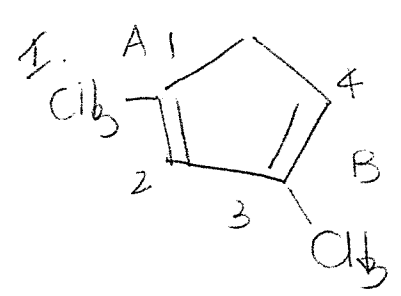


Since both the ester and the ketone react, cannot be  $\text{NaBH}_4$

"New"  $-\text{CH}_2\text{CH}_3$  group "added" to  $\text{C}_3$  (ketone) and two new  $-\text{CH}_2\text{CH}_3$  groups added/substituted @  $\text{C}_6$   
 Must be GRIGNARD ( $\text{CH}_3\text{CH}_2^-$ ) nucleophile (III)

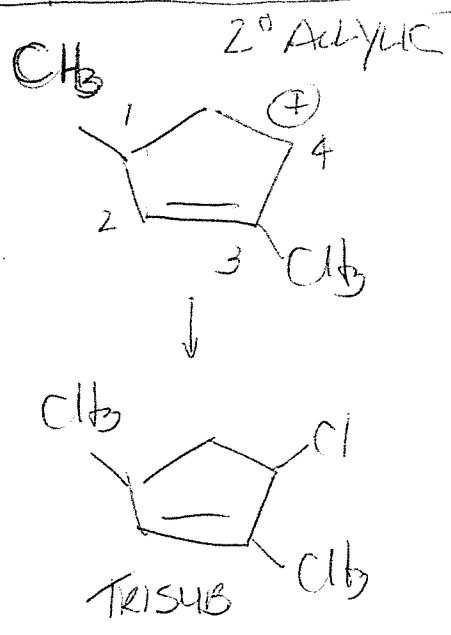
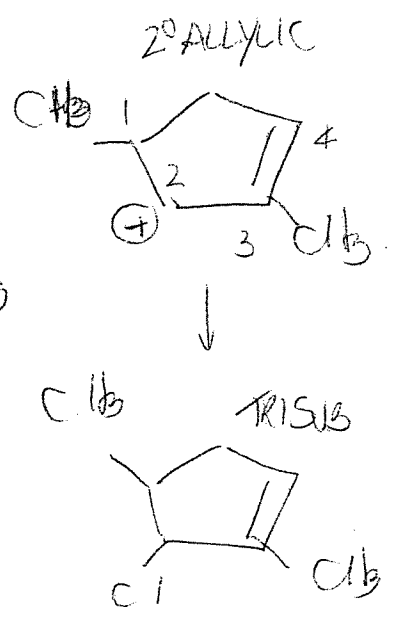
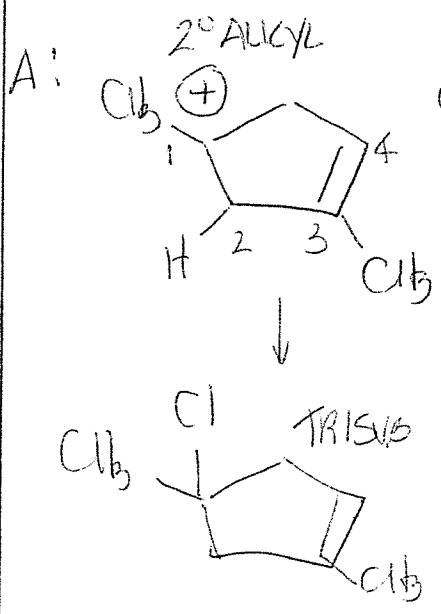
(A)

15.

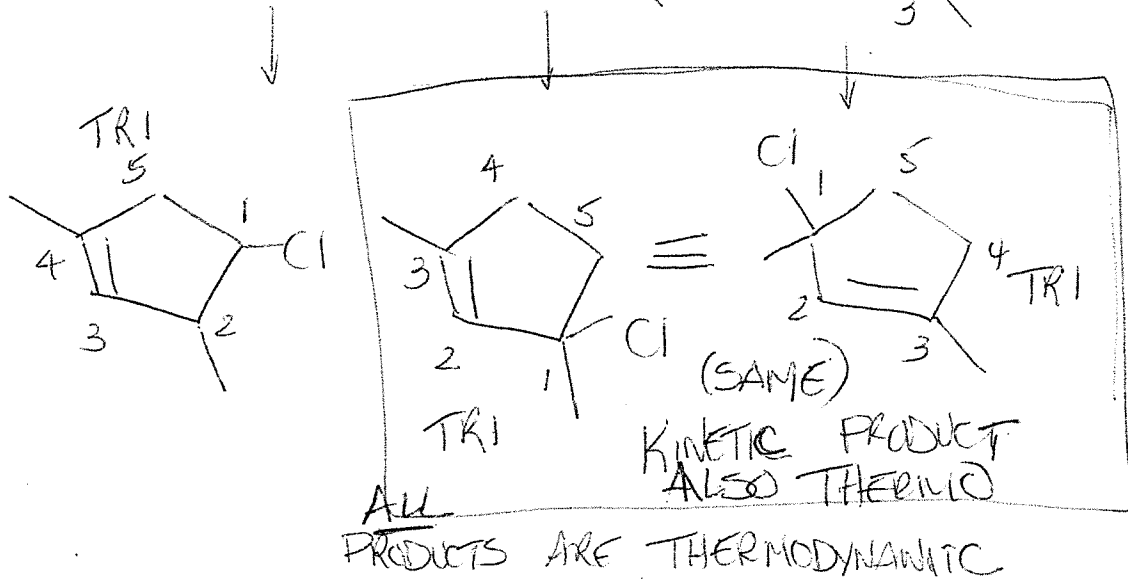
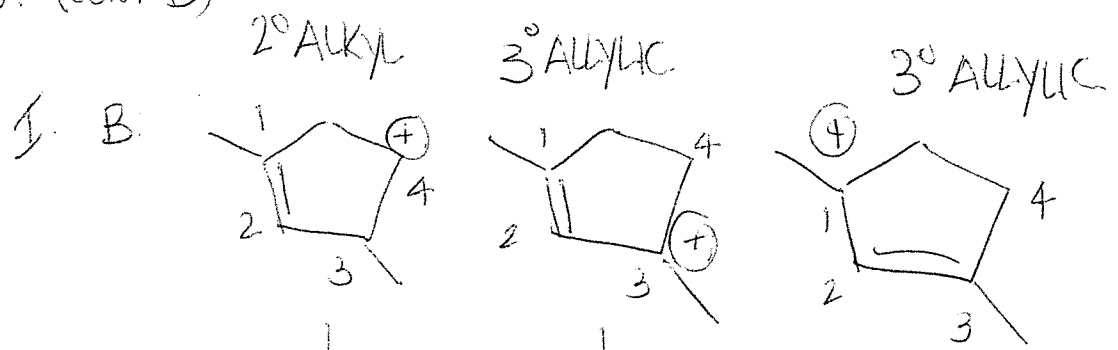


1 eq equiv HCl

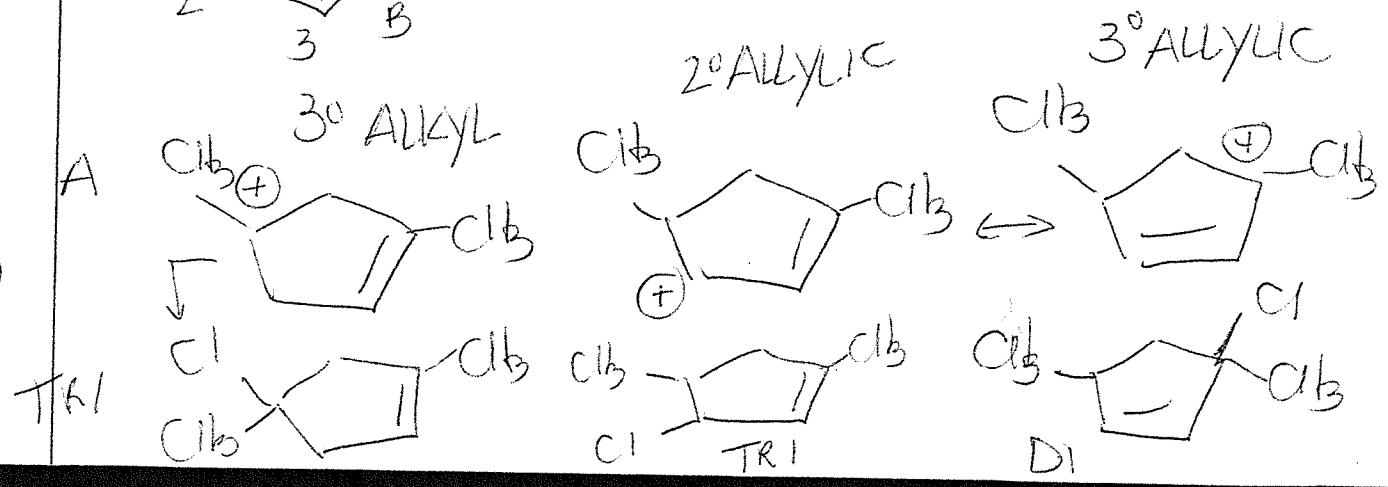
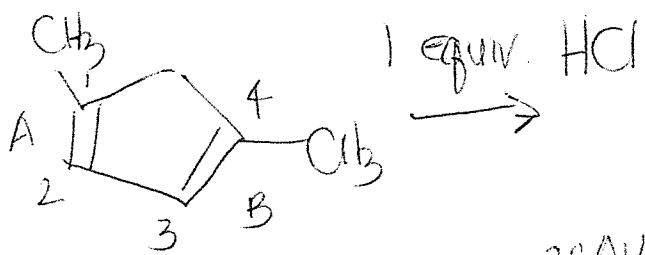
Check all possible  $\text{C}^+$  (and resonance forms) for stability to determine KINETIC PRODUCT(S)  
 Check all possible sub of alkene for THERMO



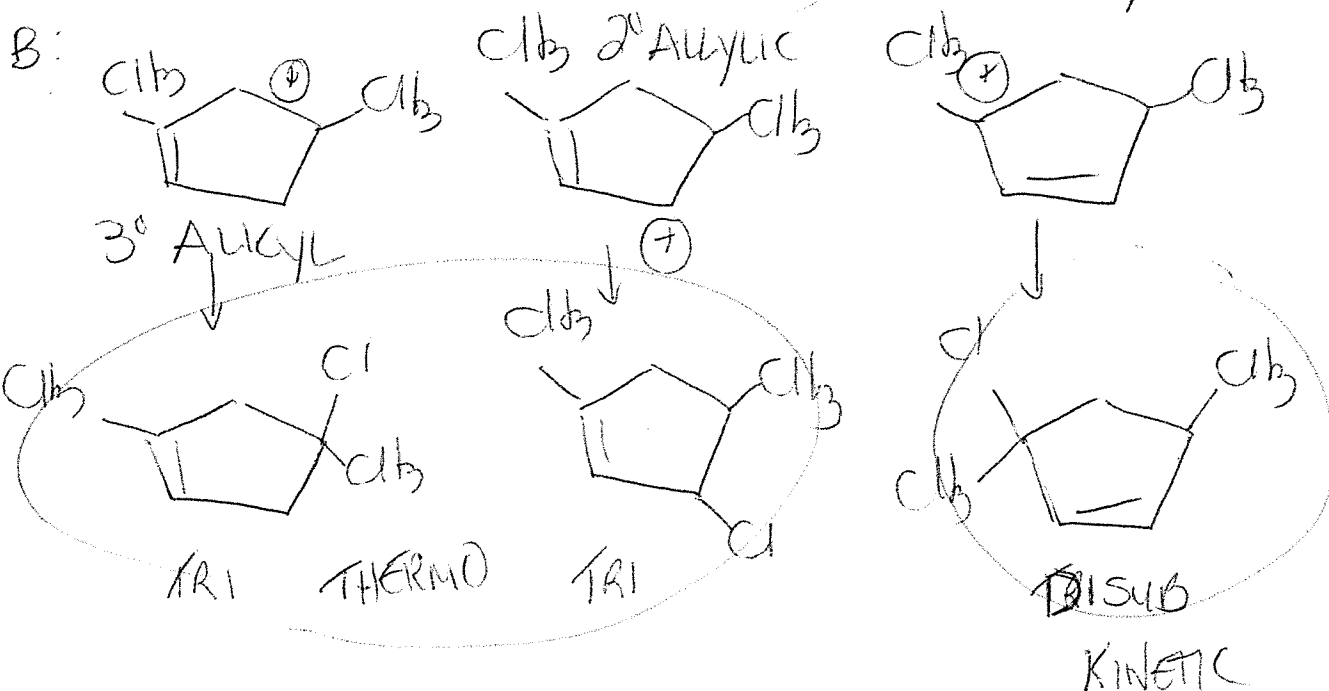
15. (CONT'D)



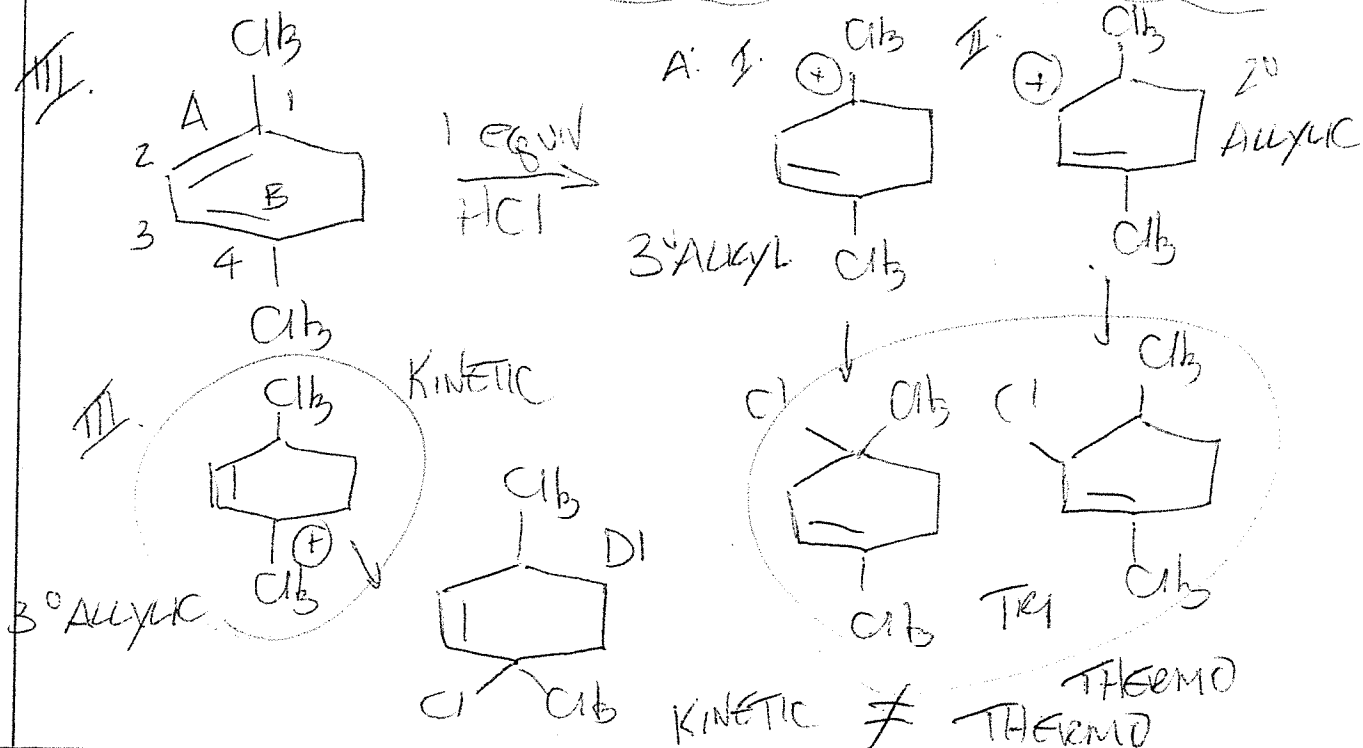
II.



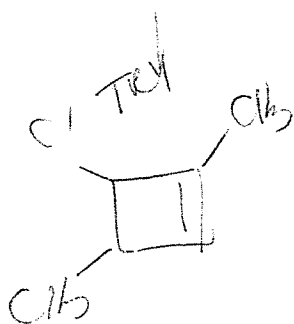
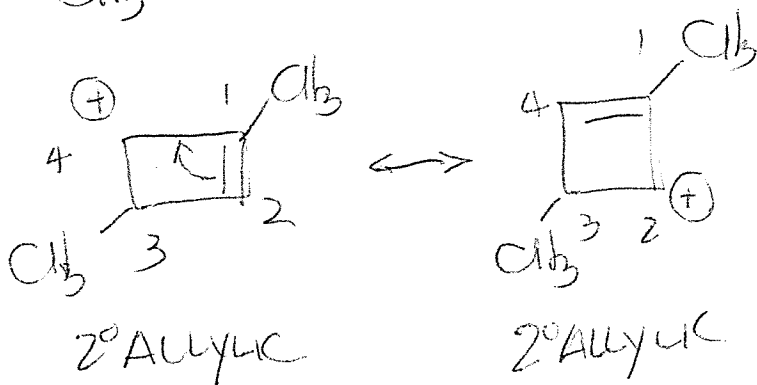
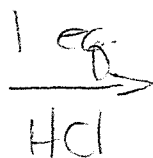
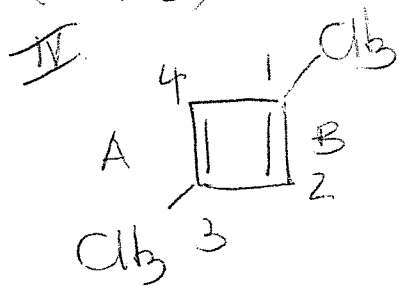
15. (CONT'D) (SAME AS B)



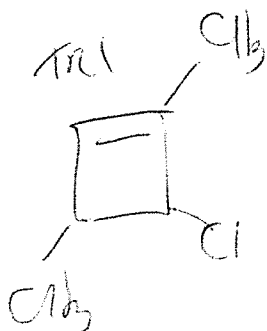
3° ALLYLIC GIVES KINETIC  
ALL TRISUB PRODUCTS GIVE THERMO  
 KINETIC PRODUCTS ≠ THERMO PRODUCTS



15. (CONT'D)

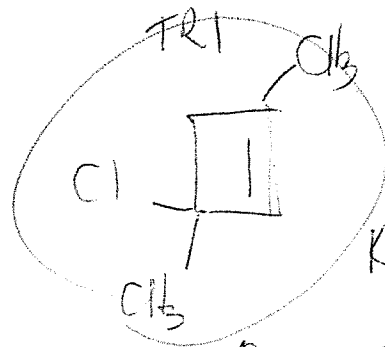


THERMO



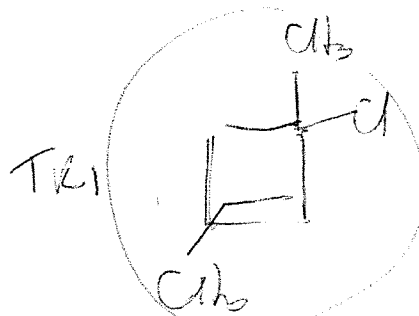
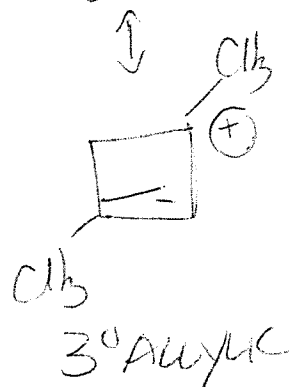
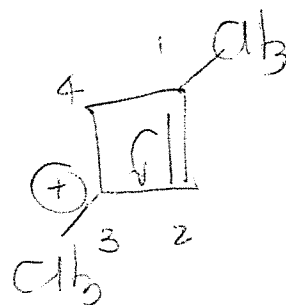
I & II

(A)



KINETIC  
+  
THERMO

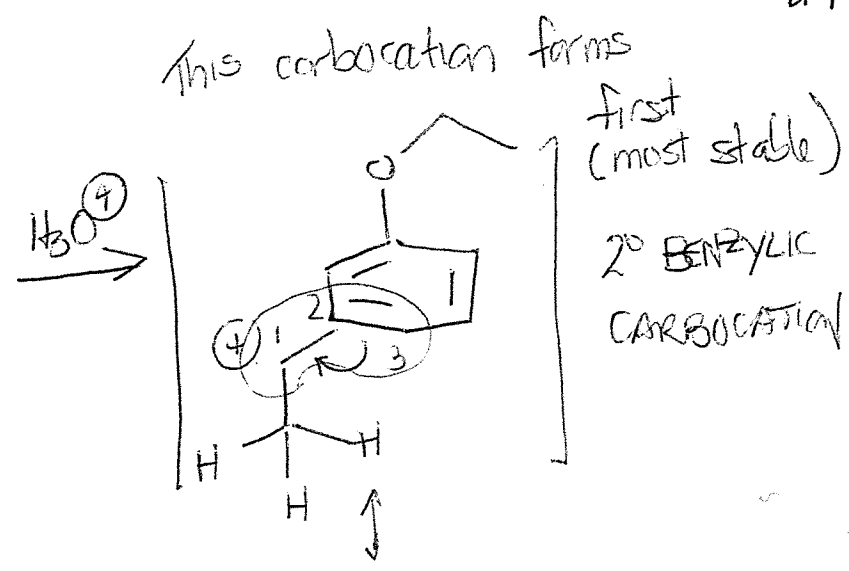
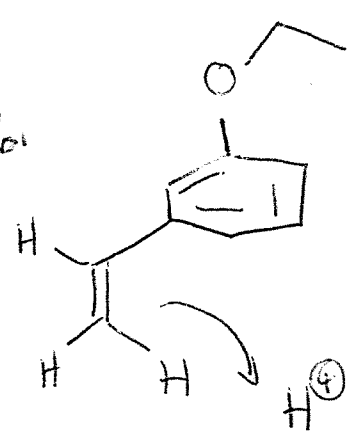
3° ALLYLIC



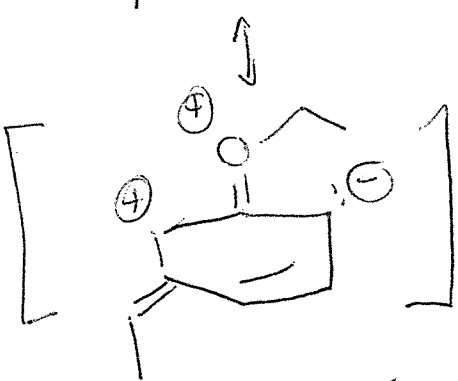
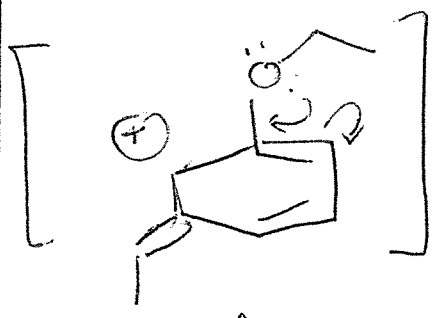
KINETIC  
+  
THERM



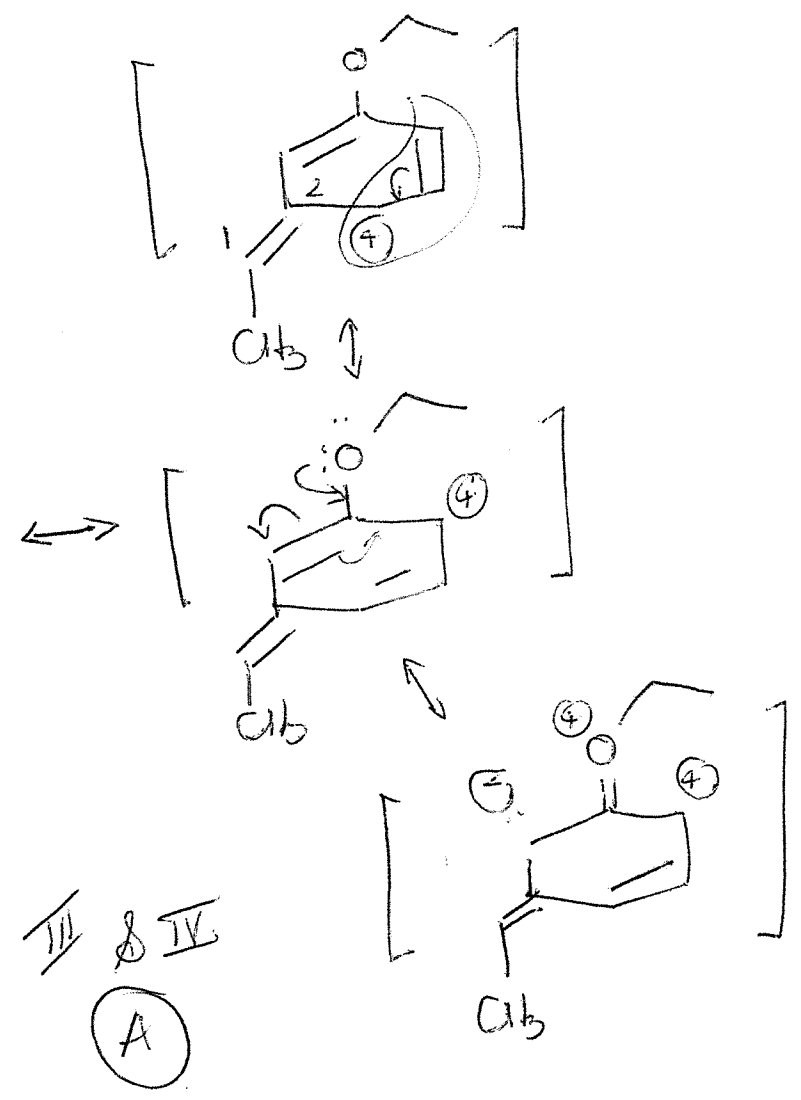
1/6.



corresponds to III.

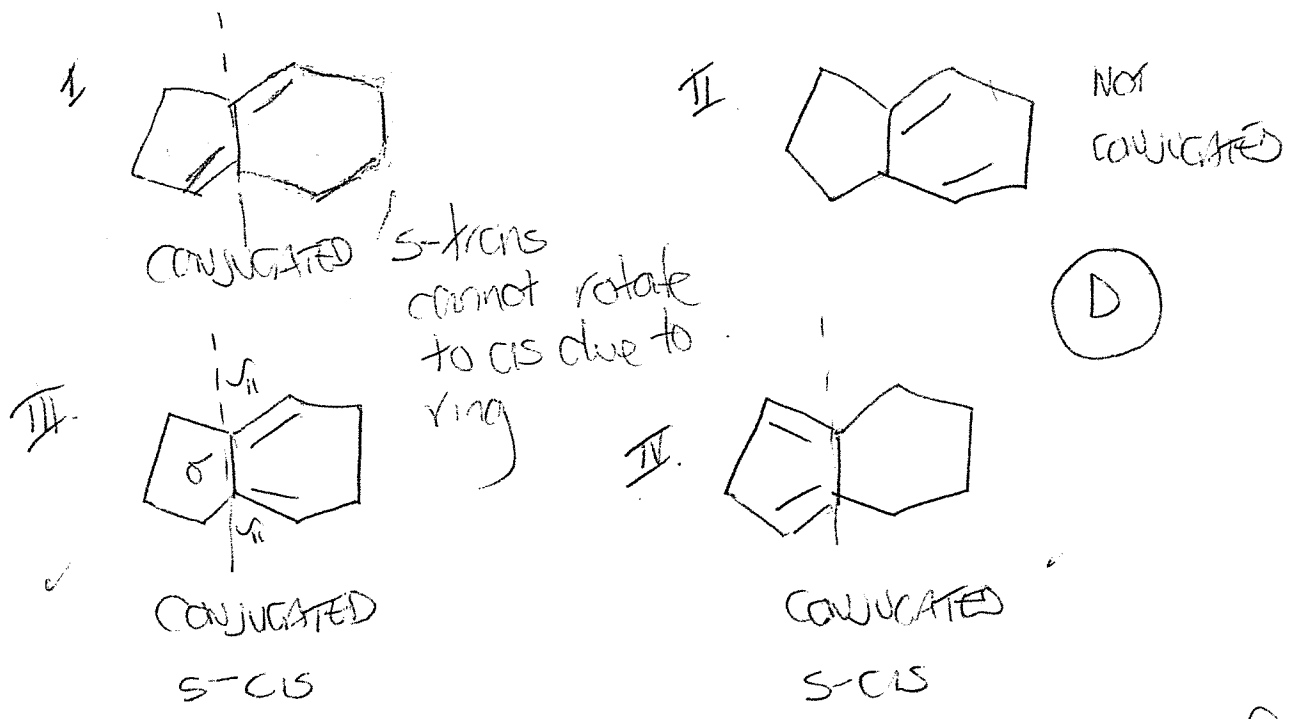


Corresponds to IV.

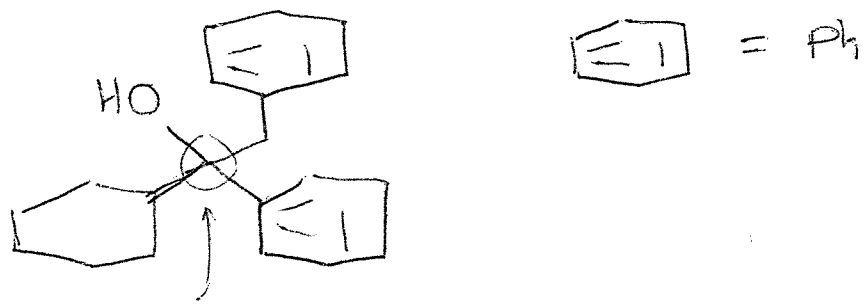


III & IV  
(A)

17. Diel-Alder reaction requires diene adopts s-cis conformation and the diene be CONJUGATED

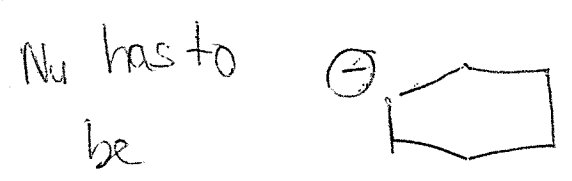
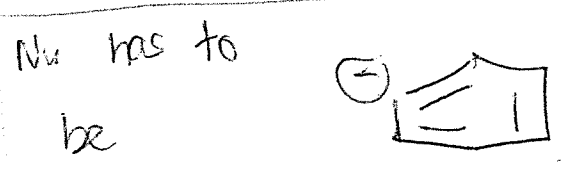
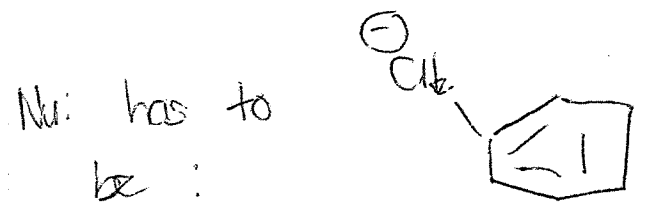
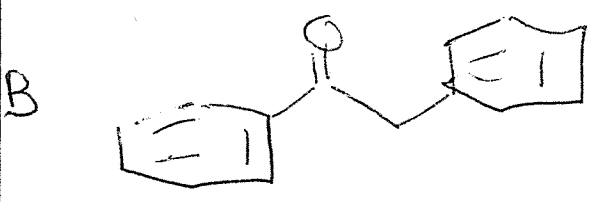
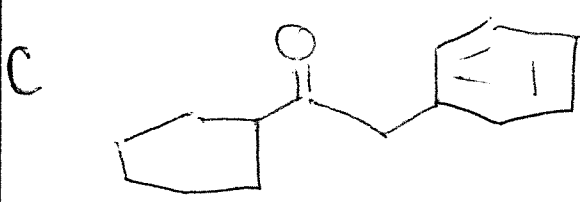
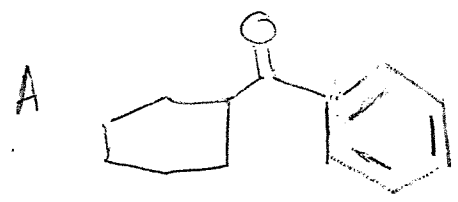


18.



Carbon bonded to OH in product is derived from carbonyl of starting material

18. (CONT'D)



These are the three possible carbonyl starting materials.  
(D is not an option)

The Nu needed to give the product shown depends on which carbonyl you start with  
with  
(H<sup>-</sup> cannot be Nu)  
for any of these

A + IV

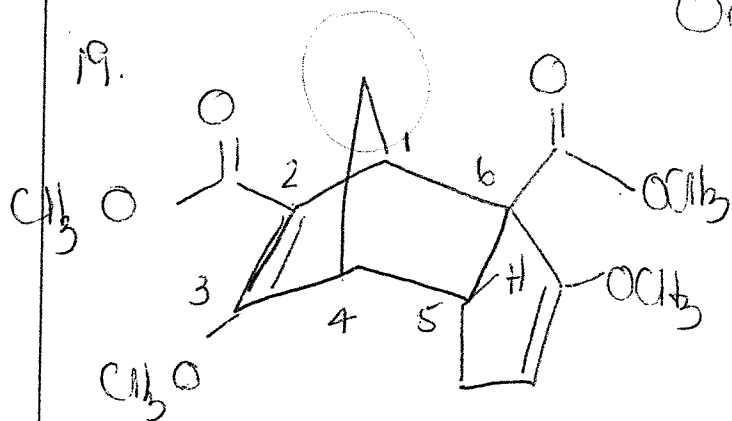
B + IV (B)

C + III

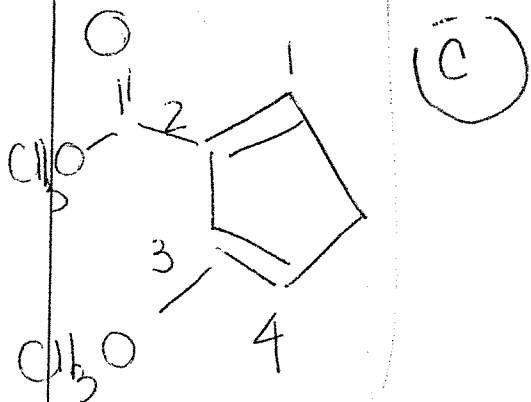
The bridge indicates the diene is part of ring.

One carbon bridge  $\Rightarrow$  5-membered ring

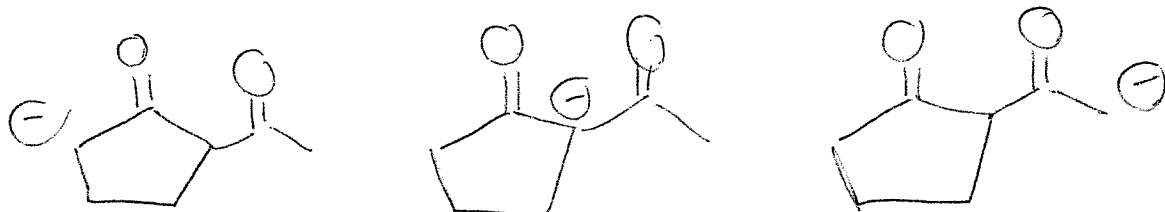
19.



Find cyclohexene and C<sub>2</sub>-C<sub>3</sub> alkene of the cyclohexene. This represents the  $\sigma$  bond of the diene

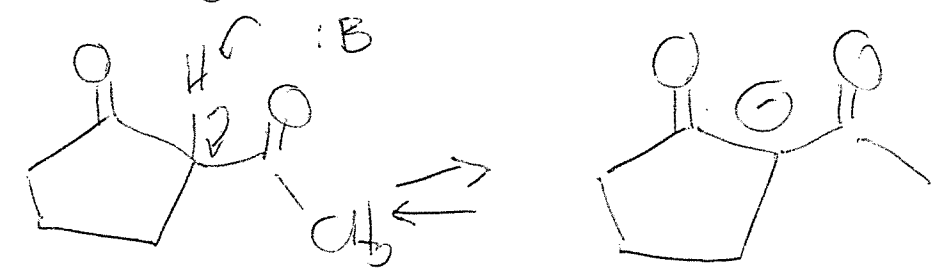


20. There are 3 possible enolates that could be generated from 2-ACP



MOST STABLE due to resonance

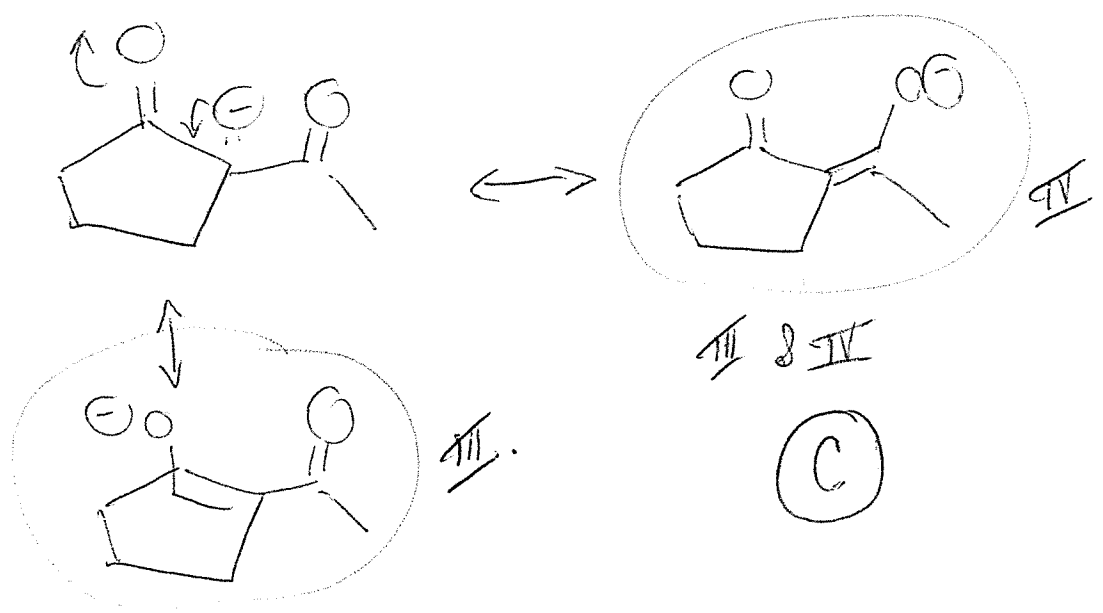
20. (CONT'D) Most acidic hydrogen (lowest pKa) has the most stable conjugate base. In this case, the enolate is the conjugate base.



ACID

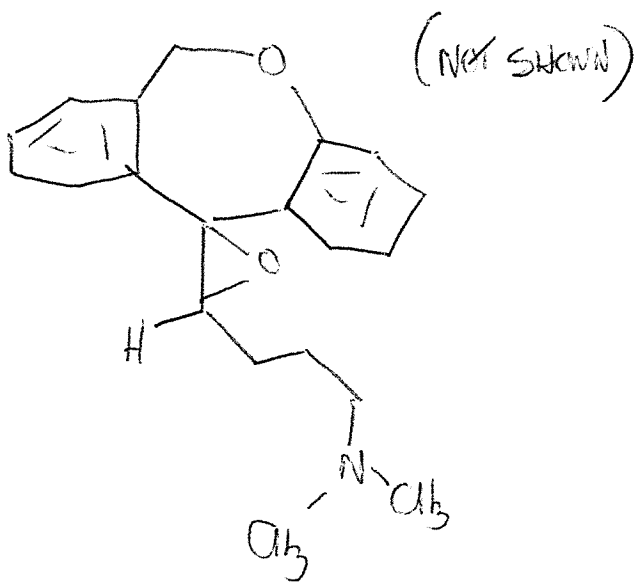
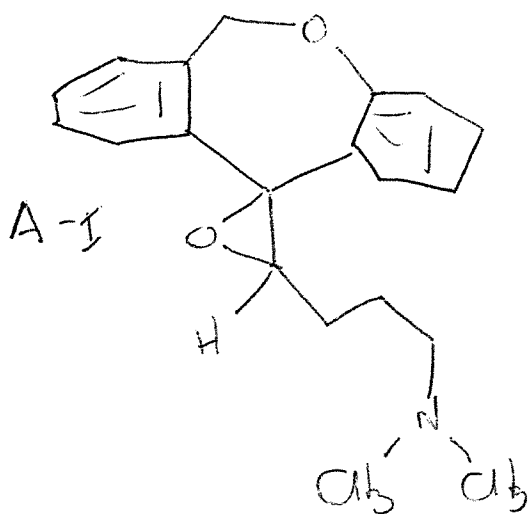
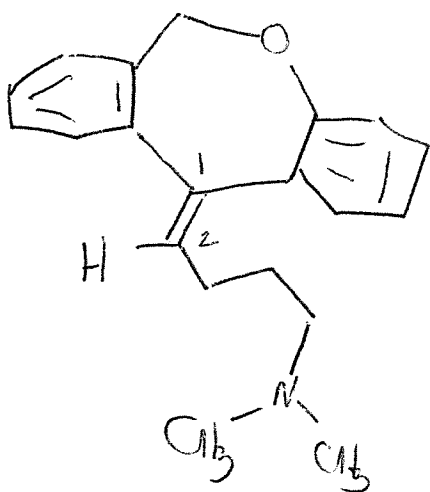
CONJUGATE BASE

This conjugate base is stabilized by resonance more than the other enolates



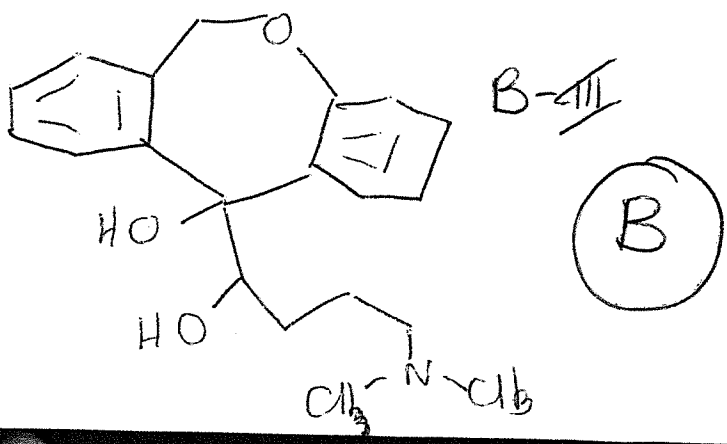
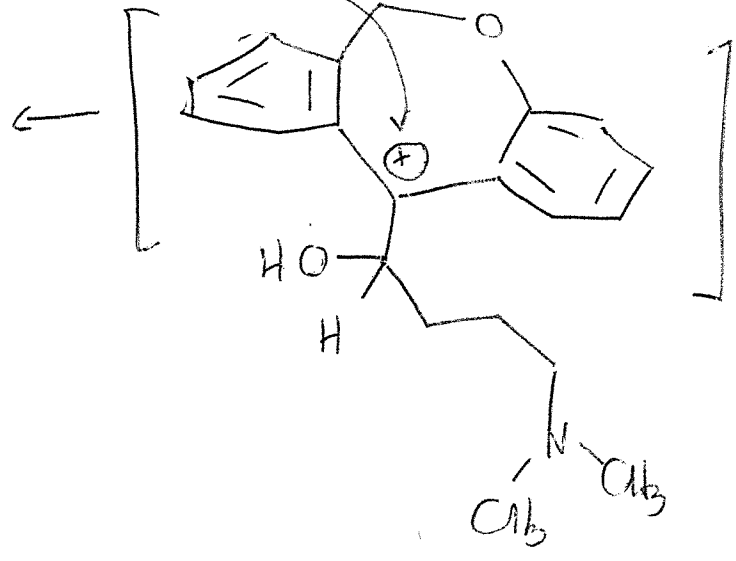
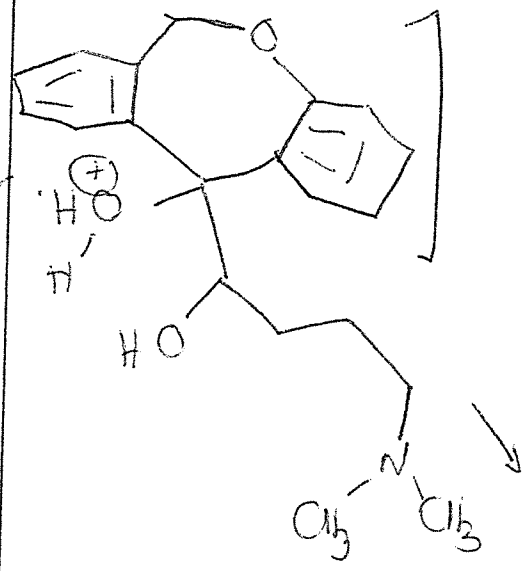
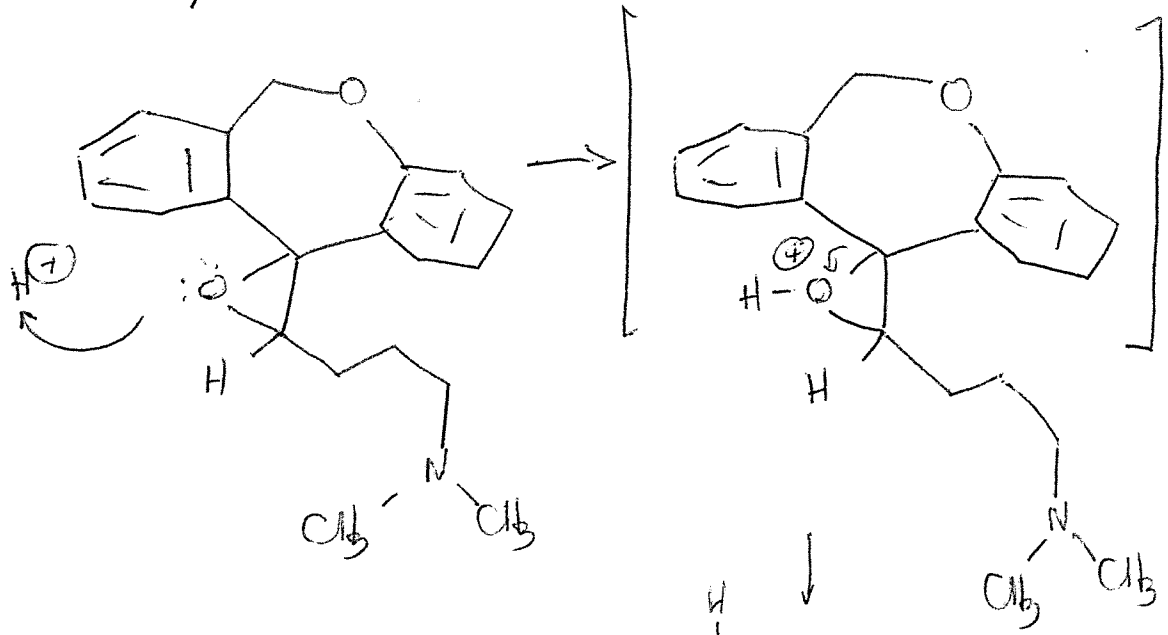
21.

m-CPBA reacts on both sides of the alkene. If bonds of benzene rings are not alkenes and do not react with mCPBA



The epoxide then reacts with water (H<sub>2</sub>O) under acidic conditions via an S<sub>N</sub>1 reaction.

21. (cont'd)





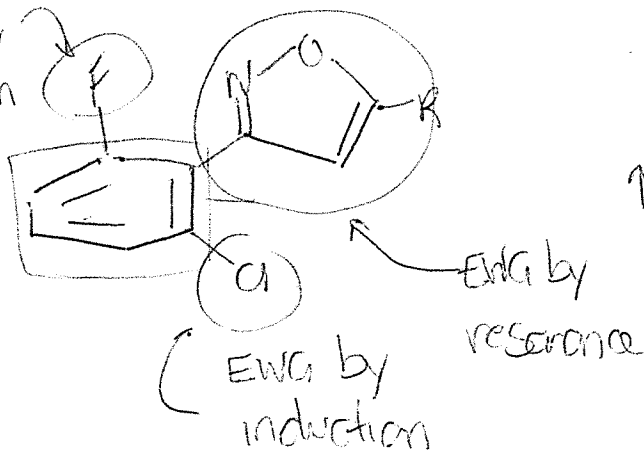
I. TRUE

EDG by resonance

EDG by resonance

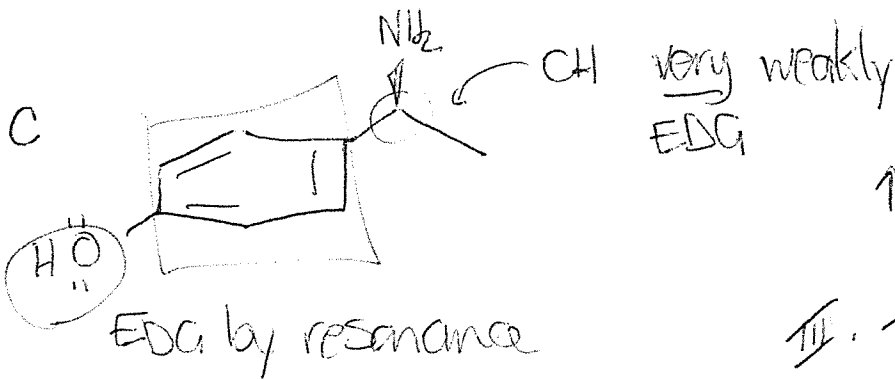
(D)

EWG by induction  
B



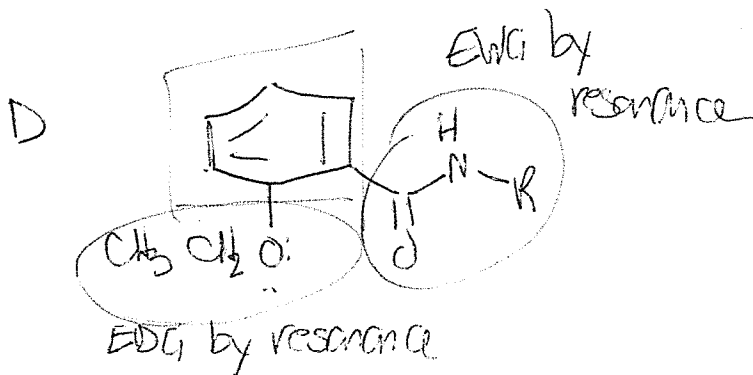
II. TRUE

↑ ⊕ character of ring



↑ ⊖ character of ring

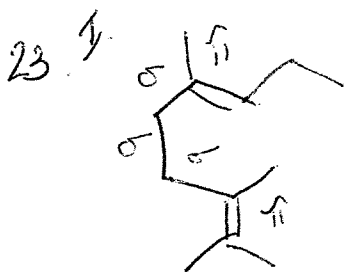
III. TRUE



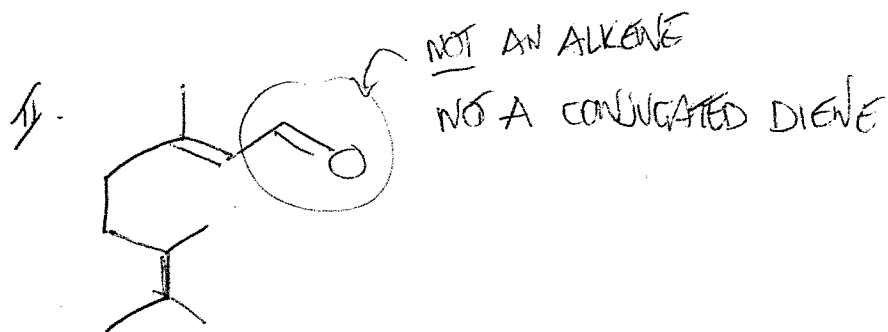
IV. FALSE



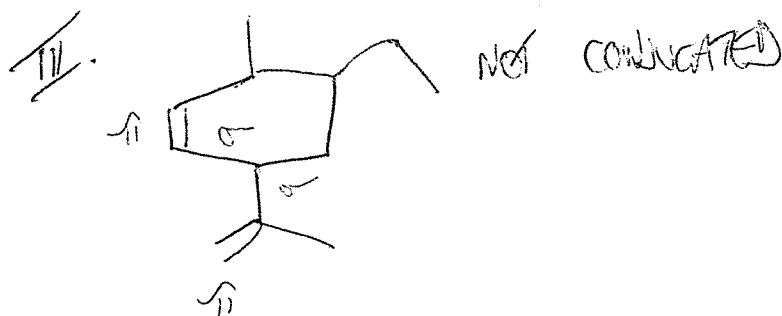
CONJUGATED DIENE: TWO ALKENES SEPARATED BY ONE  $\sigma$  BOND



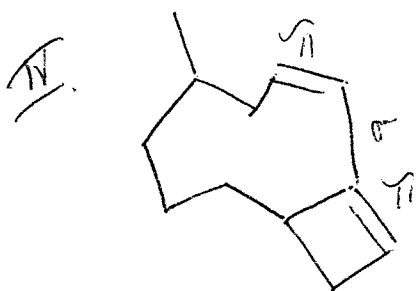
NOT CONJUGATED



NOT AN ALKENE  
NOT A CONJUGATED DIENE



NOT CONJUGATED

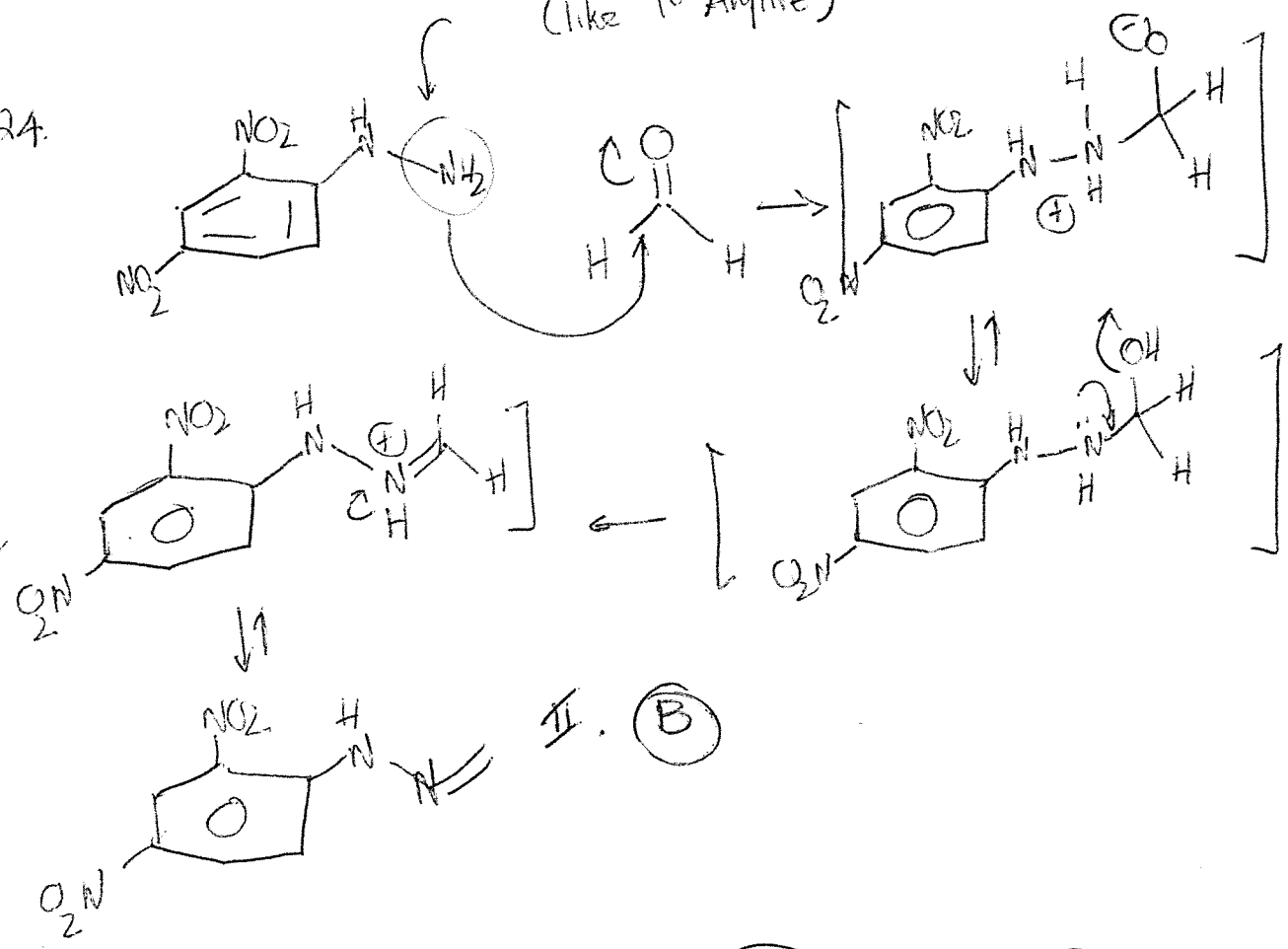


CONJUGATED  
DIENE

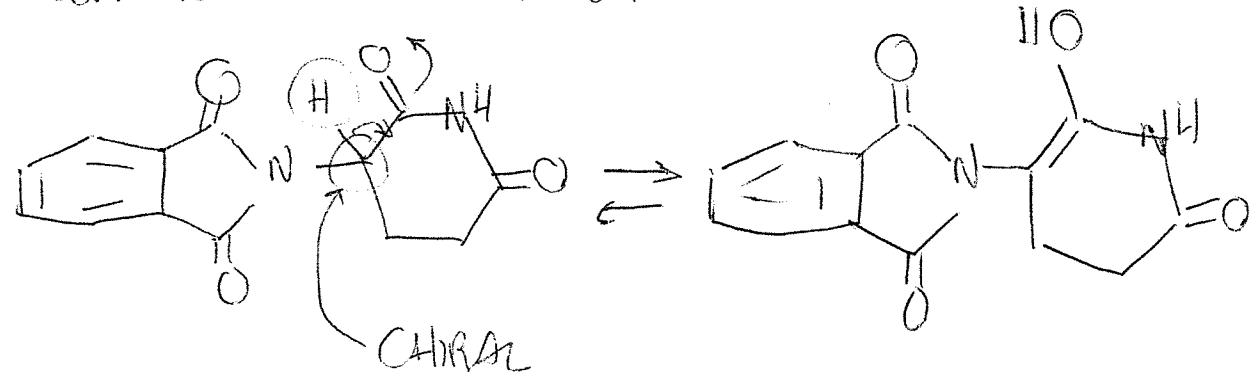
(E)

This NH<sub>2</sub> is the Nu  
(like 10 Amide)

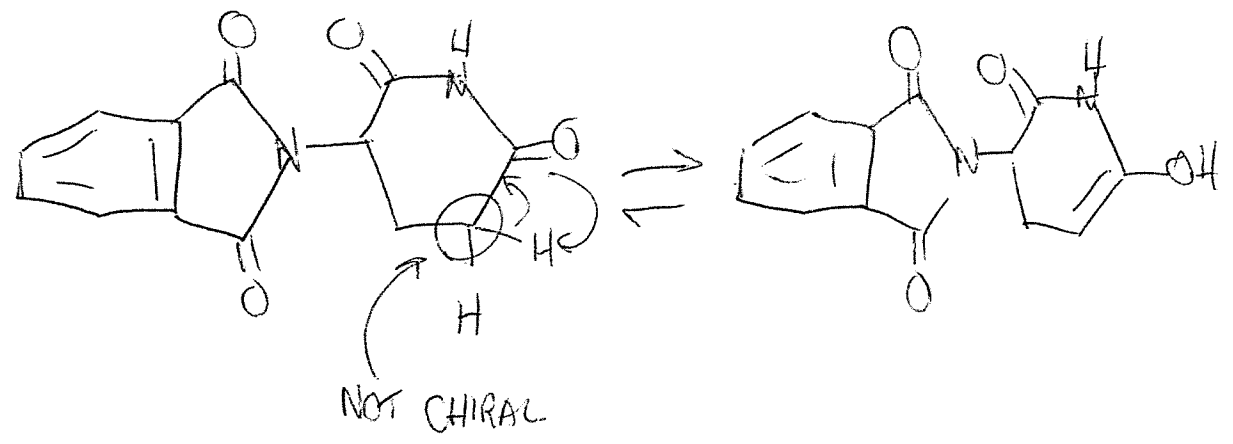
24.



25. There are two  $\alpha$ -carbons of thalidomide that can tautomerize to an enol



25. (CONT'D)



The R-enantiomer tautomerizes to enol. The  $sp^3$  chiral carbon is destroyed in this process. When the enol goes back to the carbonyl it can go to either R- or S-

