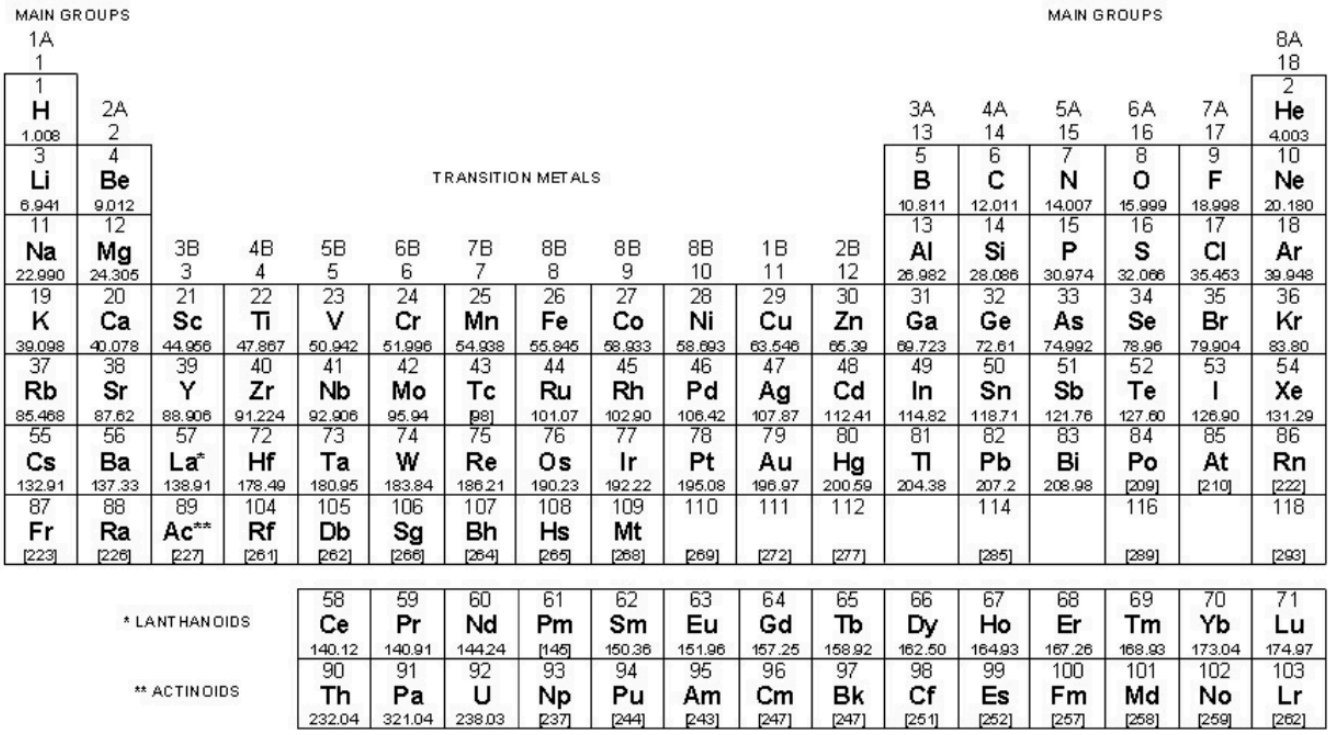
OCI Dr. Nsengiyumva

Practice Final Exam (Key)



MAIN GROUPS 1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	MAIN GROUPS 3A	4A	5A	6A	7A	8A
1 H 1.008							TRANSITION METALS										2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.992	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc [98]	44 Ru 101.07	45 Rh 102.90	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La* 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]	89 Ac** [227]	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [265]	109 Mt [268]	110 [269]	111 [272]	112 [277]		114 [285]		116 [289]		118 [293]

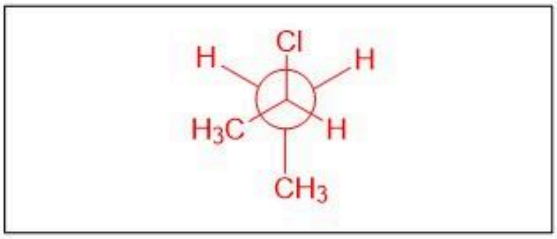
* LANTHANOIDS	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
** ACTINOIDS	90 Th 232.04	91 Pa 321.04	92 U 238.03	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [262]

Problem #	Points	Problem #	Points
Q1	10	Q10	7
Q2	8	Q11	9
Q3	7	Q12	4
Q4	3	Q13	4
Q5	5	Q14	5
Q6	5	Q15	6
Q7	3	Q16	9
Q8	3	Q17	5
Q9	7	Total:	100

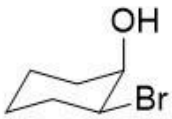
1. (10 points) Draw the Following

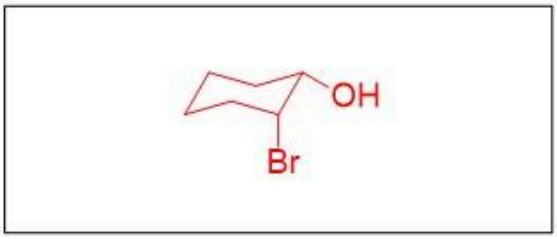
A. Draw a compound with an H-NMR peak ~12 ppm and a pKa < 10.

B. Draw the Newman projection of (S)-2-chlorobutane in which Me and Cl are anti to each other.

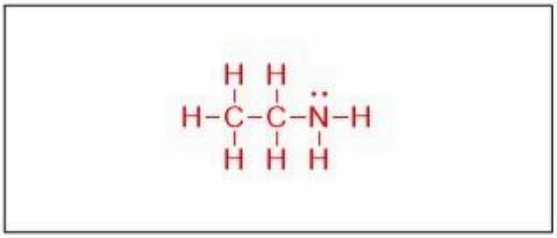


C. Draw the enantiomer of the following chair conformation.

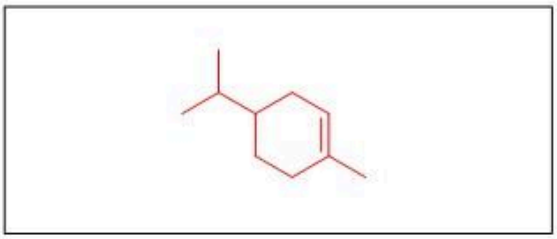




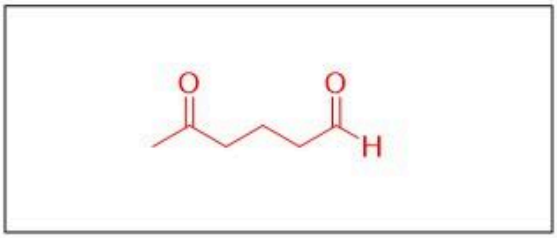
D. Draw the Lewis structure of ethylamine ($CH_3CH_2NH_2$).



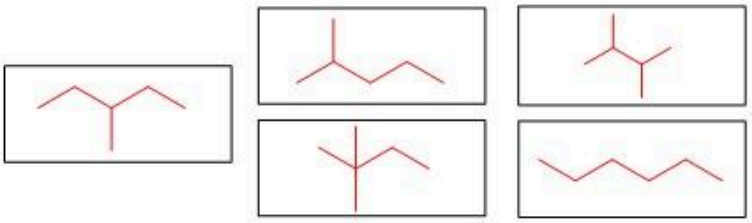
E. Draw 4-isopropyl-1-methylcyclohex-1-ene



F. Draw the product of the reaction between methylcyclopentene and 1) O_3, -78 °C 2) DMS.



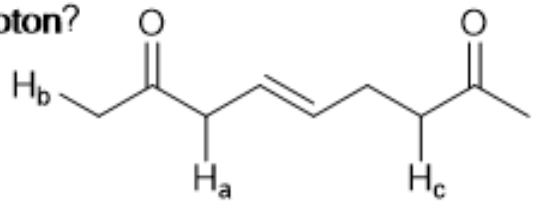
G. Draw all the constitutional isomers of C_6H_{14}.



2. (8 points) **Multiple Choice:** choose the best answer

A. Which of the following is the most **acidic proton**?

(A) H_a (B) H_b (C) H_c

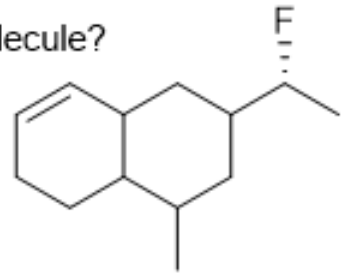


letter

A

B. How many **stereocenters** are in the following molecule?

(A) 1 (B) 3 (C) 4 (D) 5



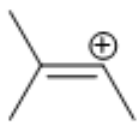
D

C. How many **degrees of saturation** is in the molecule illustrated in **B.**?

(A) 3 (B) 4 (C) 5 (D) 6

A

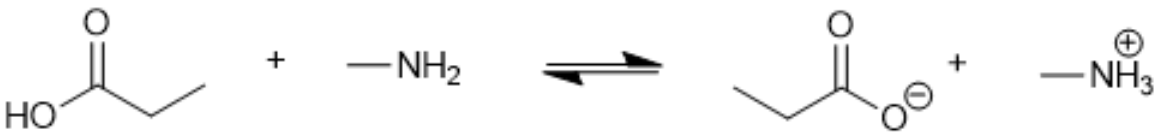
D. Which of the following form of carbocation intermediates is the **least stable**?

(A)  (B)  (C)  (D) 

B

E. Which side of this acid-base reaction is **more favored**?

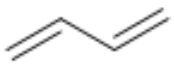
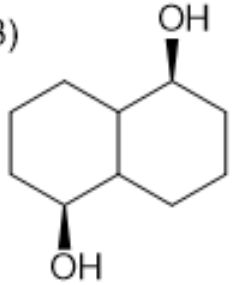
(A) Left (B) Right (C) Neither

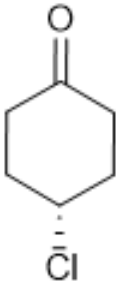


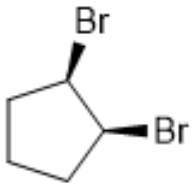
pKa 4.7 10.6

B

F. Which of the following molecule is **chiral**?

(A)  (B) 

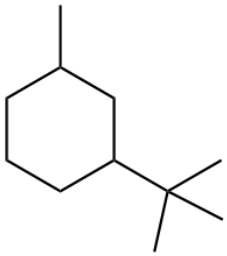
(C) 

(D) 

B

G. Which position is the **-CH_3 group** in for the molecule's preferred chair conformation?

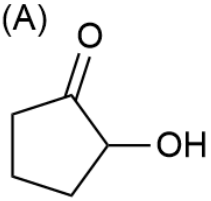
(A) Axial (B) Equitorial (C) Neither



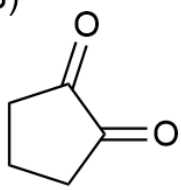
C

H. Which of the following molecules is the major product of reacting **2,3-pentanediol with xs PCC**?

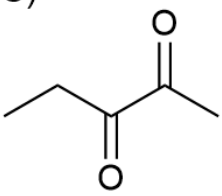
(A)



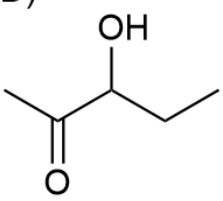
(B)



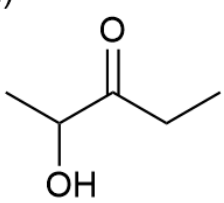
(C)



(D)

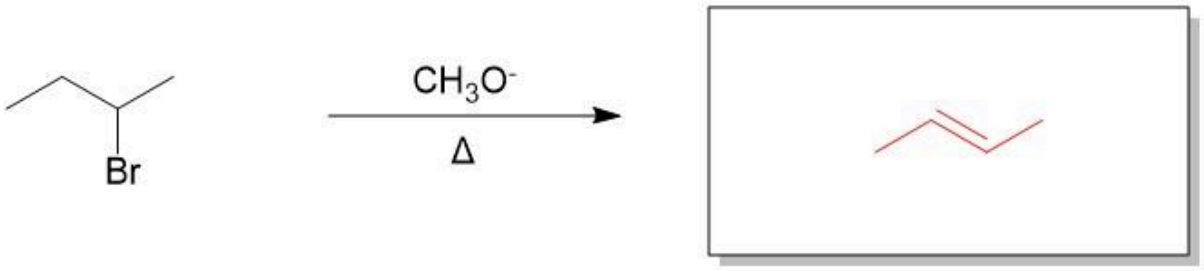


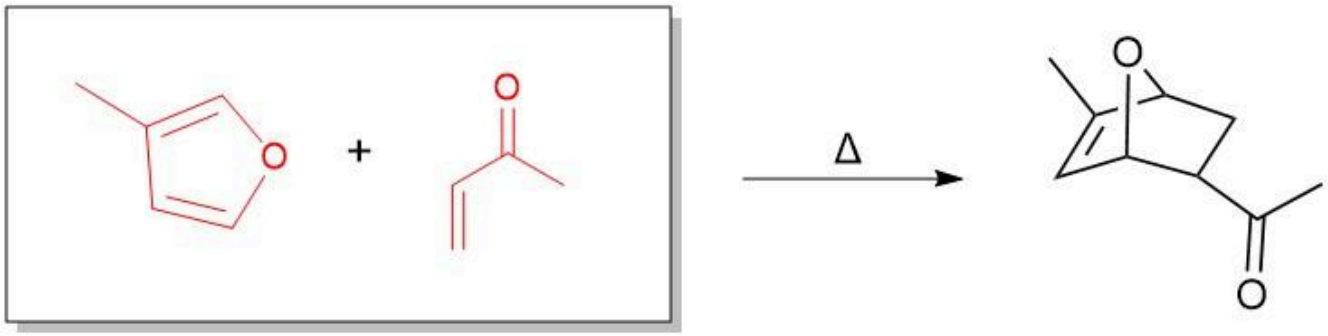
(E)

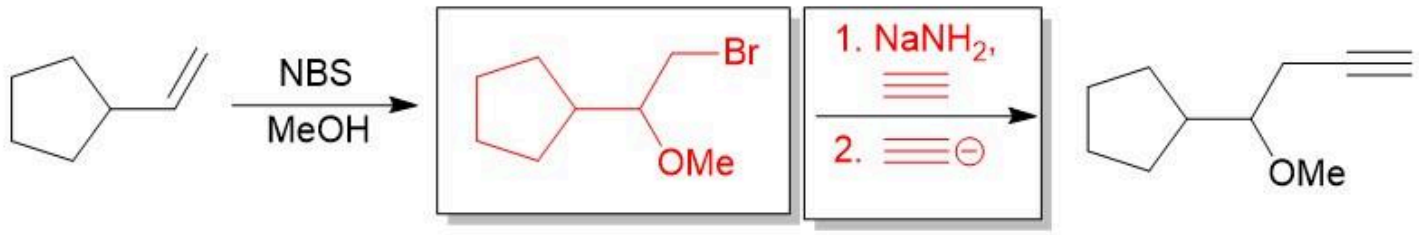


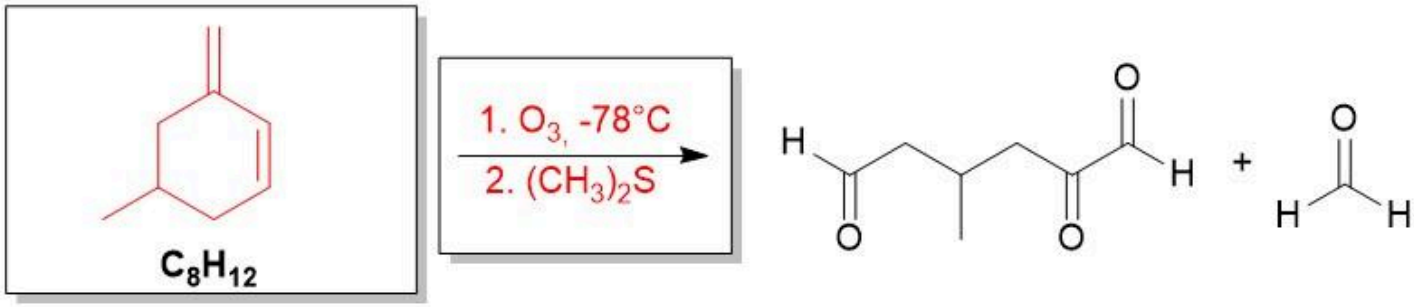
C

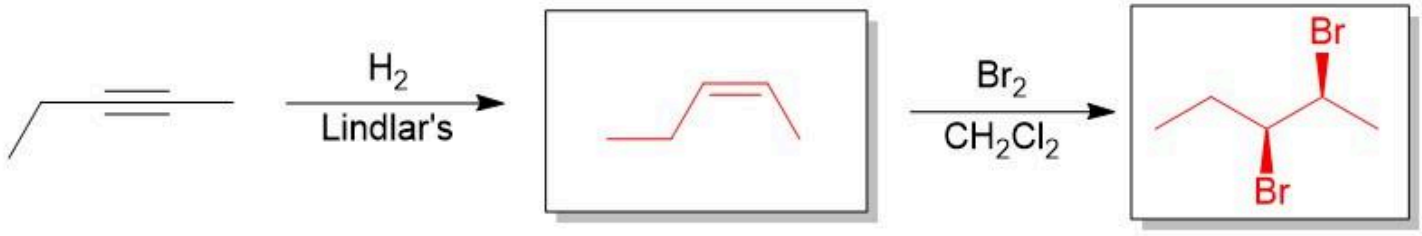
3. (7 points) Fill in the blanks with starting materials or products. Show stereochemistry, where applicable.

A. 

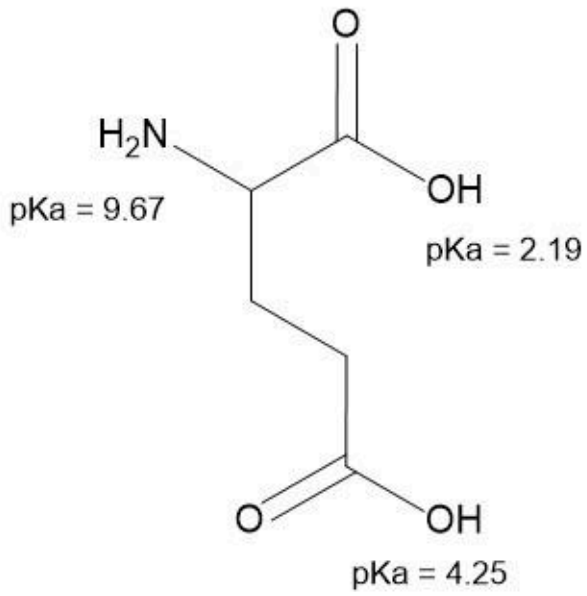
B. 

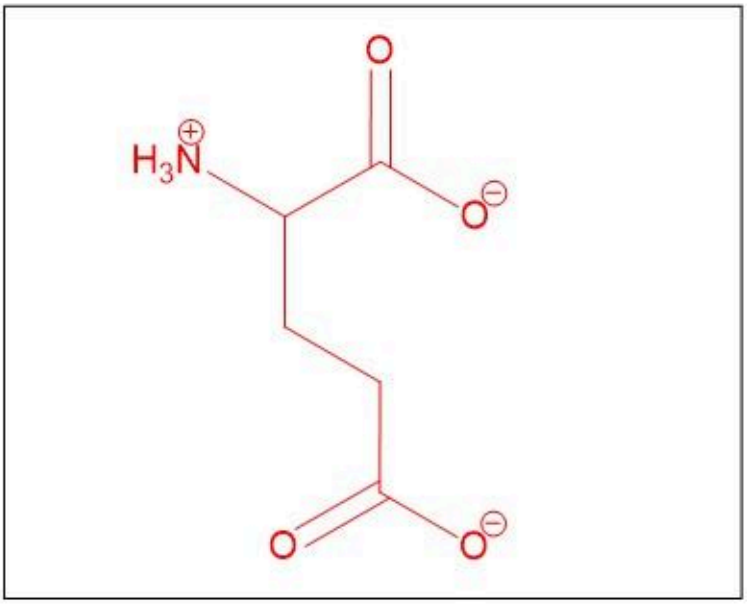
C. 

D. 

E. 

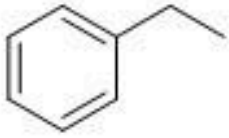
4. (3 points) Glutamic acid is shown below with the pKa values indicated for its most acidic protons. Draw its predominant form at pH = 5.





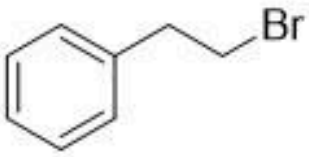
5. (5 points) Write the missing reagents for the following transformations. Be sure to label each step with a number, as they all involve multiple steps.

A.



1. Br_2, hv
2. KOtBu, △

3. HBr, ROOR



B.

1. Br_2, hv
2. NaOMe, △

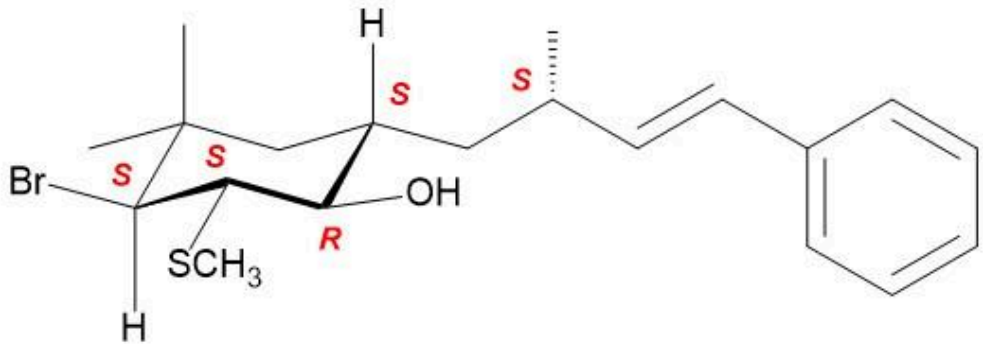
3. Br_2, CH_2Cl_2

C.

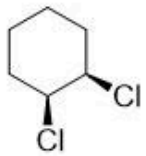
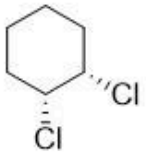
1. NBS, hv

2. NaCN

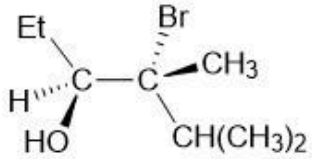
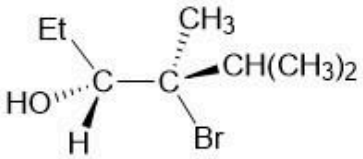
6. (5 points) Show the configuration of each asymmetric carbon in the following molecule (R or S).



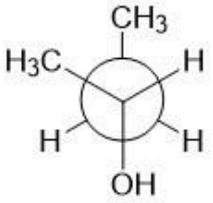
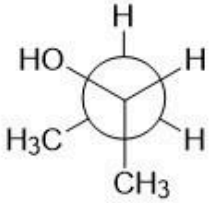
7. (3 points) Idenitfy the following molecule pairs as either constitutional isomers, enantiomers, diastereomers, or identical structures.

A.  and 

Identical (meso)

B.  and 

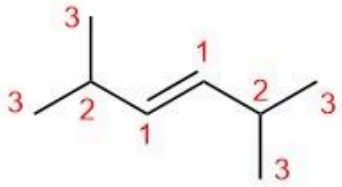
Diastereomers

C.  and 

Enantiomers

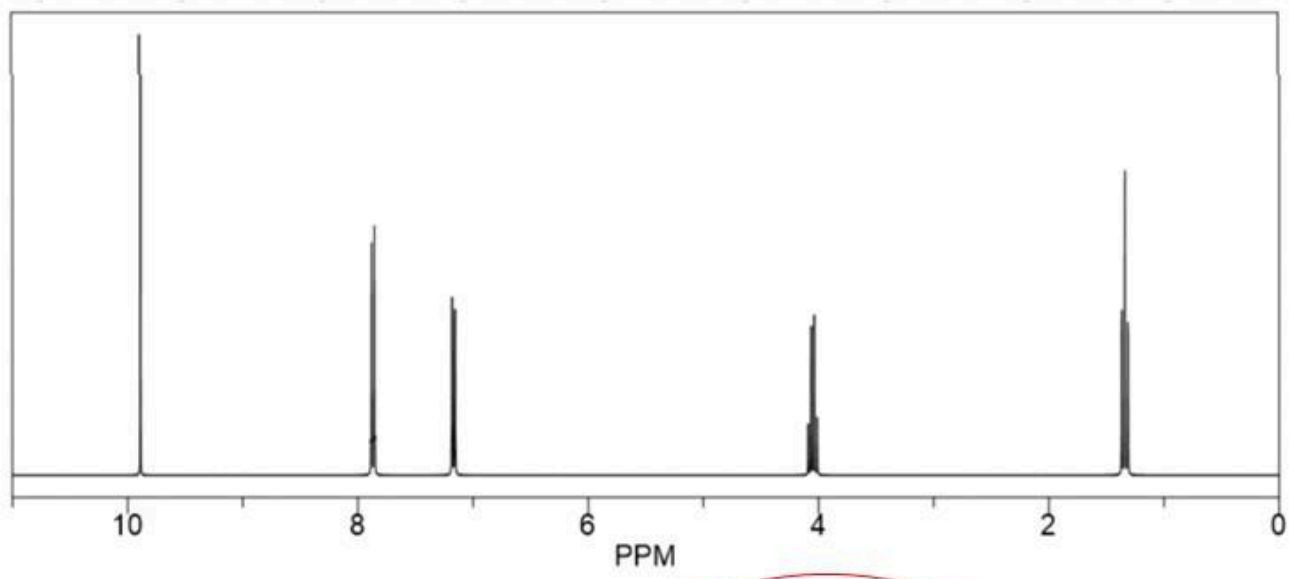
8. (3 points)

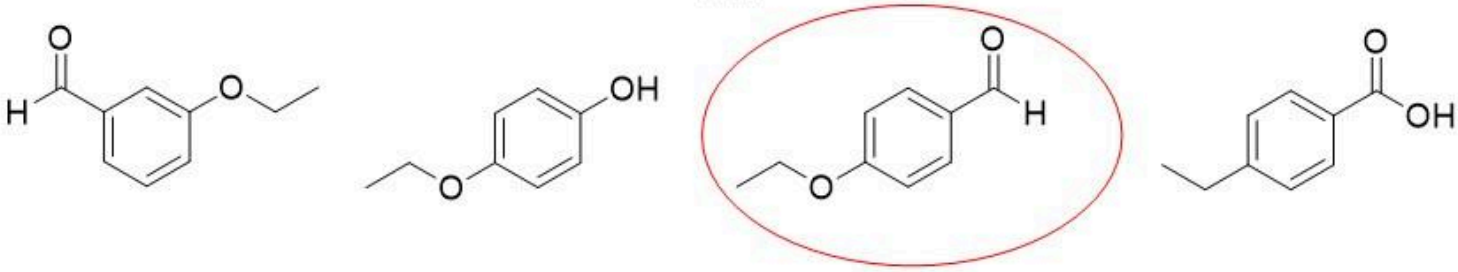
A. Identify the number of signals expected in the **^{13}C NMR** spectrum of the following compound.



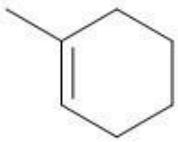
3

B. Circle the compound below that gives the following ^{1}H-NMR spectrum.
Splitting (integration) downfield to upfield: singlet (1), doublet (2), doublet (2), quartet (2), triplet (3).





9. (7 points) Fill in the blanks with major organic products. Show only one molecule per box. Show stereochemistry, where applicable. Across steps, make sure to continue the stereochemistry that you selected in step 1.

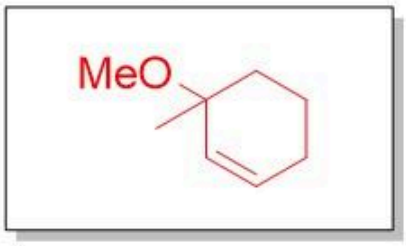


NBS, MeOH

+ En.

Draw one enantiomer

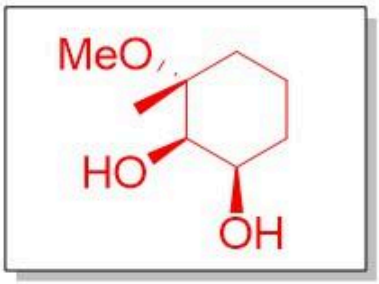
t-BuOK



Disregard stereochem.

1. OsO_4
2. $NaHSO_3$, H_2O

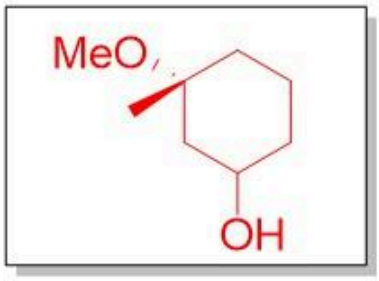
Draw one enantiomer

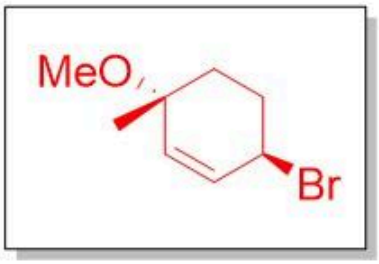


1) 9BBN-THF
2) NaOH, H_2O_2, H_2O

NBS, hv

Disregard stereochem.



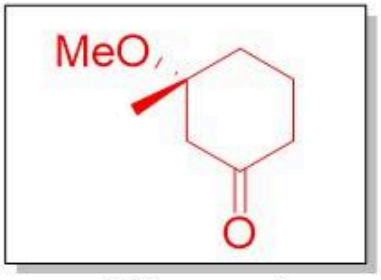


Draw one enantiomer

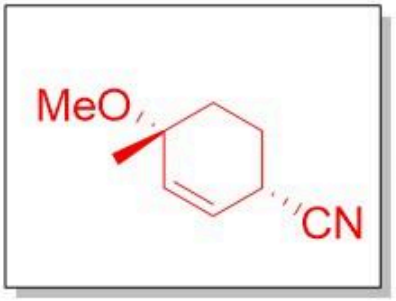
PCC

must flip Br -> CN stereochem!

KCN, HCN



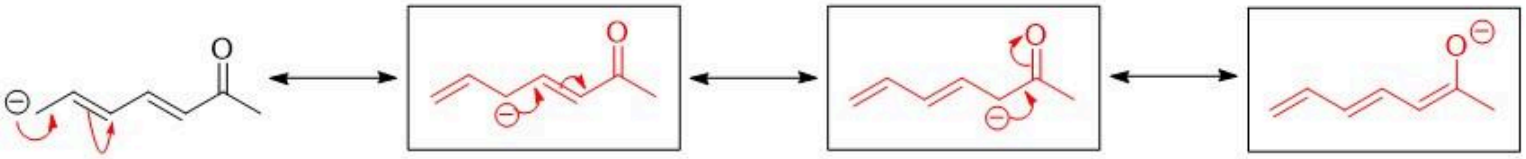
Disregard stereochem.



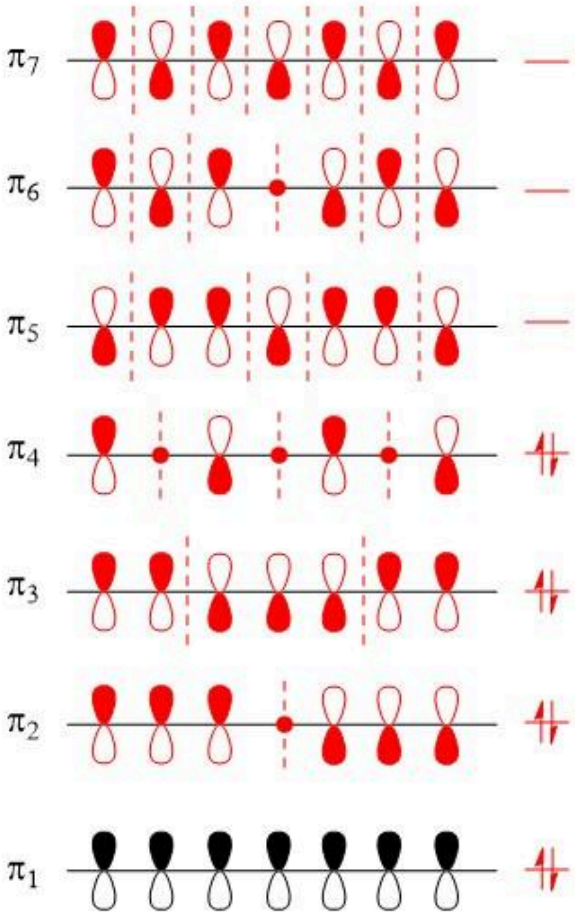
Draw one enantiomer

10. (7 points)

A. Draw the remaining resonance structures of the following conjugated anion. Be sure to show arrows.



B. Drawn below is the π_1 molecular orbital of the seven-atom π conjugated system above. Draw the remaining orbitals with their correct shading on the provided lines.



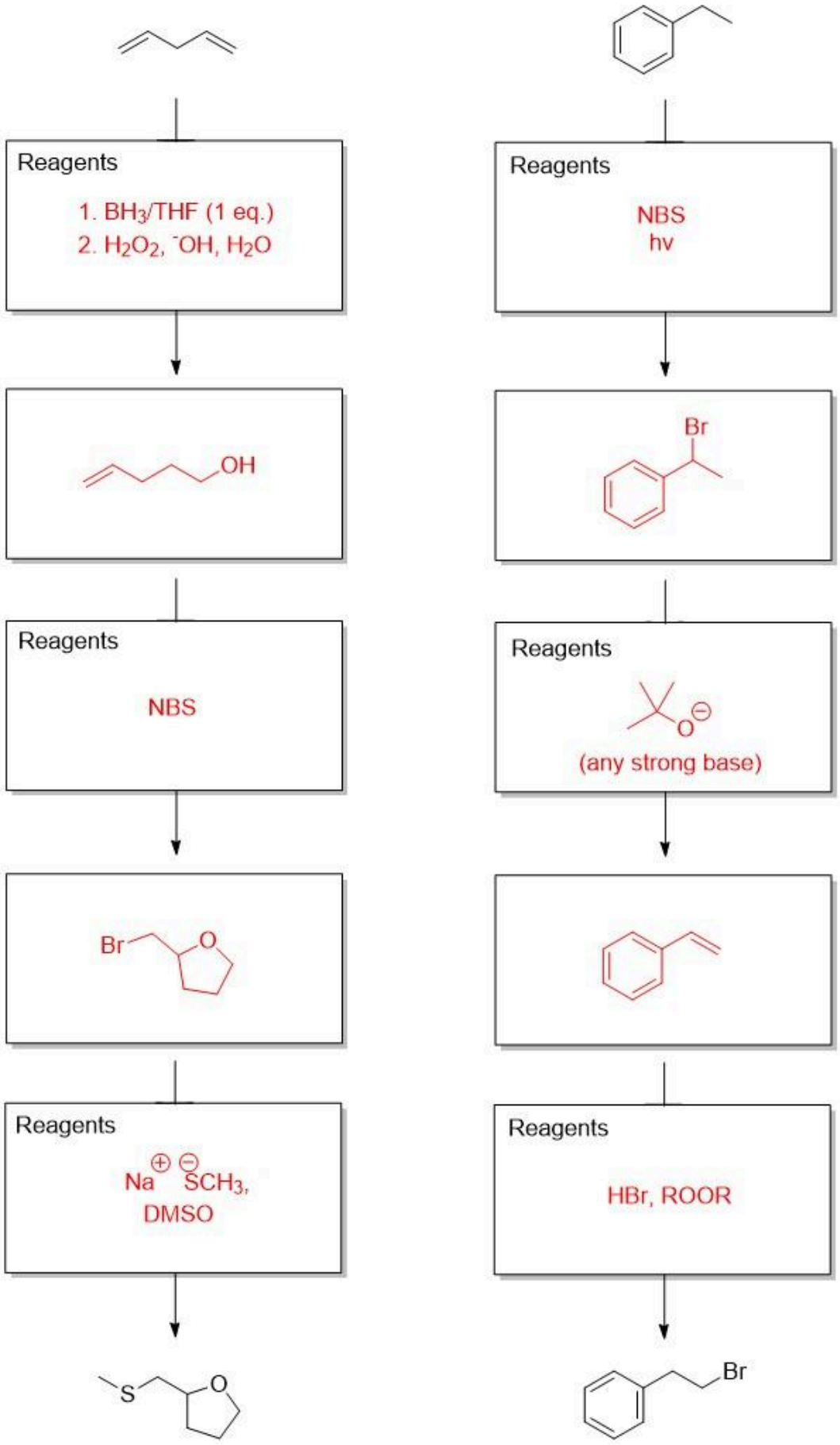
C. Which π molecular orbital is the HOMO?

π_4

D. Which π molecular orbital is the LUMO?

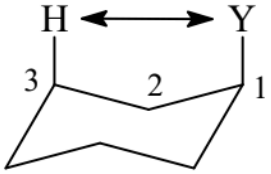
π_5

11. (9 points) Each provided reaction can occur in three transformations. Provide the conditions and the intermediates in the appropriate boxes to complete the sequence.



Interaction	Energy Cost kJ/mol
H-H eclipsed	4.0
H-CH_3 eclipsed	6.0
CH_3-CH_3 eclipsed	11.0
CH_3-CH_3 gauche	3.8

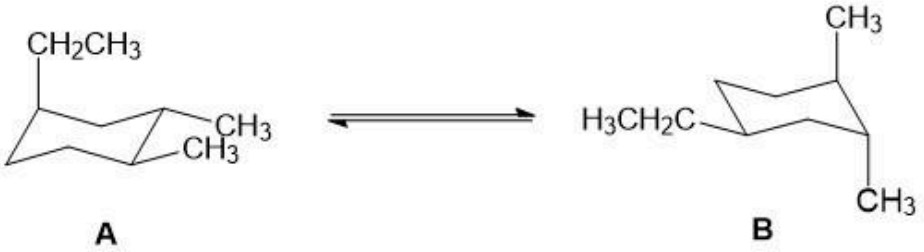
Steric Strain in Monosubstituted Cyclohexanes



Strain of one H-Y 1,3-diaxial interaction

Y	kJ/mol
-F	0.5
-Cl	1.0
-Br	1.0
-OH	2.1
-CH_3	3.8
-CH_2CH_3	4.0
-$CH(CH_3)_2$	4.6
-$C(CH_3)_3$	11.4
-C_6H_6	6.3
-COOH	2.9
-CN	0.4
CH_3-CH_3	15.4

12. (4 points)
A. What is the **energy difference** (in kJ/mol) between the two chair conformers shown below?



A **B**

A

2*4.0 + 3.8

= 11.8 kJ/mol

B

4*3.8

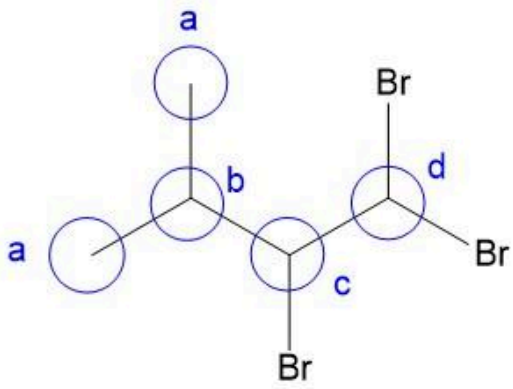
=15.2 kJ/mol

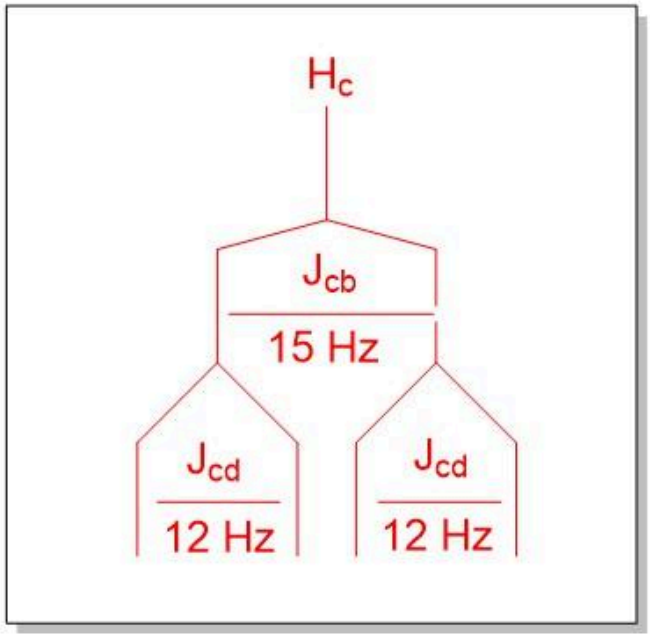
15.2 - 11.8 = 3.4 kJ/mol

Energy difference: 3.4 kJ/mol

More stable conformer (A or B): A

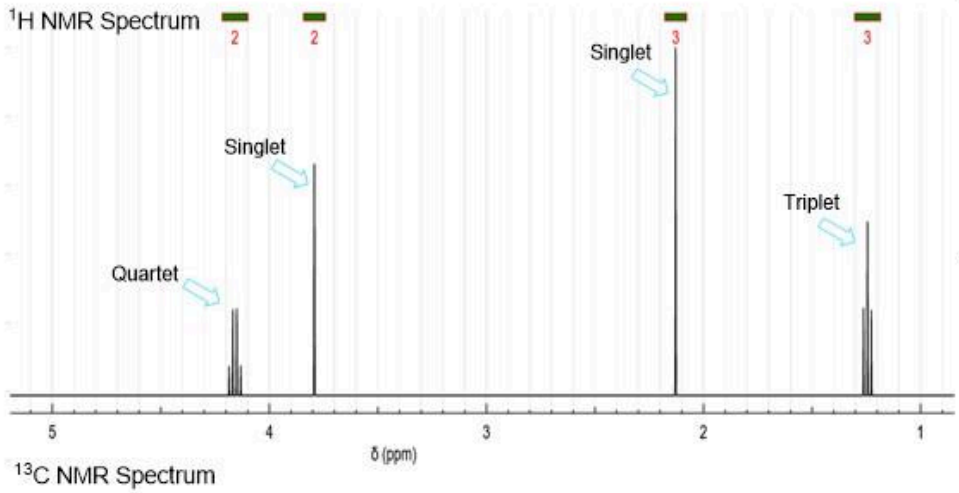
13. (4 points) The J values for this compound are J_{cb} = 15Hz and J_{cd} = 12Hz. Using this information draw the expected splitting pattern for signal C. Note: these values are made up and only meant to be used for this question.

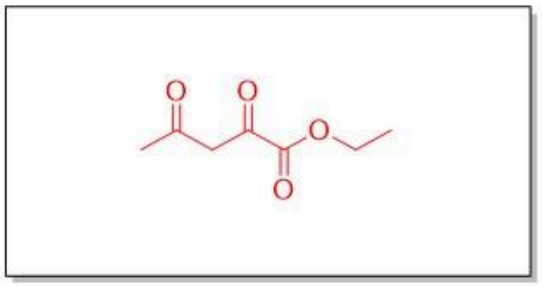


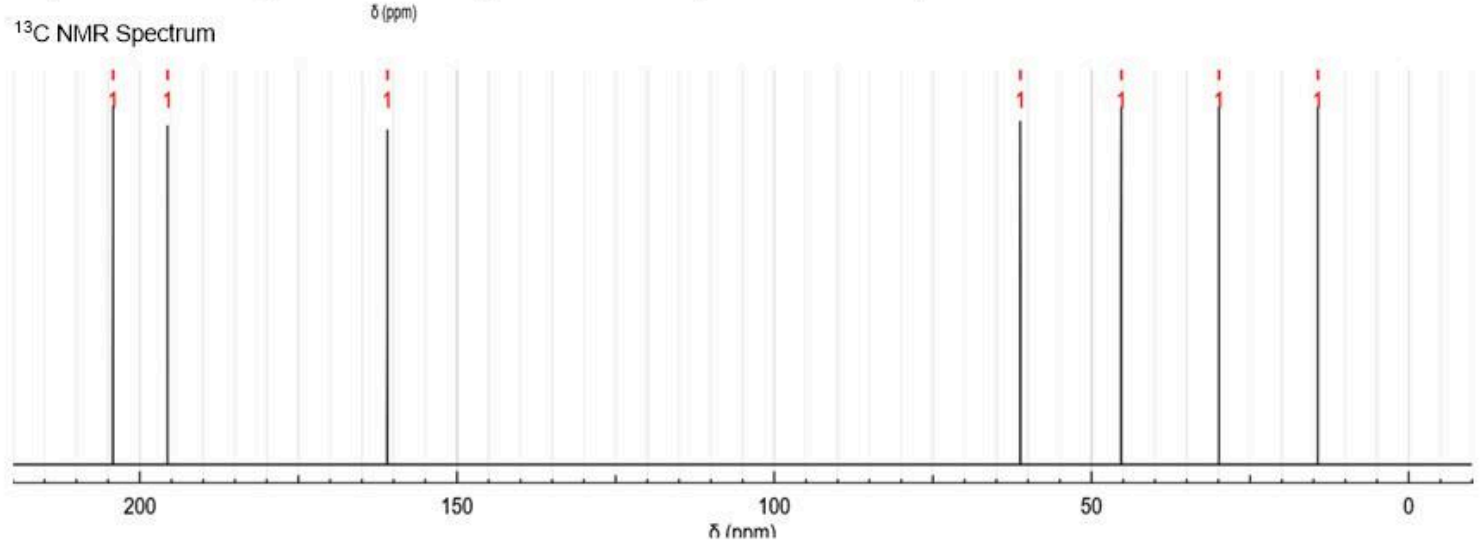


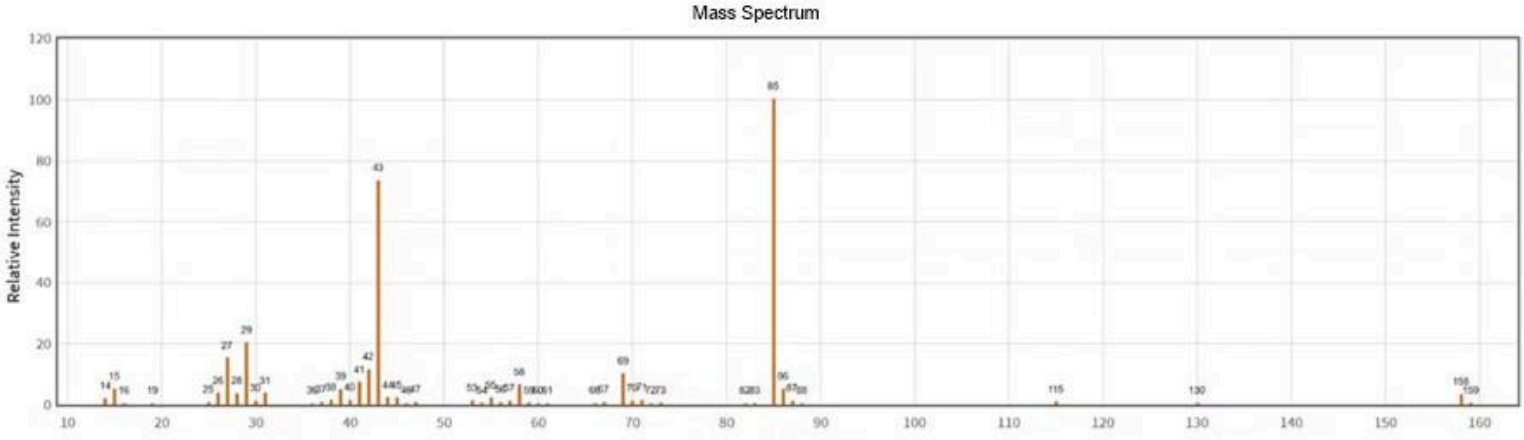
How many peaks? 4

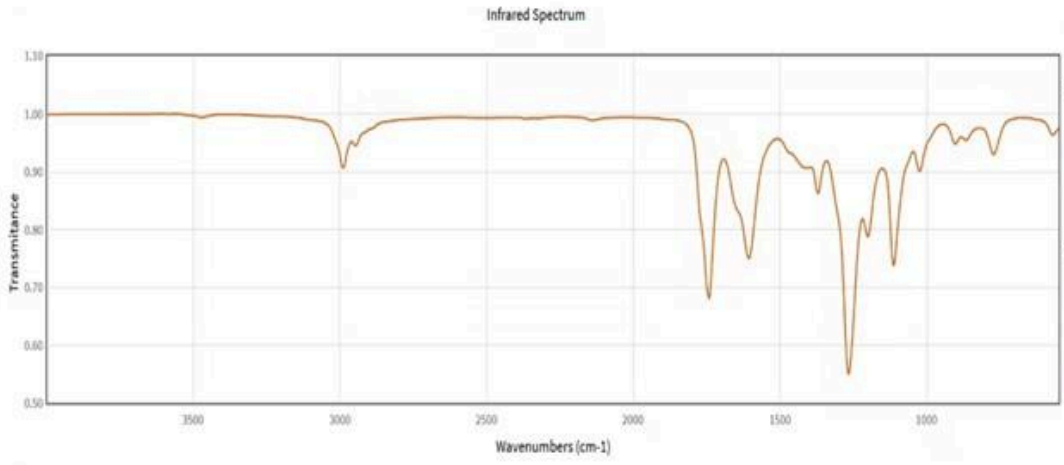
14. (5 points) Deduce the structure of a compound with the molecular formula $C_7H_{10}O_4$ that exhibit the following results from its IR, ^{1}H NMR, ^{13}C NMR, and Mass spectra:

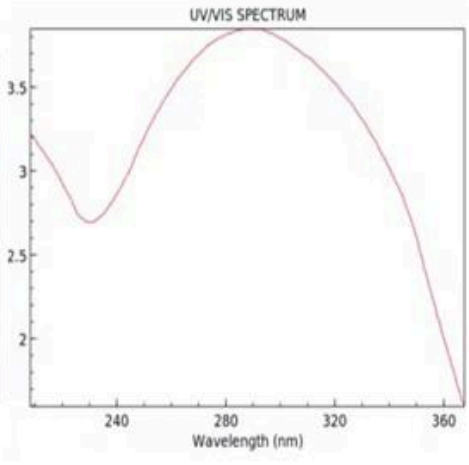






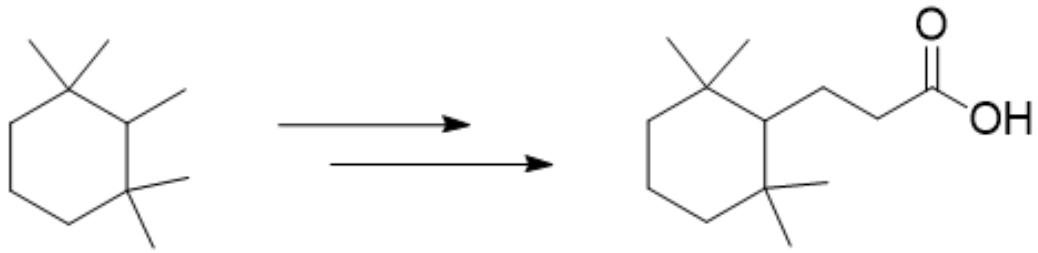


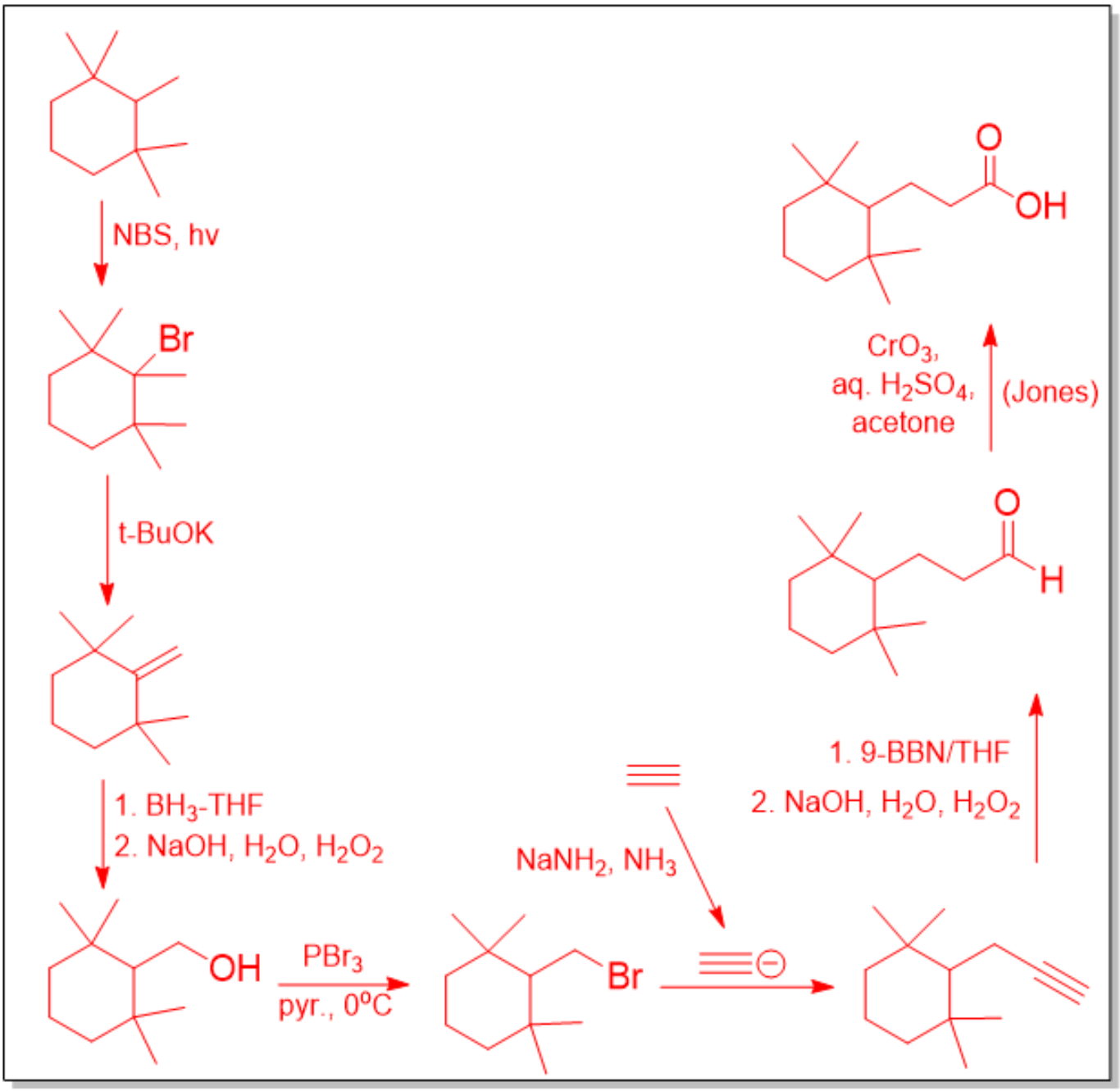




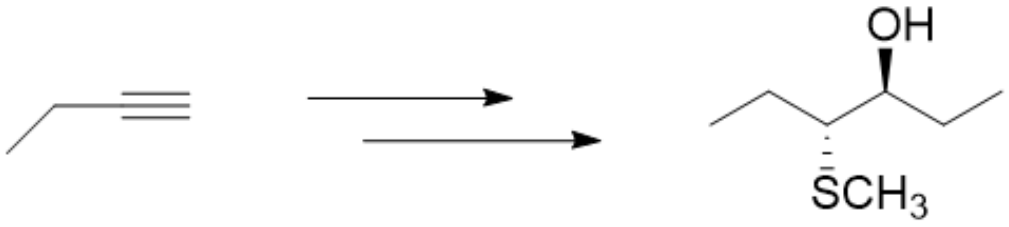
15. (6 points) Show how to synthesize the following compounds from the starting product given. You may use any monofunctional organic reagent up to 3 carbons.

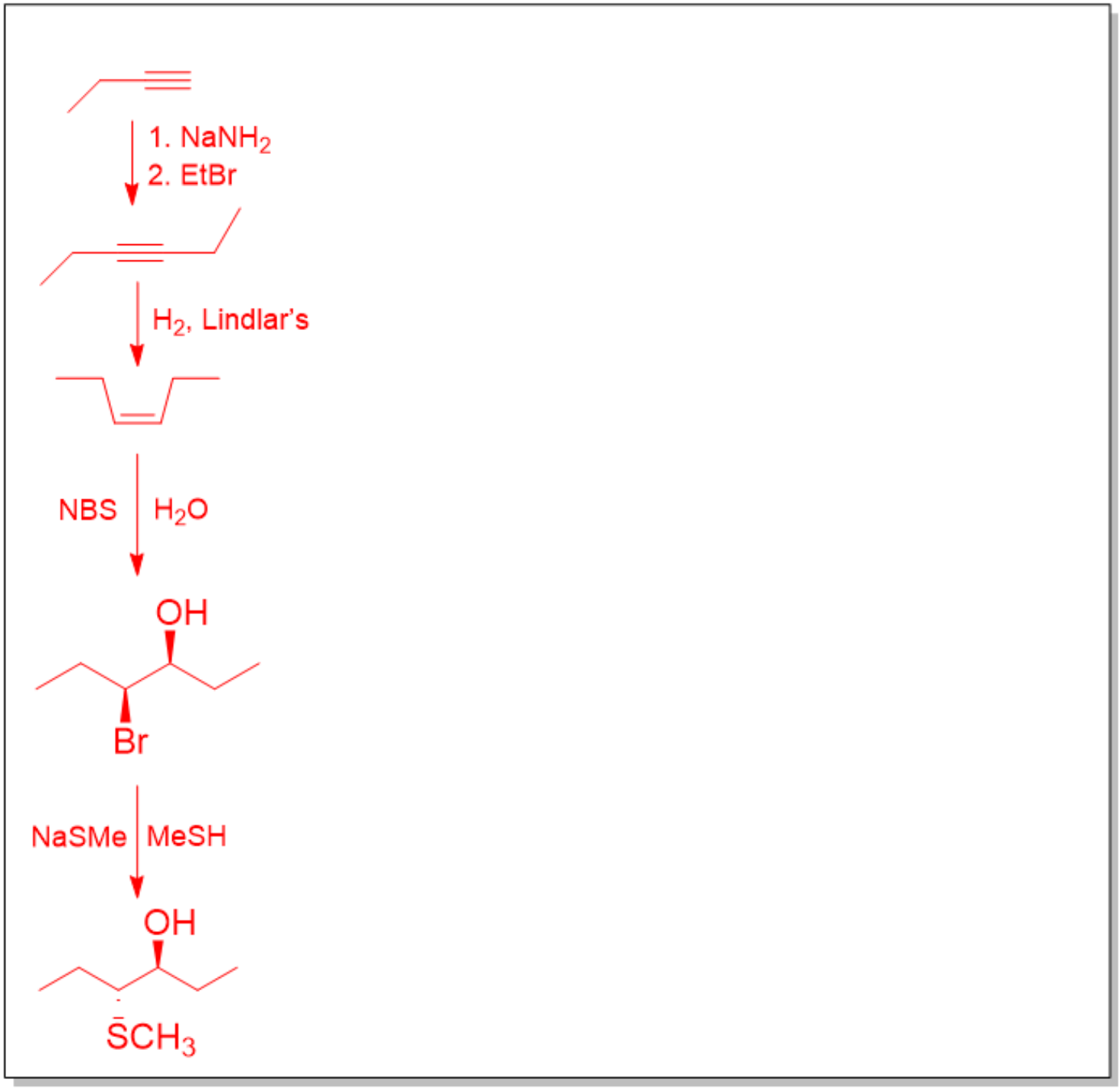
A.





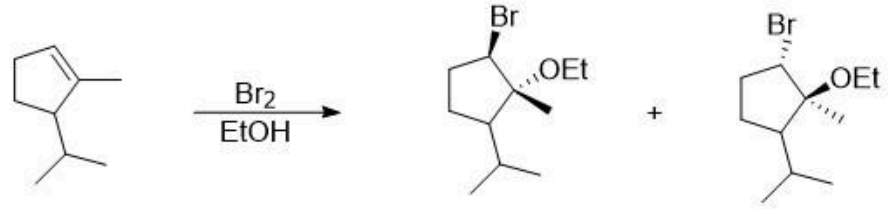
B.


OH
SCH3

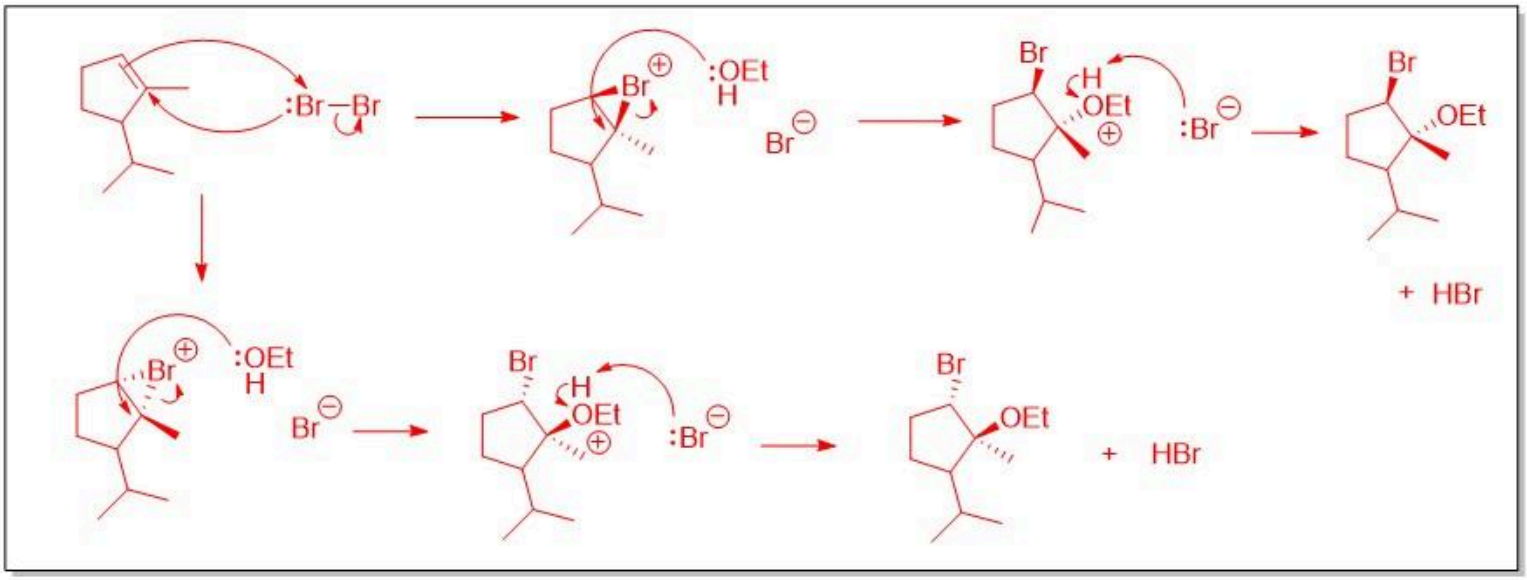

1. NaNH2
2. EtBr
H2, Lindlar's
NBS
H2O
OH
Br
NaSMe
MeSH
OH
SCH3

16. (9 points)

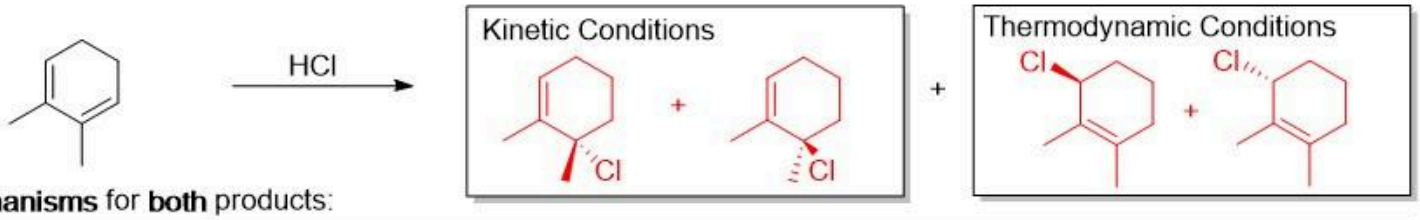
A. Provide a full electron pushing **mechanism** for the reaction below.



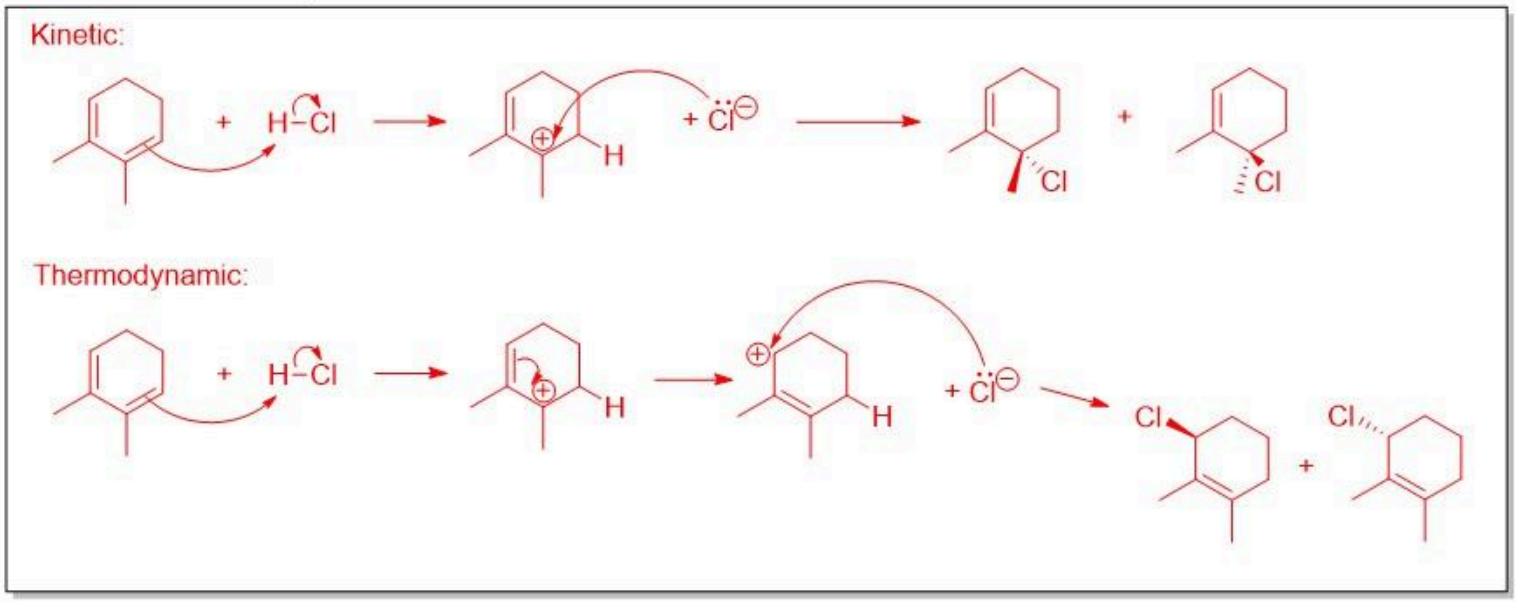
Mechanism:



B. Treating 2,3-dimethylcyclohexa-1,3-diene with one equivalent of **HCl** gives different products under different conditions. **Draw these and provide a mechanism** for "**both**" conditions. Show stereochemistry in the products.



Mechanisms for **both** products:



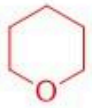
C. Which conditions are favored by **"high temperatures"? Kinetic** or **Thermodynamic** Conditions?

Thermodynamic

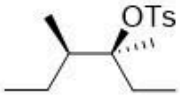
17. (5 points) Provide the **major organic product** and the mechanism by which they are formed (S_N2, S_N1, E2, or E1). Show stereochemistry when applicable, unless otherwise stated.

A. 

NaH →

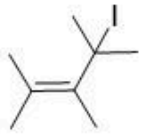


S_N2

B. 

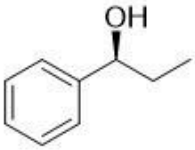
H_2O →

S_N1

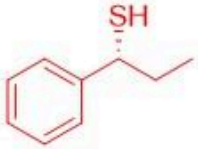
C. 

MeOH, △ →

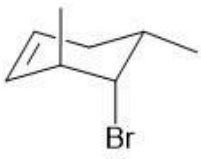
E1

D. 

1. TsCl, pyr.
2. NaSH →



S_N2

E. 

NaOEt, △ →

disregard stereochemistry

E2