

DAWSON COLLEGE
DEPARTMENT OF CHEMISTRY AND CHEMICAL TECHNOLOGY
ORGANIC CHEMISTRY I 202-BZF-05
Fall 2009

Final Examination

Instructors: D. Adley, B. Seivewright, E. Cadieux, S. Holden, H. Khouri, & S. Mäkinen

Write your name here: _____

Sign your name here: _____

Instructions:

1. This examination package contains **19** questions and **16** pages. It is your responsibility to check that there are no pages missing.
2. Fill in your name before answering the questions.
3. Answer **ALL** questions in the **space provided**.
4. Answer the questions in **ink** and do **not use liquid white** or correction tape, otherwise, your right to contest your grade will be compromised.
5. Write **CLEARLY**, messy answers will not be marked.
6. Do not detach **any** of the sheets in this booklet.
7. Please note that **NON-PROGRAMMABLE CALCULATORS** and **MOLECULAR MODELS** are permitted but cannot be passed around.
8. Whenever required, structural formulae must be shown **complete**.
9. Your attention is drawn to the college policy on cheating. This policy will be enforced.

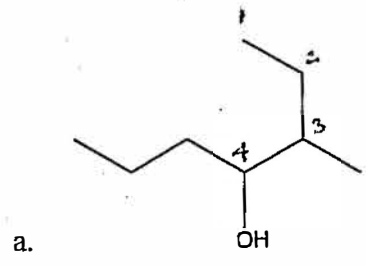
Marking Scheme:

- | | | | |
|---------------------|--------------------|--------------------|--------------------|
| 1. <u> </u> /12 | 2. <u> </u> /6 | 3. <u> </u> /4 | 4. <u> </u> /5 |
| 5. <u> </u> /6 | 6. <u> </u> /2 | 7. <u> </u> /4 | 8. <u> </u> /5 |
| 9. <u> </u> /9 | 10. <u> </u> /1 | 11. <u> </u> /7 | 12. <u> </u> /4 |
| 13. <u> </u> /4 | 14. <u> </u> /5 | 15. <u> </u> /6 | 16. <u> </u> /4 |
| 17. <u> </u> /10 | 18. <u> </u> /2 | 19. <u> </u> /4 | |

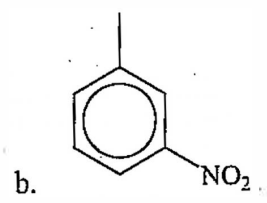
TOTAL /100

TOTAL /40

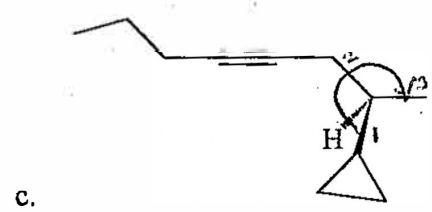
1. Give IUPAC names for the following compounds. Include R/S & E/Z nomenclature where necessary. (2 pts each, total 12 pts)



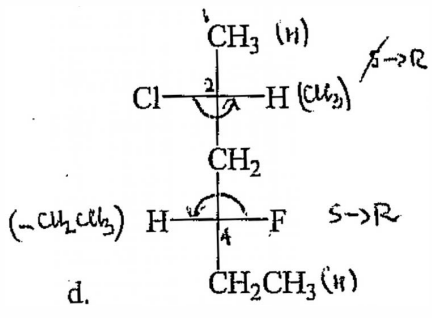
3-methyl-4-heptanol



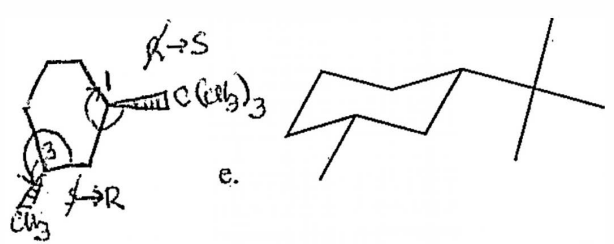
m-nitrotoluene



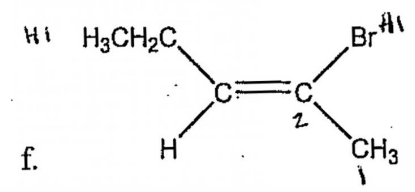
(R)-2-cyclopropyl-4-octyne
 the cyclopropyl has higher priority because it has CH attached to chiral C. Others are -CH₂- & -CH₃



(2R,4R)-2-chloro-4-fluorohexane



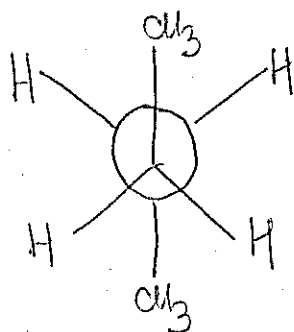
(1S,3R)-1-t-butyl-3-methylcyclohexane



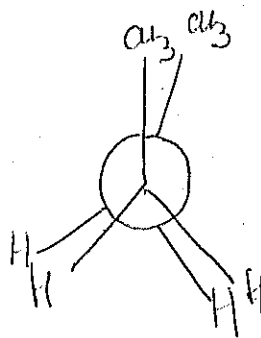
Z-2-bromo-2-pentene

2.

- a. Draw the Newman projection formulas of the most stable conformation and the least stable conformation of butane, along the C2-C3 bond. (2 pts)



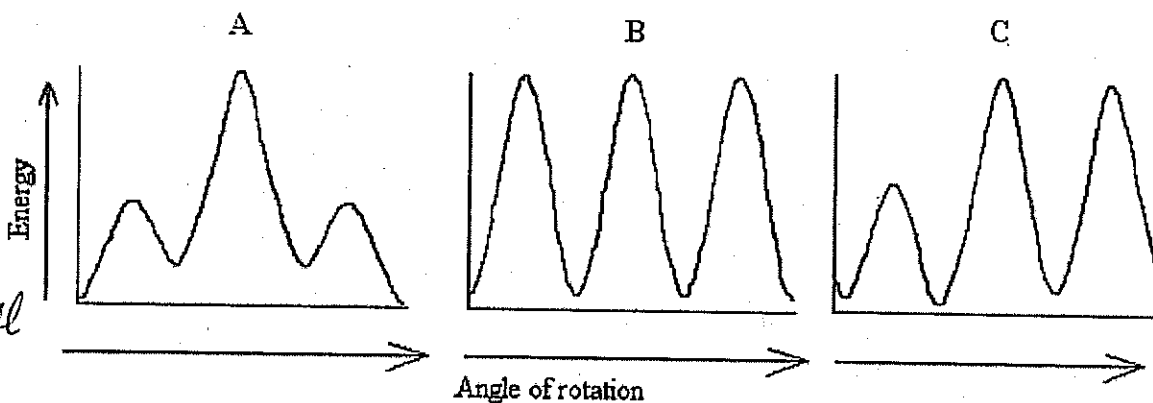
most stable



least stable

- b. For the least stable conformation, the relative positions of the two methyl groups is best described as eclipsed. (1 pt)
- c. Which of the following corresponds to the potential energy diagram for the rotation about the C2-C3 bond of butane? (1 pt)

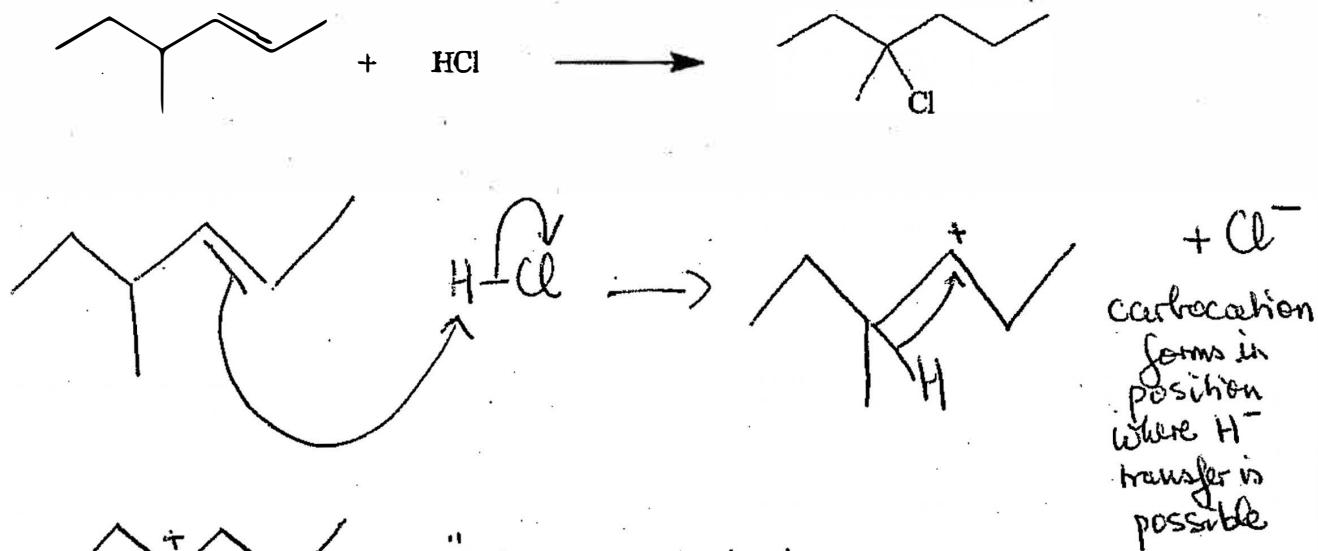
Answer: A



- d. List two reasons responsible for making the least stable conformation higher in energy. (2 pts)

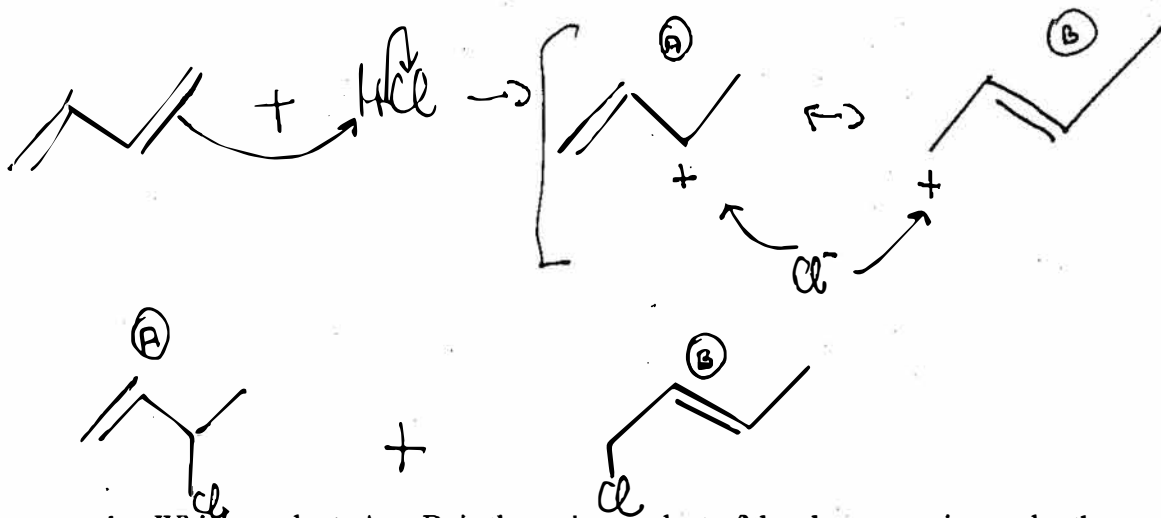
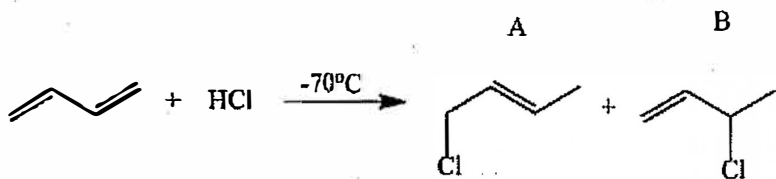
Torsional strain exists when the dihedral angle is not 60° . Torsional strain exists in ethane. In addition when the H's in ethane are replaced by alkyl groups then steric strain due to Van der Waals repulsion occurs.

3. Draw the mechanism to account for the given product using curved arrows. (4 pts)



4.

a. Draw the mechanism to account for the given products using curved arrows. (4 pts)



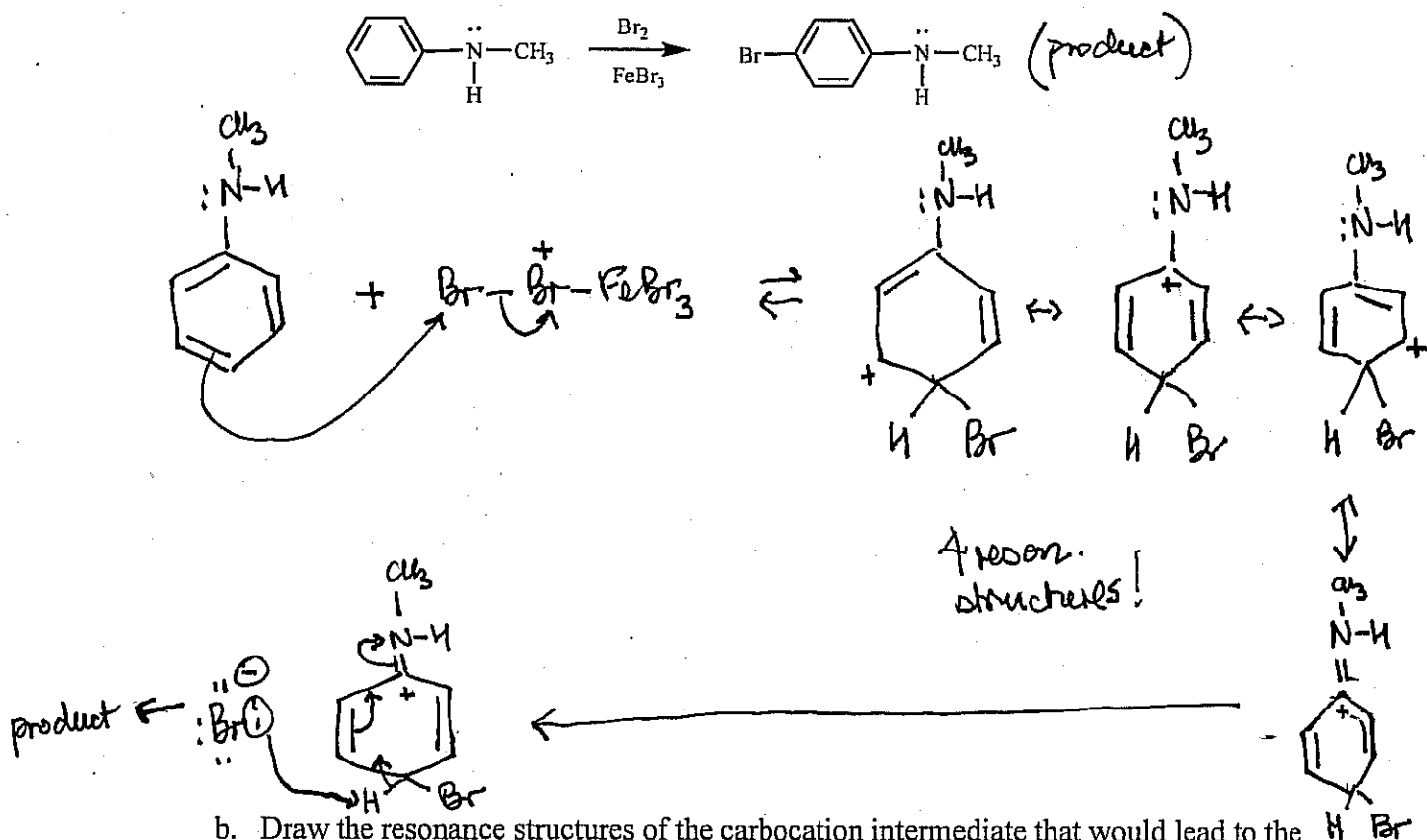
b. Which product, A or B, is the major product of the above reaction under these conditions? (1 pt)

Answer: A

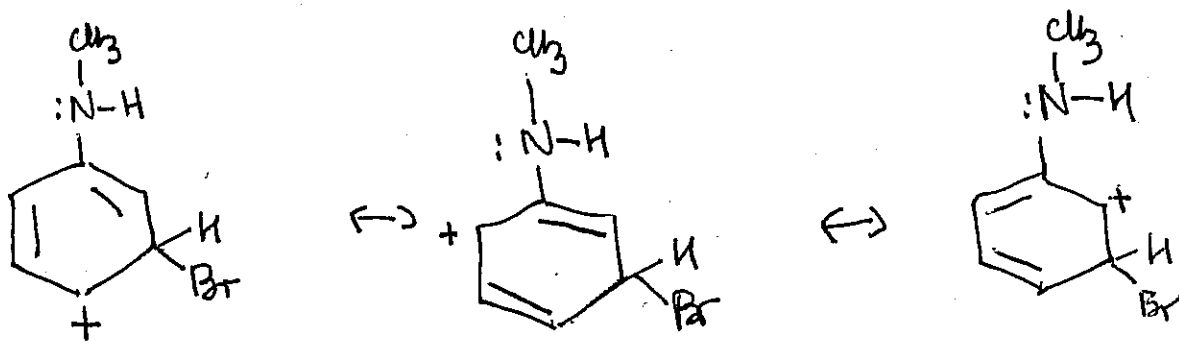
1,2 add'n preferred at least

5.

- a. Draw the mechanism of the reaction below. Use the $\text{Br}-\text{Br}^+-\text{FeBr}_3$ as the electrophile. Show all resonance structures of the carbocation (arenium ion) intermediate. (4 pts)

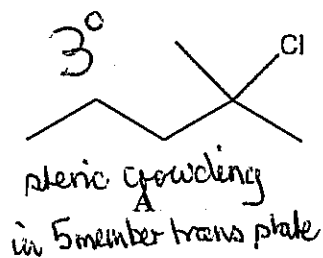


- b. Draw the resonance structures of the carbocation intermediate that would lead to the meta product. Use these structures to explain why the meta product is not formed to any significant quantities. (2 pts)



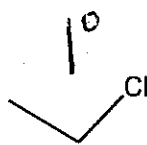
With meta attack only three res. structures possible.

6. Arrange the following substrates in order of their increasing S_N2 reactivity with NaCN. (2 pts)



A

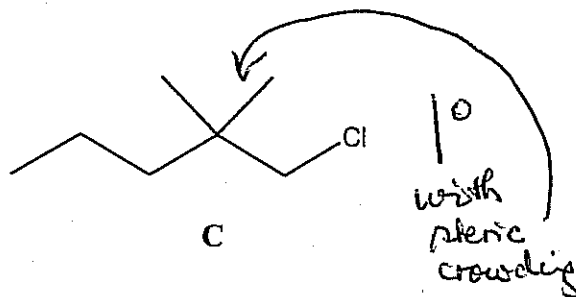
slowest



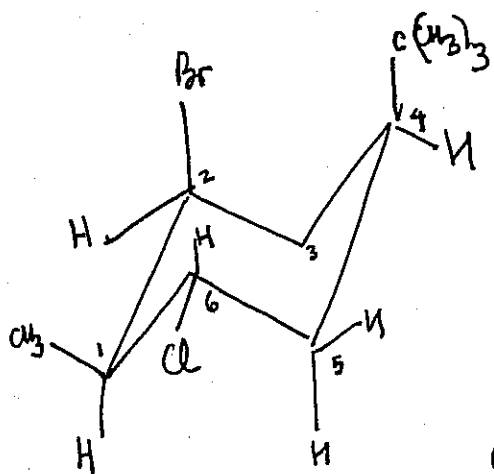
C

B

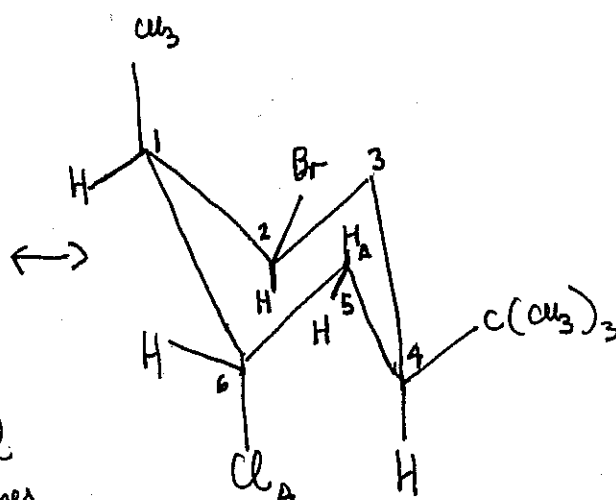
fastest



7. Draw the mechanism which accounts for the formation of the major organic product, when the two compounds are allowed to react. Draw in 3D when necessary. Use curved arrow notation. Draw and indicate clearly the structure of the major product. (4 pts)



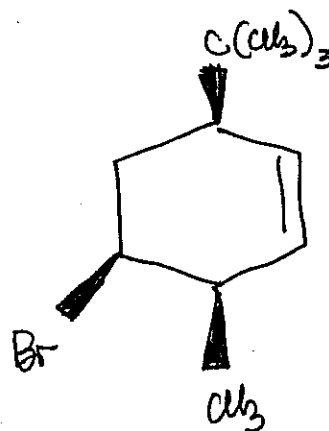
not a good conformer. t-Bu should be in equatorial pos'n.



axial becomes equatorial & vice-versa.

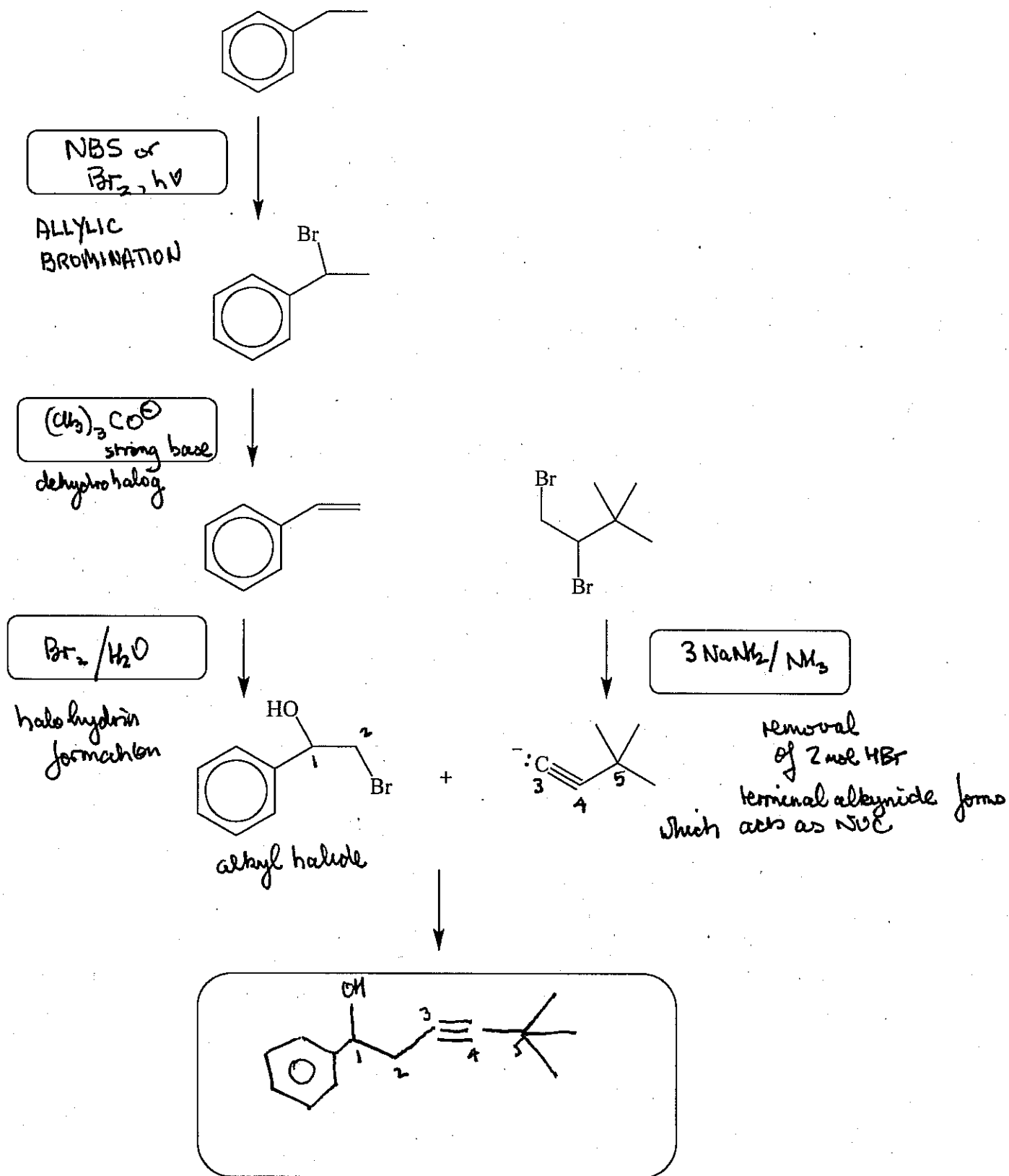
note only H_A and Cl_A are antiperiplanar

loss of HCl on C_5-C_6



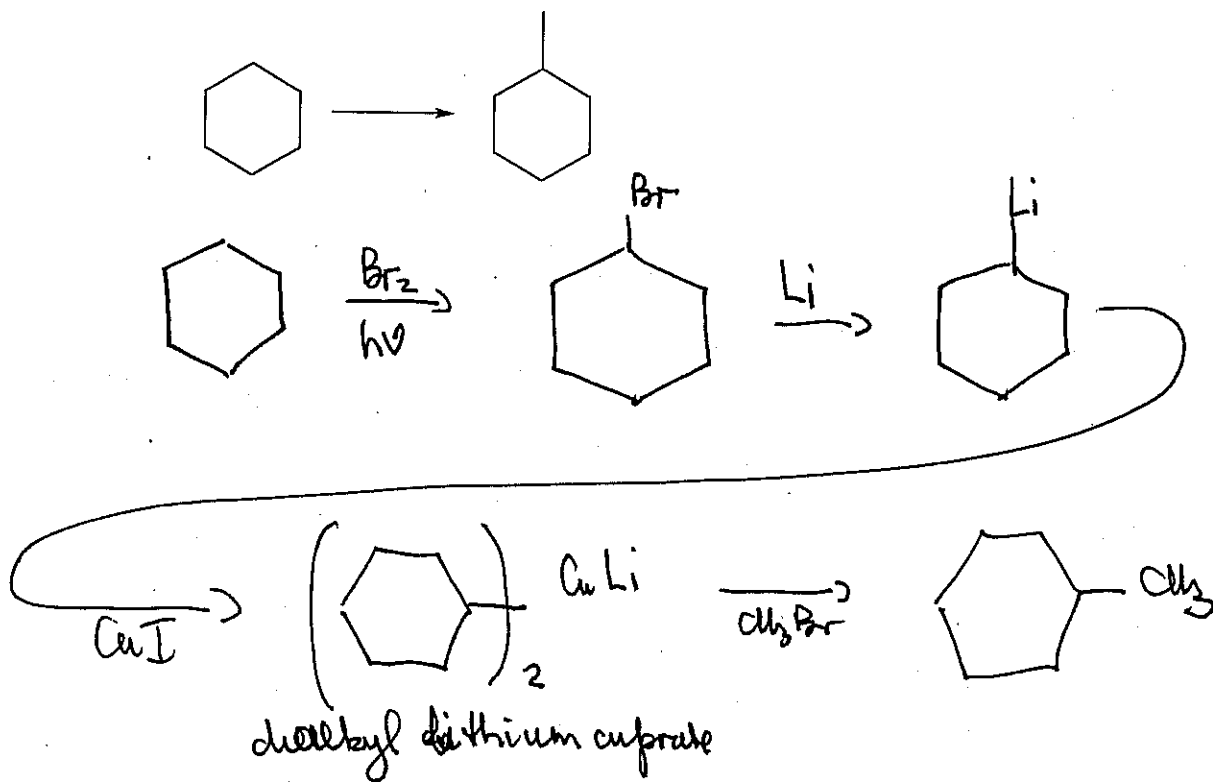
major product. (loss of HCl only)

8. Show the required reagents to synthesize the following compounds: Mechanisms are **not** required. Give the final product in the last box. (5 pts)

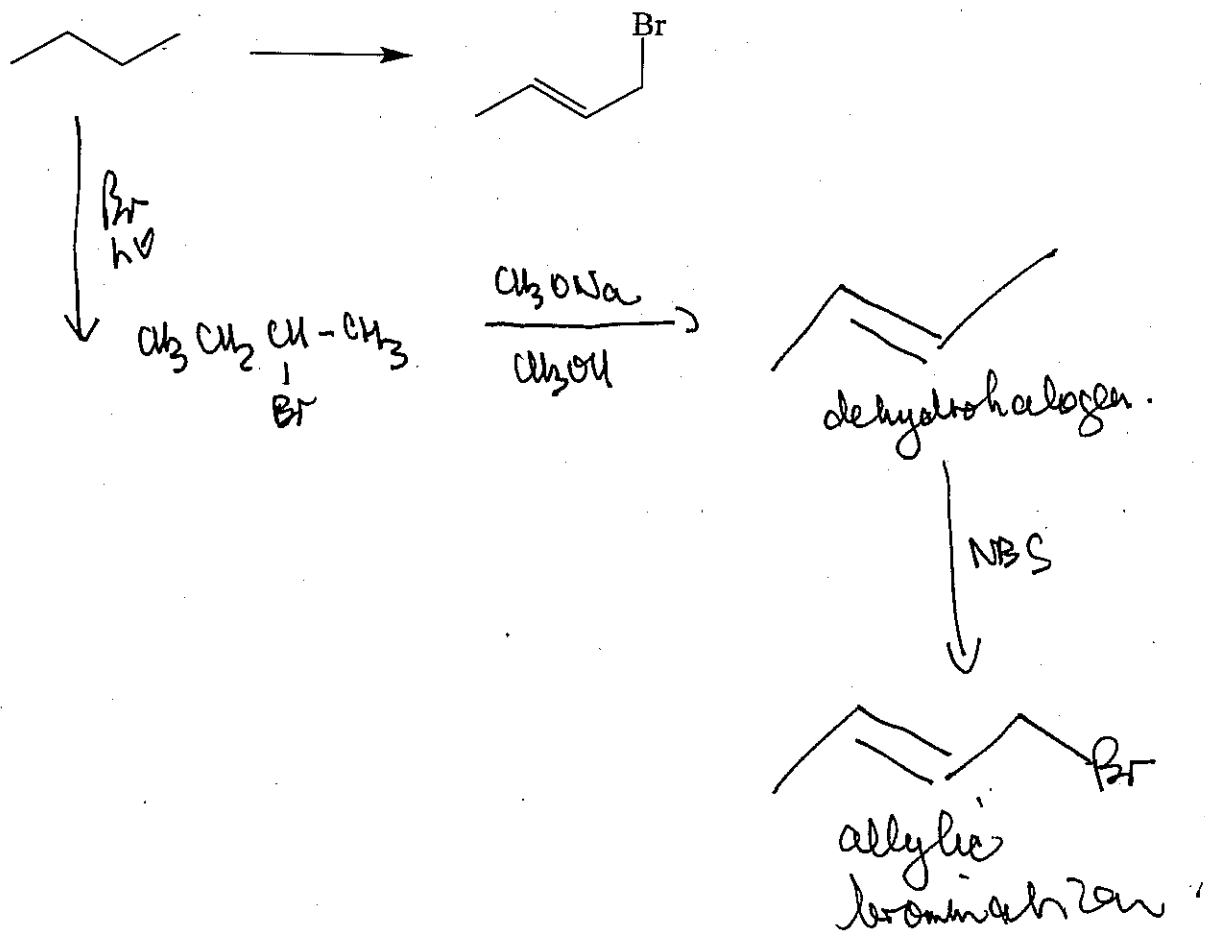


9. Show the required steps to synthesize the following compounds. Show all intermediate products. Use **any inorganic and organic reagents** necessary. Mechanisms are not required. (9 pts)

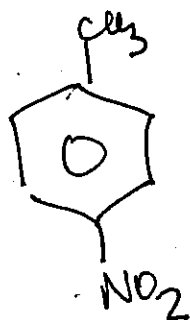
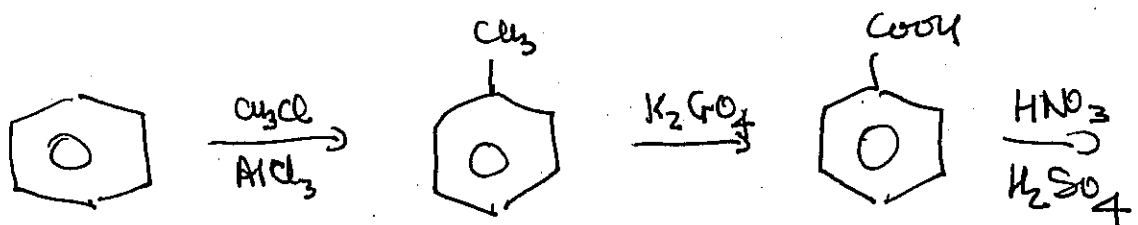
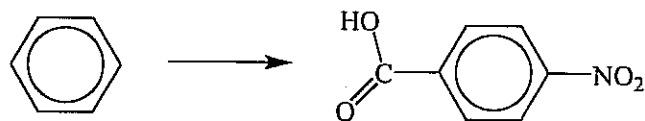
a.



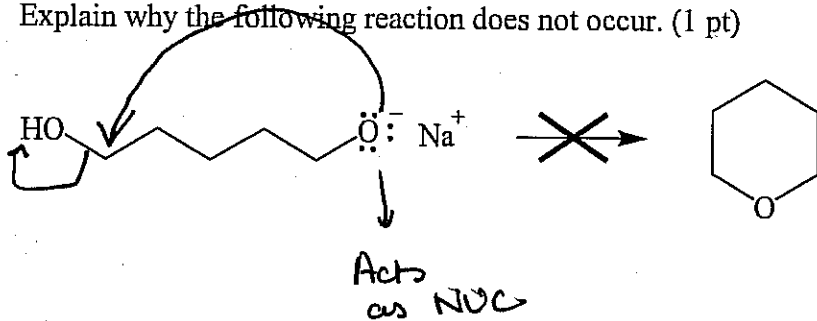
b.



c.



10. Explain why the following reaction does not occur. (1 pt)

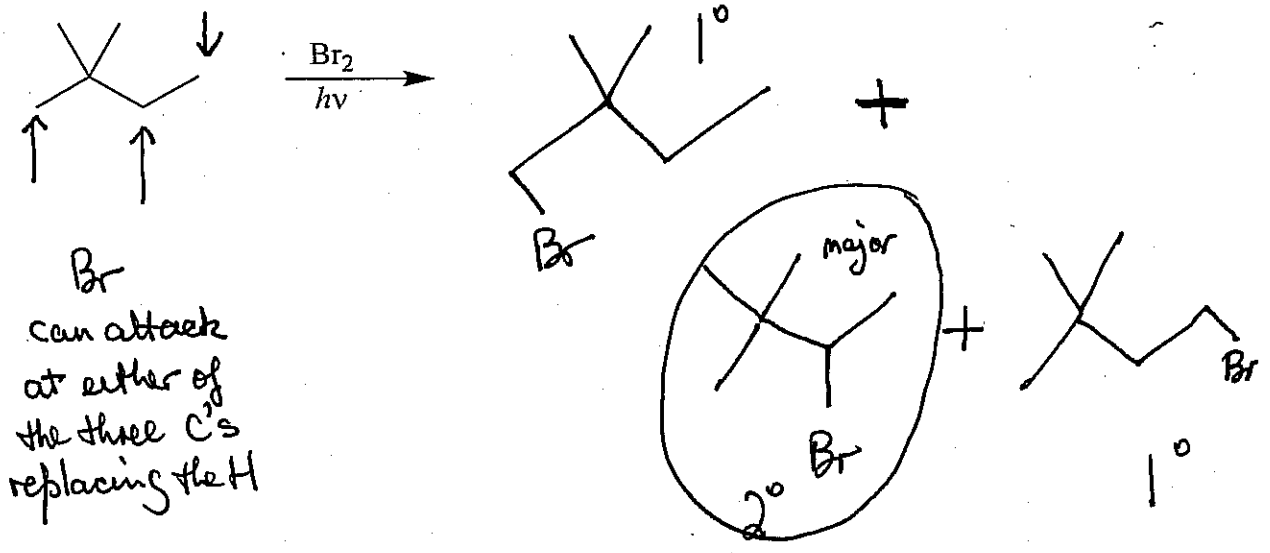


Does not work OH^- is a strong base and a poor leaving group.

11.

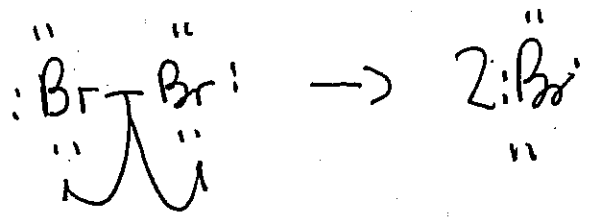
a. Give the structural formulae of all possible monobromination products for the following reaction. Circle the major product. (3 pts)

3 products.

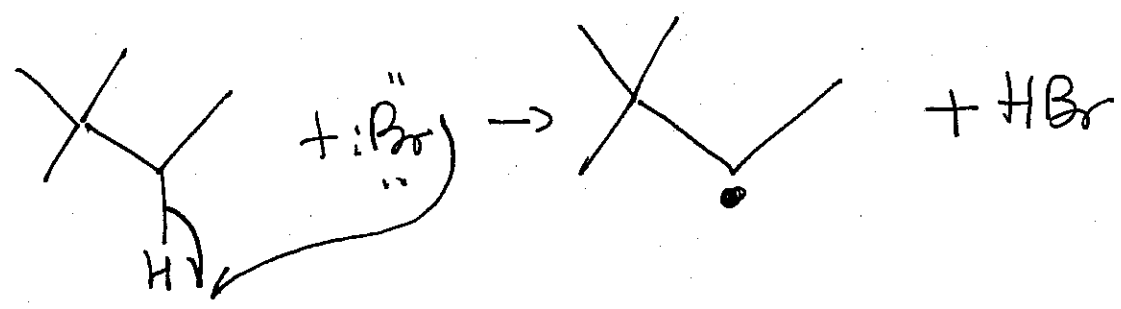


b. Draw a mechanism for the production of the 2° alkyl halide. (4 pts)

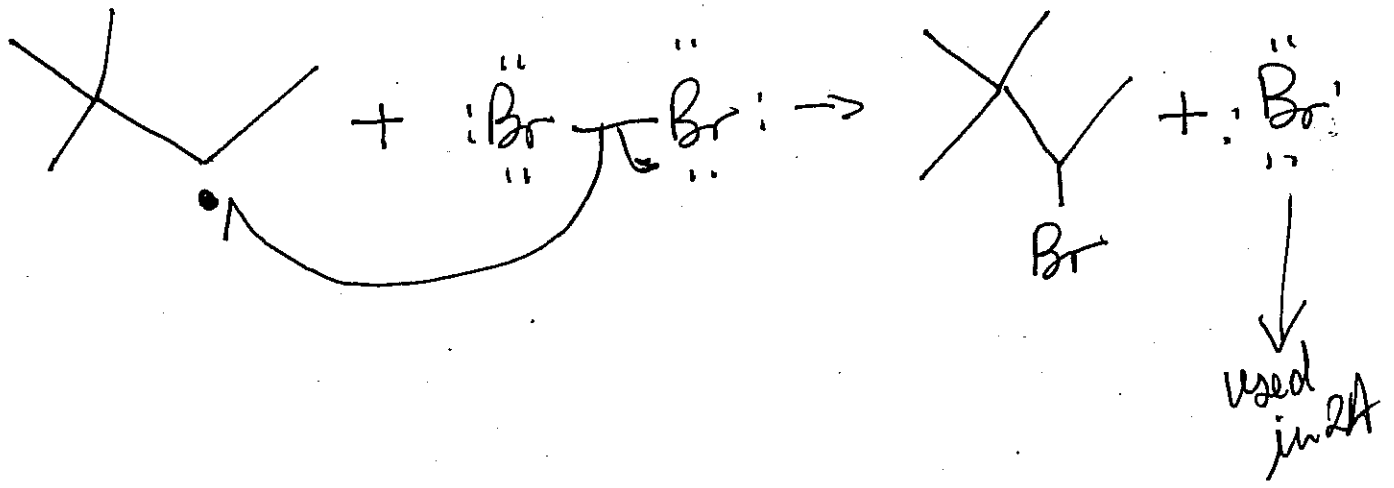
1. Chain
Initiation



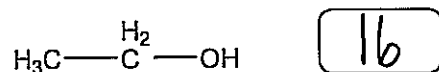
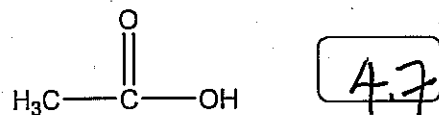
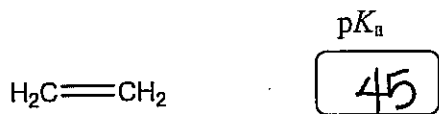
2. A.



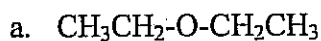
B.



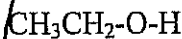
12. The compounds below have the pK_a values 4.7, 16, 45, and 62. Insert the correct pK_a value in the box for each compound. (4 pts)



13. Which of the two compounds has a higher boiling point? Explain. (4 pts)



or

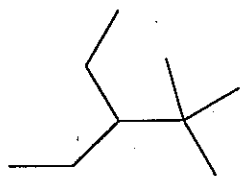


no H bonding

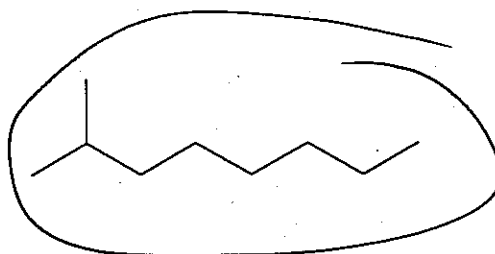
H bonding

weaker dipole-dipole interactions.

b.



or

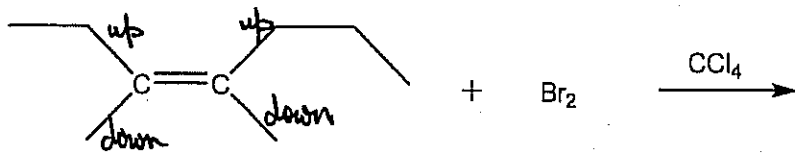


more branched
less surface area.

less branched
more surface area
stronger Van der Waals
higher B.P.

14.

a. Draw the 3D formulae of the products of the following reaction. (4 pts)

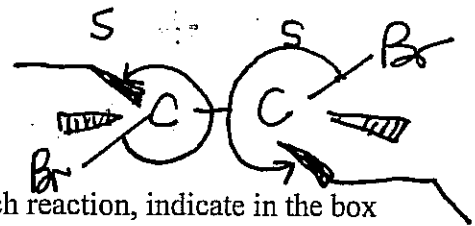


Br must be anti coplanar
Two possibilities

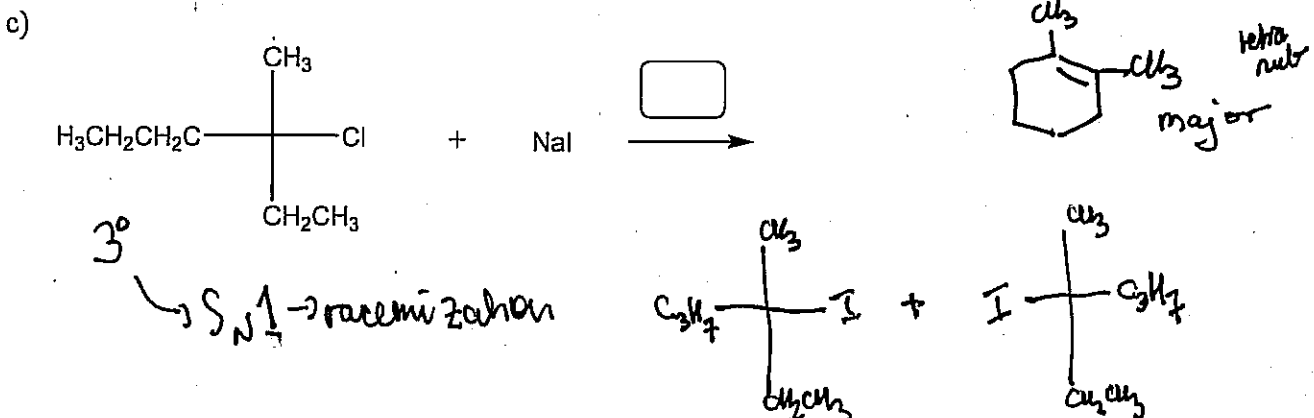
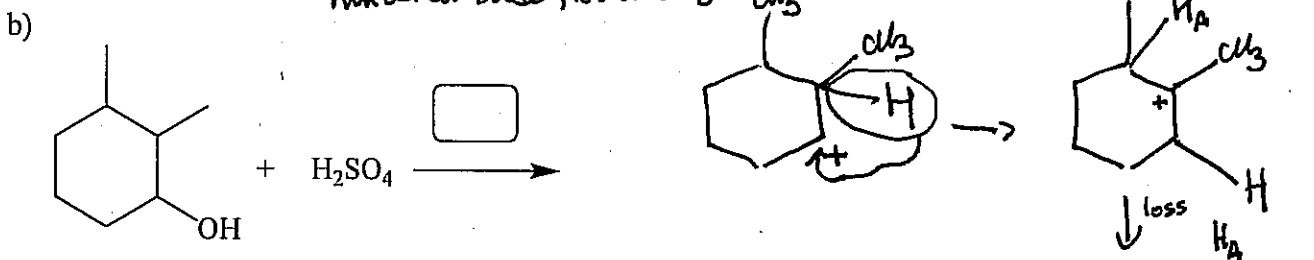
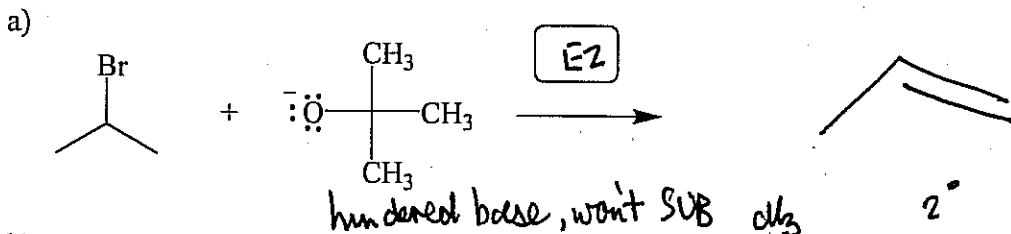


b. Will the final solution be optically active? (1 pt)

No it is a racemic mixture
50% SS + 50% RR

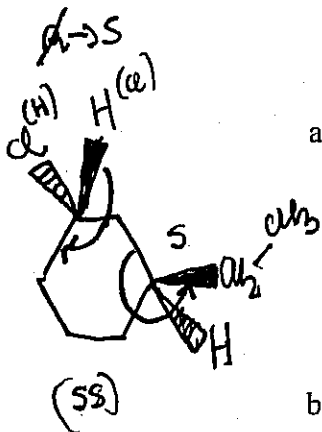


15. Give the structures of significant organic products. For each reaction, indicate in the box whether the major mechanism is S_N1 , S_N2 , E1, or E2. (2 pts each, total 6 pts)

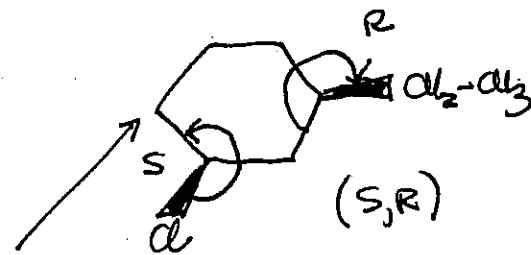
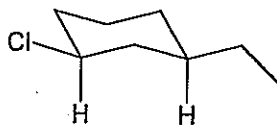
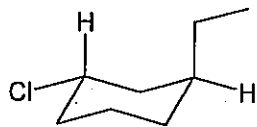


16. What is the relationship between the following molecules? Place your answer in the box. (4 pts)

- i. enantiomers
- ii. diastereomers
- iii. constitutional isomers
- iv. same molecule
- v. none of the above

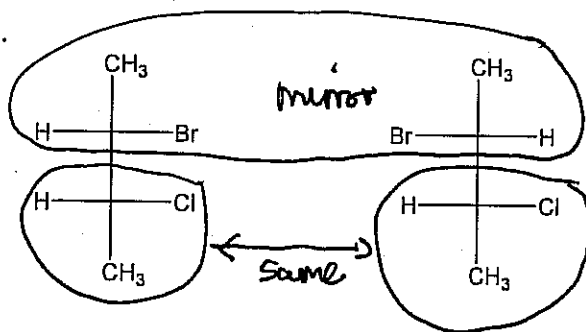


a.



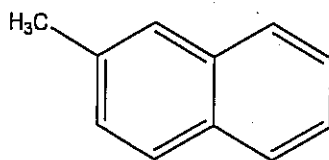
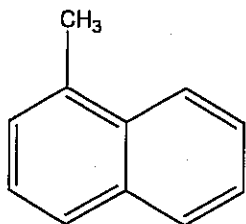
ii

b.



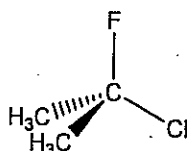
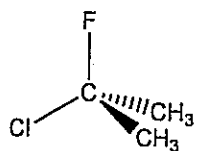
ii

c.



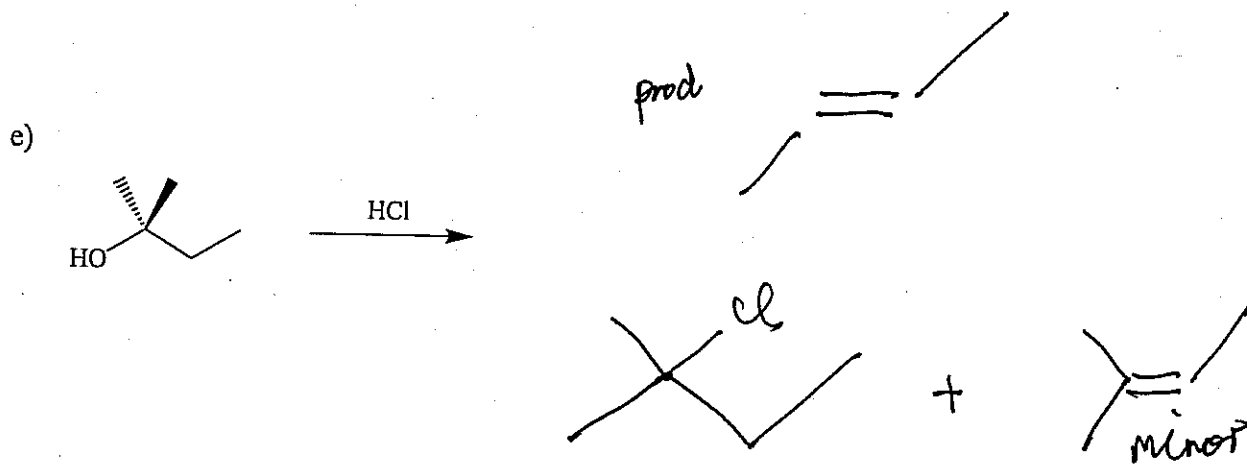
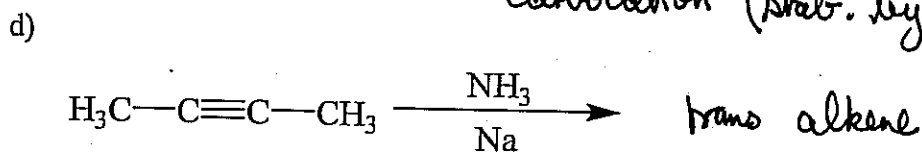
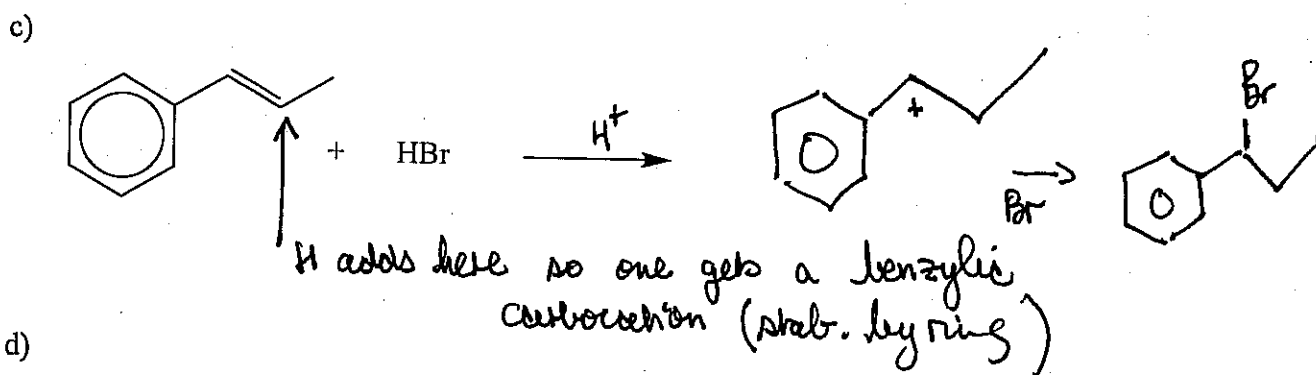
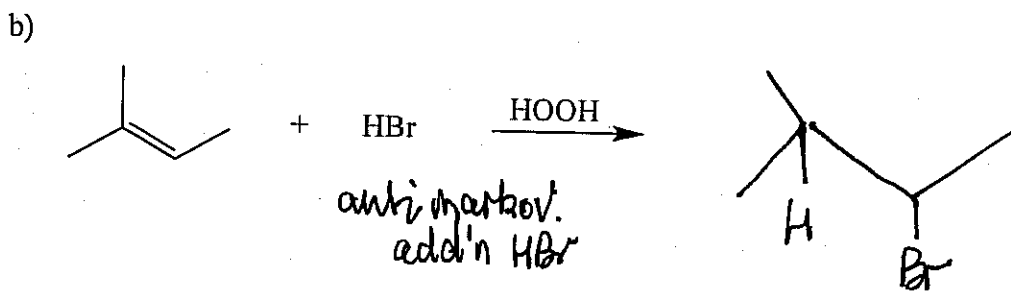
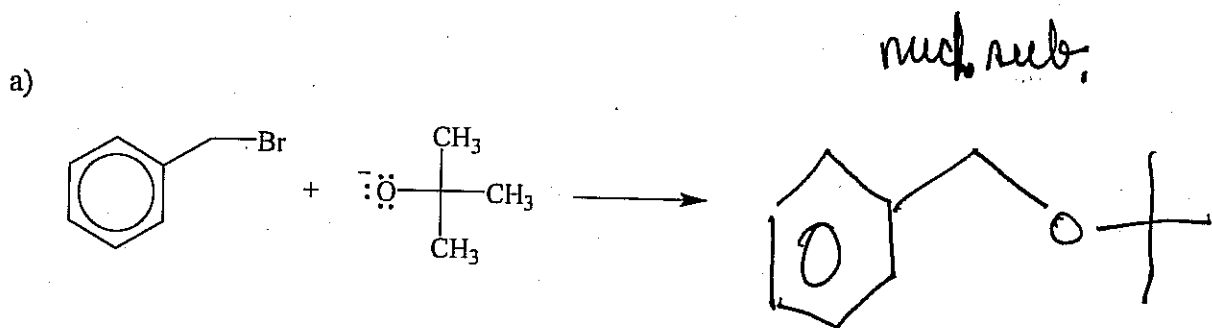
iii

d.

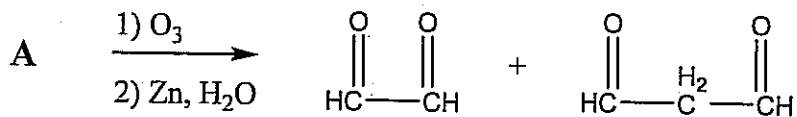


iv

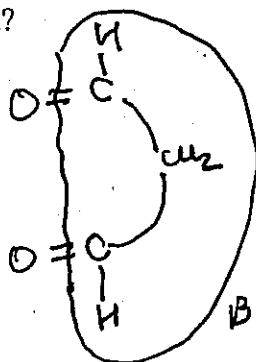
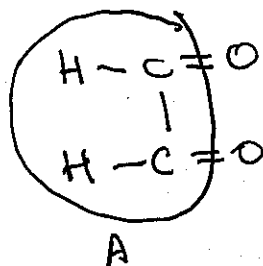
17. Give the structural formulas of the significant organic products for the following reactions. For the reactions with more than one significant organic product, circle the major product. Include stereochemistry where applicable. (2 pts each, total 10 pts)



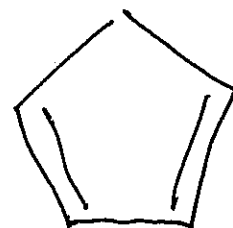
18. When subjected to ozonolysis, followed by treatment with zinc and water, compound A (C_5H_6) gives the following products: (2 pts)



What is the structure of compound A?



join A & B

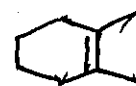


19. List the following in order of increasing stability. (4 pts)

a. 1-octene



b. 1,2-dimethylcyclohexene

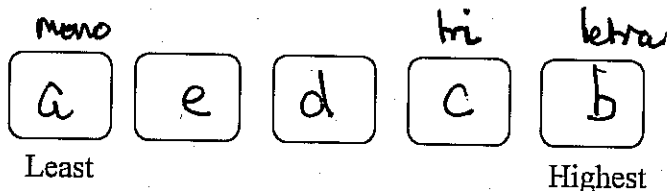


c. 3-methylpent-2-ene



d. (*E*)-2-heptene *trans*

e. (*Z*)-2-heptene *cis*



Which of the above compounds will release the most energy upon hydrogenation?

a

PERIODIC TABLE OF THE ELEMENTS

Atomic number →	Symbol →	Name (IUPAC) →	Atomic mass →
1	H	Hydrogen	1.0079
2	He	Helium	4.0026
3	Li	Lithium	6.941
4	Be	Beryllium	9.0122
5	B	Boron	10.811
6	C	Carbon	12.011
7	N	Nitrogen	14.007
8	O	Oxygen	15.999
9	F	Fluorine	18.998
10	Ne	Neon	20.180
11	Na	Sodium	22.990
12	Mg	Magnesium	24.305
13	Al	Aluminum	26.982
14	Si	Silicon	28.086
15	P	Phosphorus	30.974
16	S	Sulfur	32.065
17	Cl	Chlorine	35.453
18	Ar	Argon	39.948
19	K	Potassium	39.098
20	Ca	Calcium	40.078
21	Sc	Scandium	44.956
22	Ti	Titanium	47.867
23	V	Vanadium	50.942
24	Cr	Chromium	51.996
25	Mn	Manganese	54.938
26	Fe	Iron	55.845
27	Co	Cobalt	58.933
28	Ni	Nickel	58.693
29	Cu	Copper	63.546
30	Zn	Zinc	65.408
31	Ga	Gallium	69.723
32	Ge	Germanium	72.64
33	As	Arsenic	74.922
34	Se	Selenium	78.96
35	Br	Bromine	79.904
36	Kr	Krypton	83.798
37	Rb	Rubidium	85.468
38	Sr	Strontium	87.62
39	Y	Yttrium	88.906
40	Zr	Zirconium	91.224
41	Nb	Niobium	92.906
42	Mo	Molybdenum	95.94
43	Tc	Technetium	(98)
44	Ru	Ruthenium	101.07
45	Rh	Rhodium	102.91
46	Pd	Palladium	106.42
47	Ag	Silver	107.87
48	Cd	Cadmium	112.41
49	In	Indium	114.82
50	Sn	Tin	118.71
51	Sb	Antimony	121.76
52	Te	Tellurium	127.60
53	I	Iodine	126.90
54	Xe	Xenon	131.29
55	Cs	Cesium	132.91
56	Ba	Barium	137.33
57	*La	Lanthanum	138.91
58	Ra	Radium	(226)
59	Pr	Praseodymium	140.91
60	Nd	Neodymium	144.24
61	Pm	Promethium	(145)
62	Sm	Samarium	150.36
63	Eu	Europium	151.96
64	Gd	Gadolinium	157.25
65	Tb	Terbium	158.93
66	Dy	Dysprosium	162.50
67	Ho	Holmium	164.93
68	Er	Erbium	167.26
69	Tm	Thulium	168.93
70	Yb	Ytterbium	173.04
71	Lu	Lutetium	174.97
72	Hf	Hafnium	178.49
73	Ta	Tantalum	180.95
74	W	Tungsten	183.84
75	Re	Rhenium	186.21
76	Os	Osmium	190.23
77	Ir	Iridium	192.22
78	Pt	Platinum	195.08
79	Au	Gold	196.97
80	Hg	Mercury	200.59
81	Tl	Thallium	204.38
82	Pb	Lead	207.2
83	Bi	Bismuth	208.98
84	Po	Polonium	(209)
85	At	Astatine	(210)
86	Rn	Radon	(222)
87	Fr	Francium	(223)
88	Ra	Radium	(226)
89	#Ac	Actinium	(227)
90	Th	Thorium	232.04
91	Pa	Protactinium	231.04
92	U	Uranium	238.03
93	Np	Neptunium	(237)
94	Pu	Plutonium	(244)
95	Am	Americium	(243)
96	Cm	Curium	(247)
97	Bk	Berkelium	(247)
98	Cf	Californium	(251)
99	Es	Einsteinium	(252)
100	Fm	Fermium	(257)
101	Md	Mendelevium	(258)
102	No	Nobelium	(259)
103	Lr	Lawrencium	(260)
104	Rf	Rutherfordium	(261)
105	Db	Dubnium	(262)
106	Sg	Seaborgium	(266)
107	Bh	Bohrium	(264)
108	Hs	Hassium	(277)
109	Mt	Moscovium	(268)
110	Uun	Ununium	(281)
111	Uuu	Ununium	(272)
112	Uub	Unbinium	(285)
113	Uut	Ununtrium	(284)
114	Uuq	Ununquadium	(289)
115	Uup	Ununpentium	(288)
116	Uuq	Ununhexium	(285)
117	Uuh	Ununheptium	(288)
118	Uuo	Ununoctium	(286)

* Main-Group elements are also called *Representative Elements*.