

CHM 2120B
Midterm #2
November 10, 2010

*Answers
Version B.*

First Name: _____ Last Name: _____

Student Number: _____

Seat number: _____

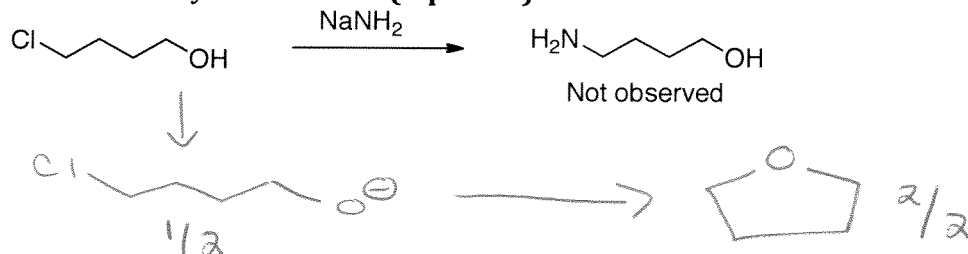
Approximate total number of marks: 58

Notes:

- The marks are given as a guide and are subject to minor changes.
- You can write in pen or in pencil.
- The use of molecular models is permitted but they cannot be shared.
- The use of faculty-approved calculators and rulers are permitted but cannot be shared.

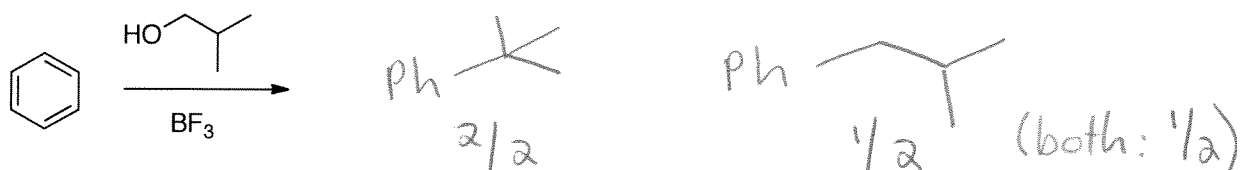
1a	2a	3b	4b	5b	6b	7b	8	1b	2b	3a	4a	5a	6a	7a	0		
1 H															2 He		
3 Li	4 Be										5 B	6 C	7 N	8 O	9 F	10 Ne	
11 Na	12 Mg										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Ha	106 106												

1. The following reaction would not work as shown. Draw the product that would actually be obtained. **(2 points)**

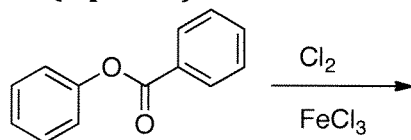


2. Give the major product(s) for each of the following reactions:

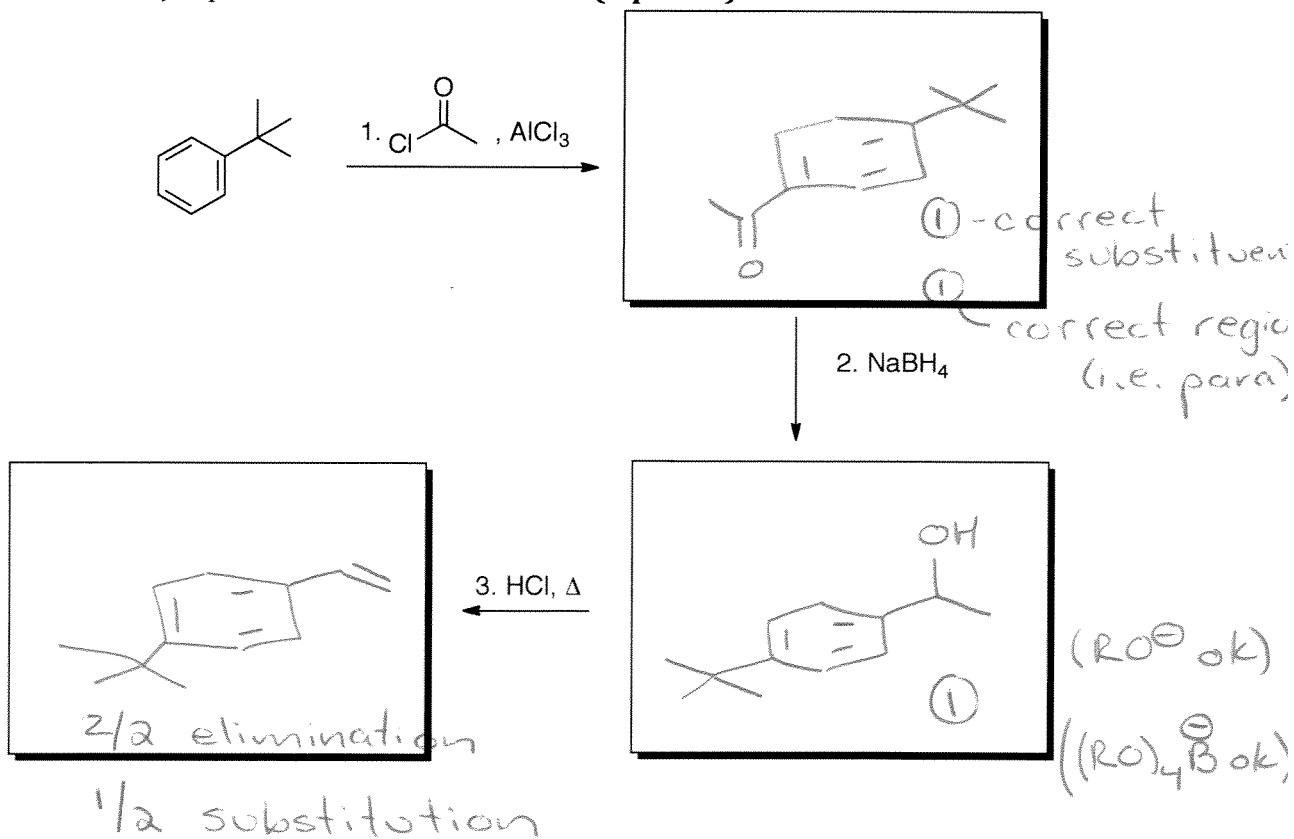
a. **(2 points)**



b. **(2 points)**

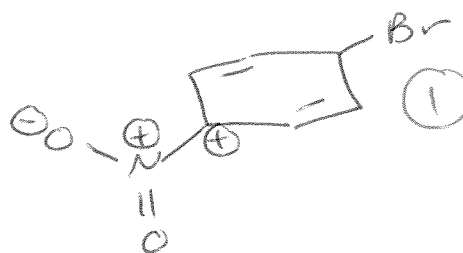
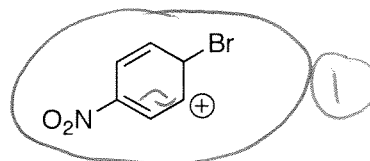
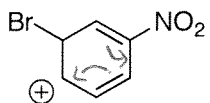


3. Give the major product after each reaction. **(5 points)**



4.

- a. Circle the least stable cation of the pair. **(1 point)**
b. Clearly justify your answer and include the key structures that support your answer. **(4 points)**



never 2

① adjacent ⊕'s
→ more stable

2 adjacent ⊕'s
① is very unstable

- c. What is the type of intermediate shown in this question? **(1 point)**

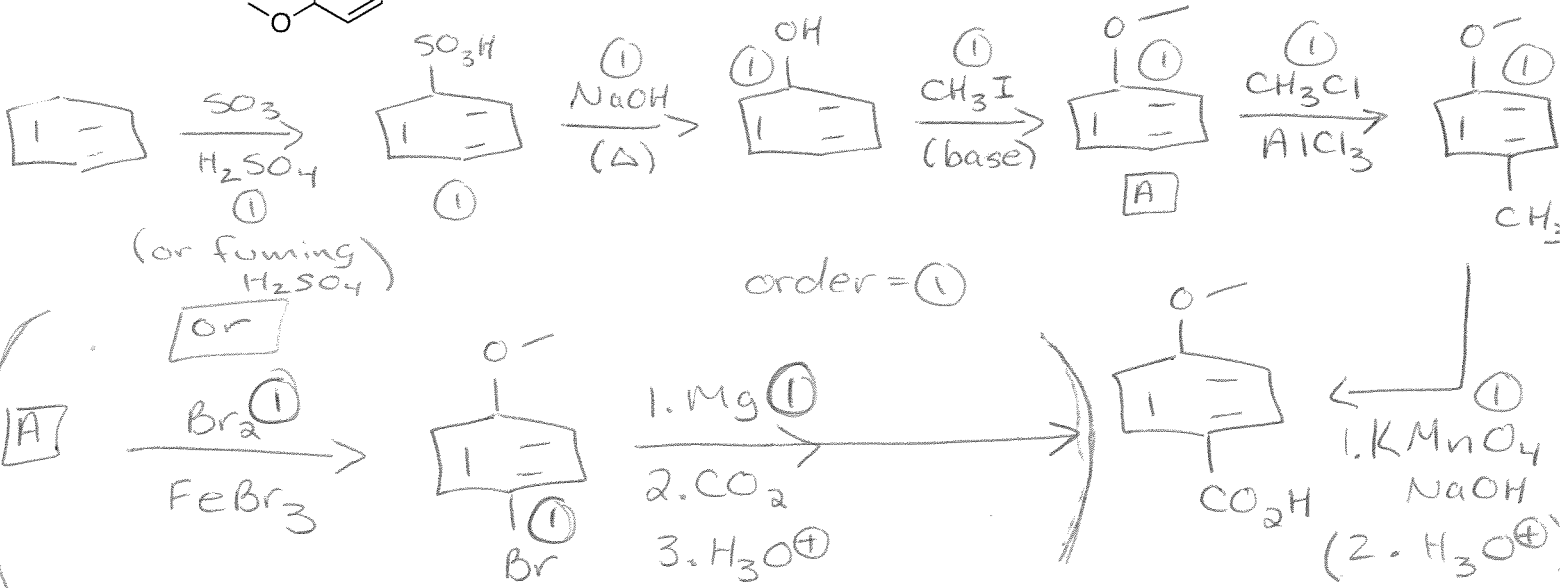
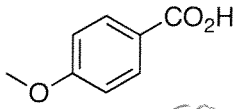
arenium

- d. Name the final product that is produced when the circled cation reacts with a base. **(2 points)**

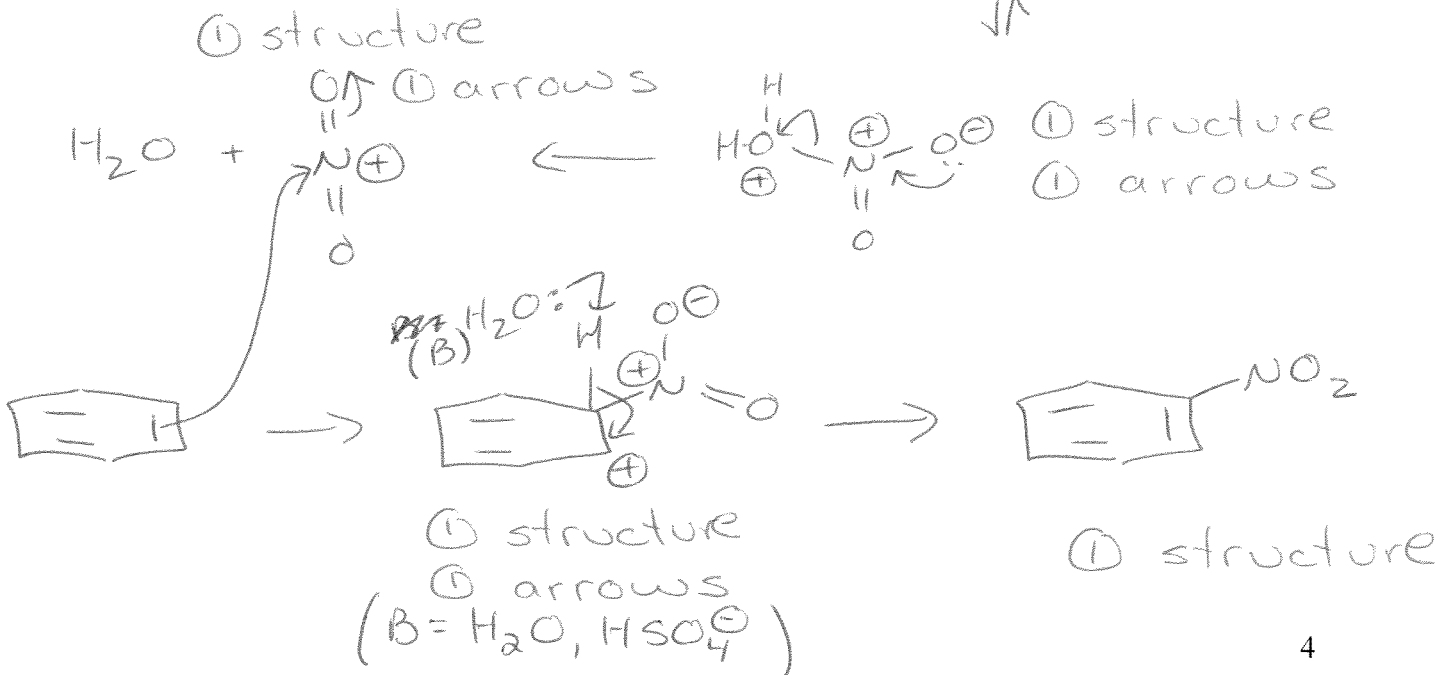
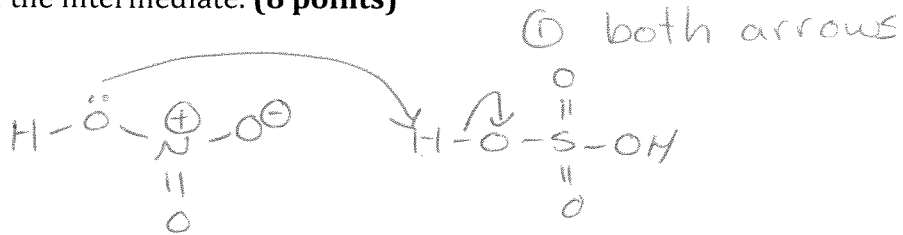
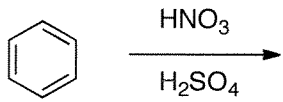
p-bromonitrobenzene
or

1-bromo-3-nitrobenzene.

5. Propose a synthesis of the following compound from benzene. (10 points)



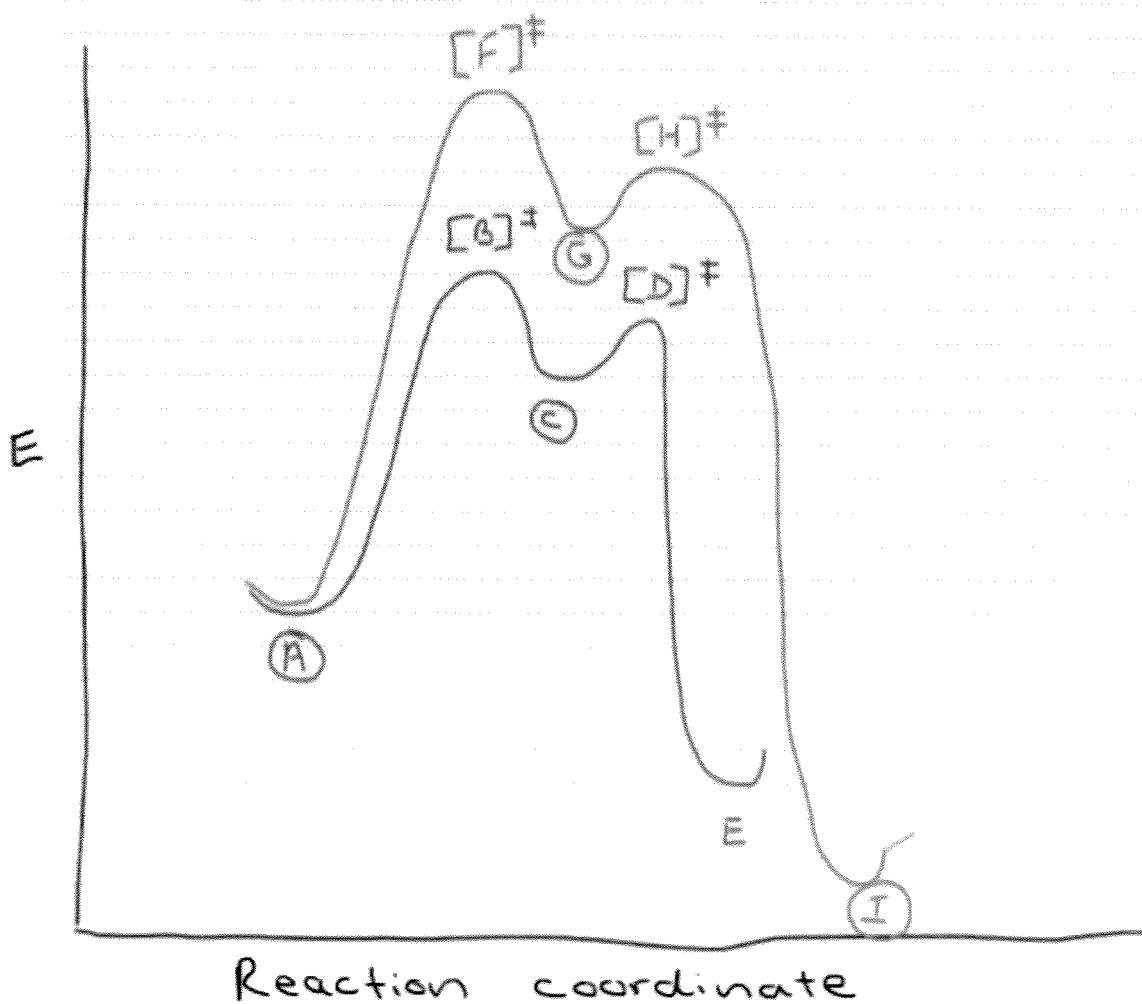
6. Draw the mechanism for the following reaction. It is not necessary to draw any resonance structures of the intermediate. (8 points)



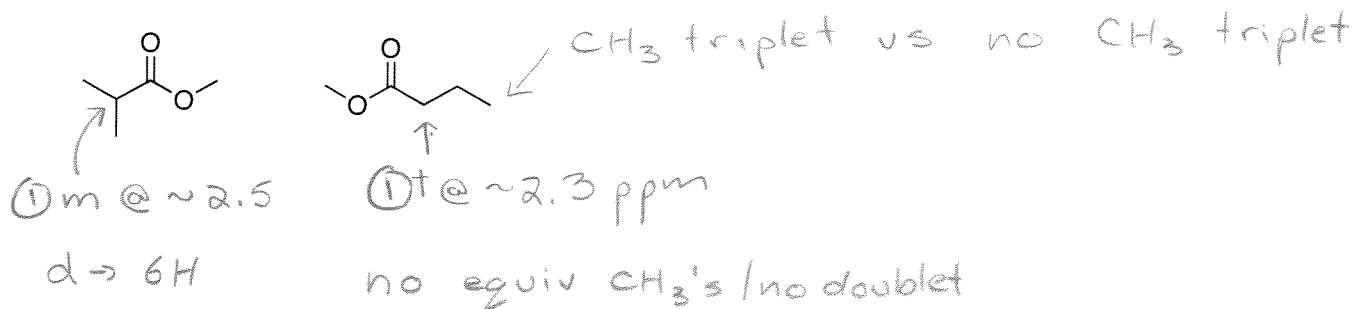
7. Consider the following reaction coordinate diagram, in which **A** is the starting material. (4 points)

- a. Which final product forms the fastest? E (1)
- b. Which is the most stable final product? I (1)
- c. Which structure does [F] most closely resemble? G (1)
- d. In one sentence, explain your answer in part c.

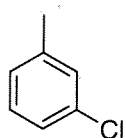
[F][‡] resembles the species to which it is closest in energy. (1)



8. How would you distinguish between the following isomers by proton NMR? (2 points)



9. How many ¹H NMR signals would be observed in the following compound? (2 points)



5 2/2

evidence that there is no plane of symmetry: 1/2

10. (4 points)

- Identify the key functional groups in the following IR spectrum.
- Circle the compound that corresponds to the following IR spectrum.

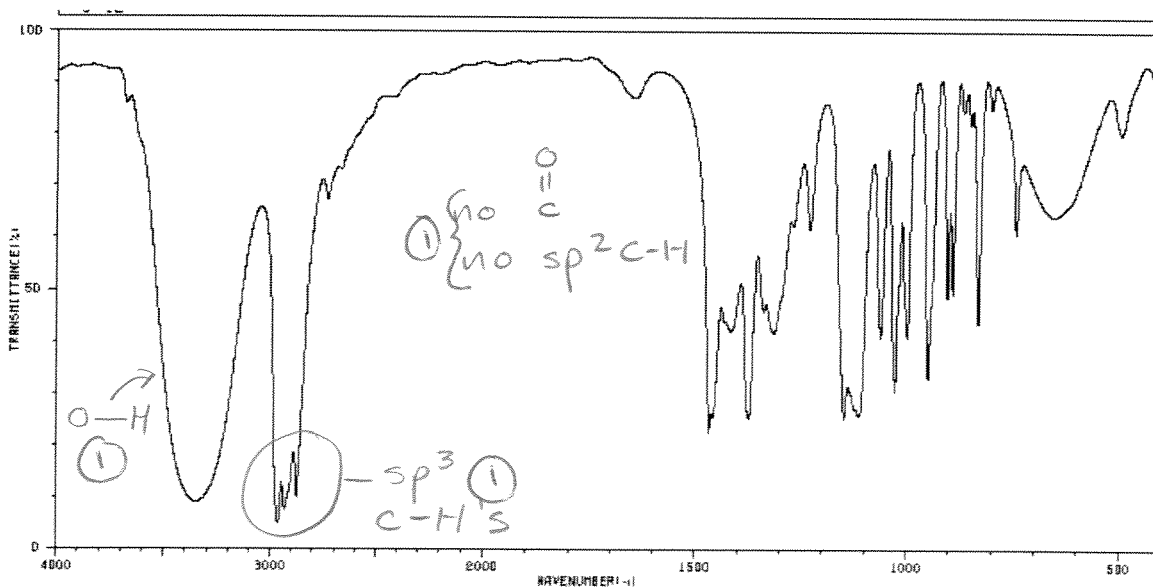
2-Pentanol

①

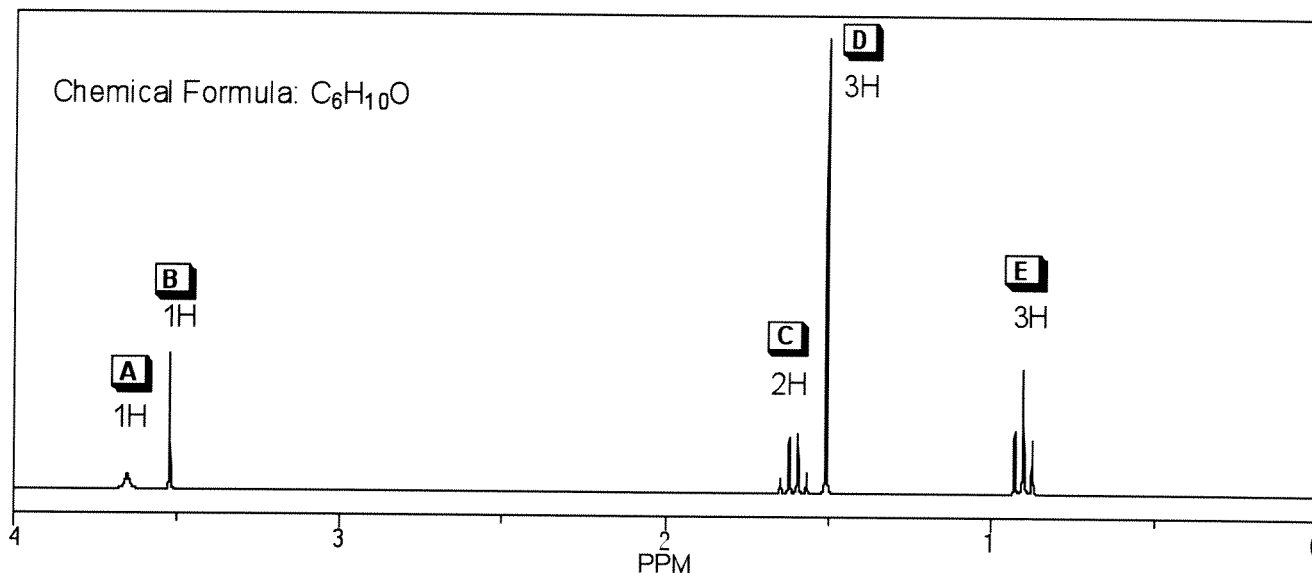
1-phenylpropan-1-one

Propanoic acid

Benzyl alcohol



11. What is the structure of the unknown compound whose molecular formula is $C_6H_{10}O$? The 1H NMR spectrum of this compound is below. (9 points)
 The IR shows the following peaks: 3400 cm^{-1} (strong, broad), 3290 cm^{-1} (medium, sharp), $\sim 2940\text{ cm}^{-1}$ (multiple peaks, medium, sharp), and 2219 cm^{-1} (medium, sharp).

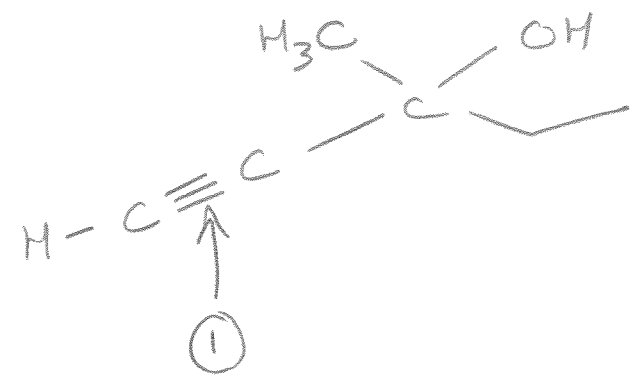


Signal	δ (ppm)	# H's	Multiplicity	Comments/Ideas
A	~3.6	1H	(br) s	$n=0$ $\boxed{-OH}$ ①
B	~3.5	1H	s	$n=0$ $\boxed{\equiv CH}$ ① (CH on alkyne)
C	~1.6	2H	q	$n=3$ $\boxed{-CH_2CH_3}$ ①
D	~1.5	3H	s	$n=0$ $\boxed{-CH_3}$ ①
E	~0.9	3H	t	$n=2$ $-CH_2CH_3$

errors ignored in column of ideas

① ①

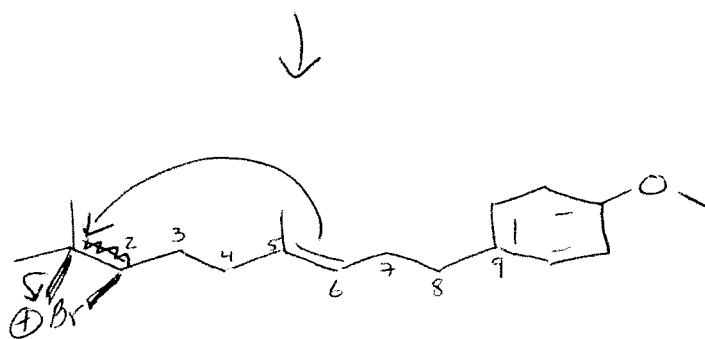
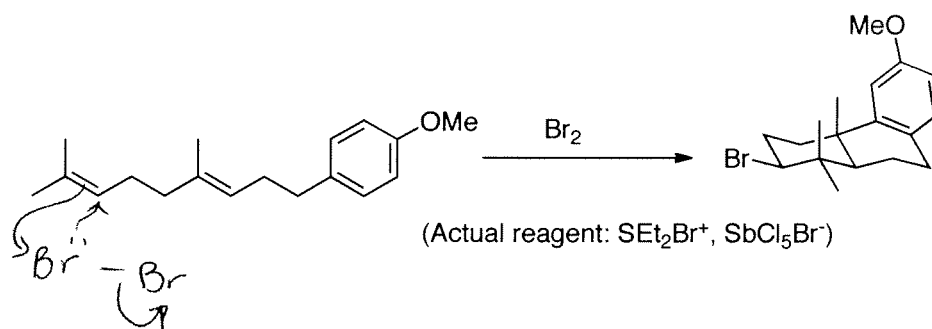
$DU = 2$



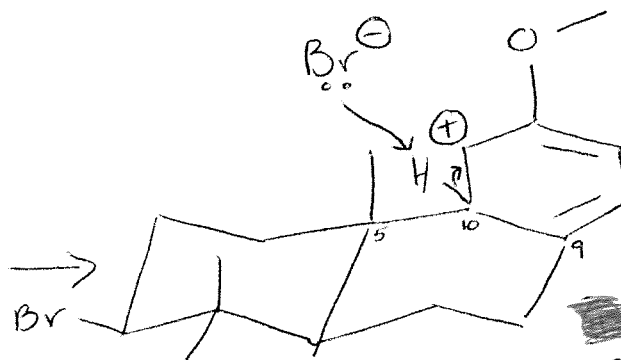
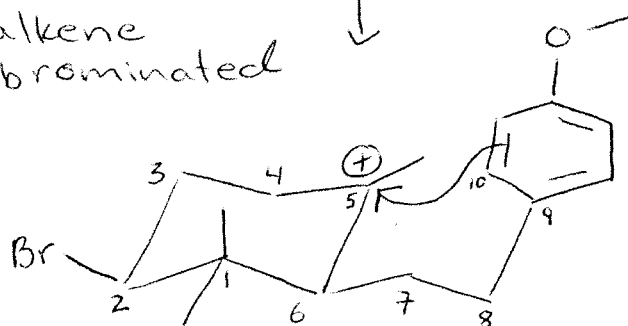
errors not ignored unless crossed out

BONUS! (3 points)

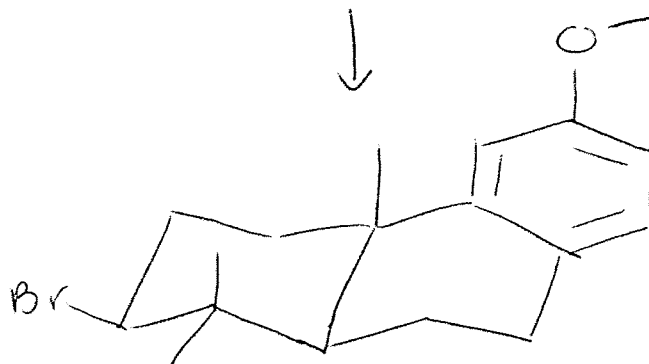
Provide a mechanism for the following transformation:



① alkene brominated



① cyclization

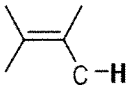
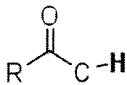
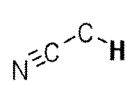
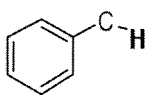
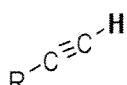
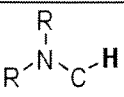
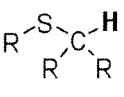
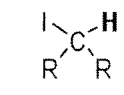
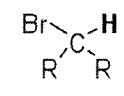
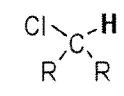
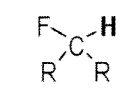
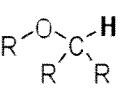
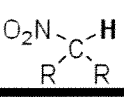
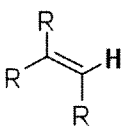
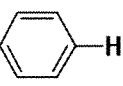
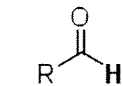
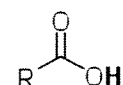


3/3 - perfect mechanism

IR: Key Absorptions (cm⁻¹):

C-H	Alkyl	C-H	2850-2960	m-s, sharp
C-H	sp ²	C-H	just >3000	m-s, sharp
Alcohol		RO-H	3200-3650	s, broad
Carboxylic acid		RC(=O)O-H	2500-3300	s, broad
Amine		R₂N-H	3300-3500	s, broad
Carbonyl		R₂C=O	1650-1780	s, sharp
Nitrile		RC≡N	2220-2260	v, sharp
Alkynyl		C≡C-H	~3300	m-s, sharp
Alkynyl		C≡C	2100-2260	v, sharp

¹H NMR - Key APPROXIMATE chemical shifts (ppm):

$R-C-CH_n$ 0.7 - 1.7  $R-C(=O)-H$ 2.1-2.5  $N≡C-H$ 2.1 - 3.0   $R-C≡C-H$ 1.7 - 3.6 	$R-N-C-H$ 2.2 - 2.9  $R-S-C-H$ 2.0 - 3.0  $I-C-H$ 2.0 - 4.0  $Br-C-H$ 2.7 - 4.1  $Cl-C-H$ 3.1 - 4.1  $F-C-H$ 4.2 - 4.8  $R-O-C-H$ 3.0 - 5.0  O_2N-C-H 4.1 - 4.3 	$R-C=C-H$ 4.5 - 7.0   $R-C(=O)-H$ 9.0 - 10.0  $R-C(=O)-OH$ 11.0 - 12.0 
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