

CHM 2120A  
Midterm #2  
November 17, 2011  
Professor: A. Flynn

First Name: \_\_\_\_\_ Last Name: \_\_\_\_\_

Student Number: \_\_\_\_\_

Seat number: \_\_\_\_\_

Approximate total number of marks: 66

Notes:

The marks are given as a guide and are subject to minor changes.

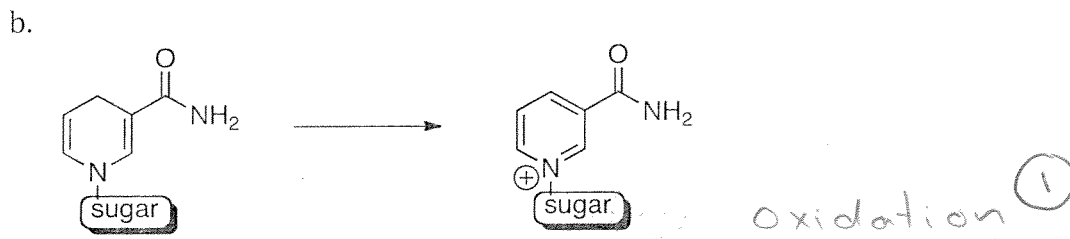
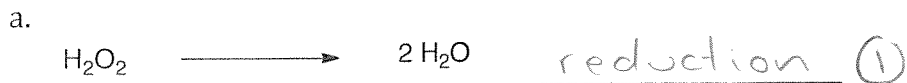
You can write in pen or in pencil.

The use of molecular models is permitted but they cannot be shared.

The use of faculty-approved calculators and rulers is permitted but they cannot be shared.

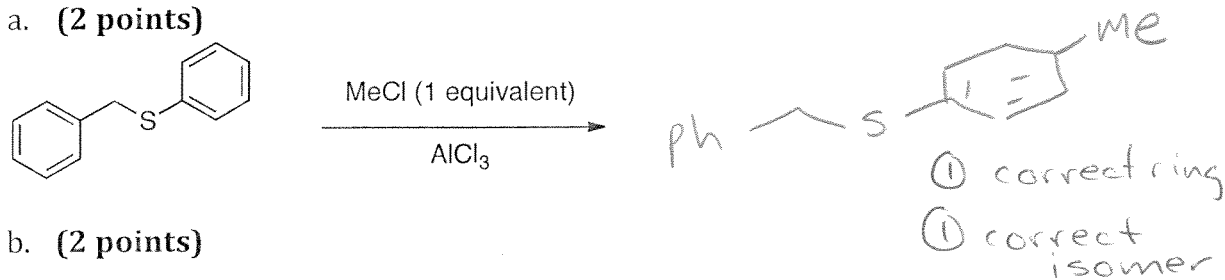
1a	2a	3b	4b	5b	6b	7b	8	1b	2b	3a	4a	5a	6a	7a	0		
1 H															2 He		
3 Li	4 Be										5 B	6 C	7 N	8 O	9 F	10 Ne	
11 Na	12 Mg										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 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. Decide whether each of the following represent an oxidation or a reduction reaction. (2 points)

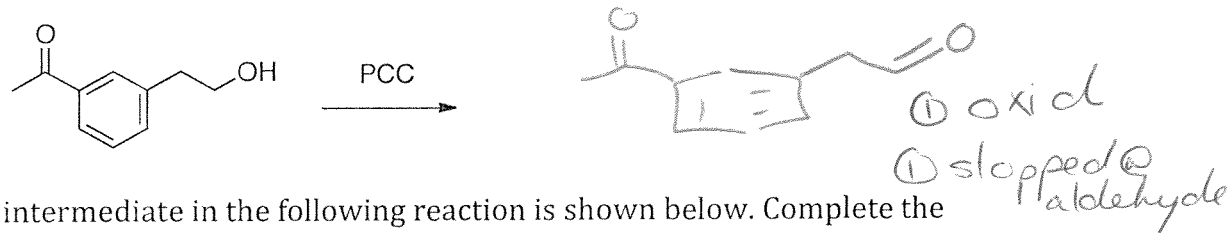


2. Give the major product(s) for each of the following reactions:

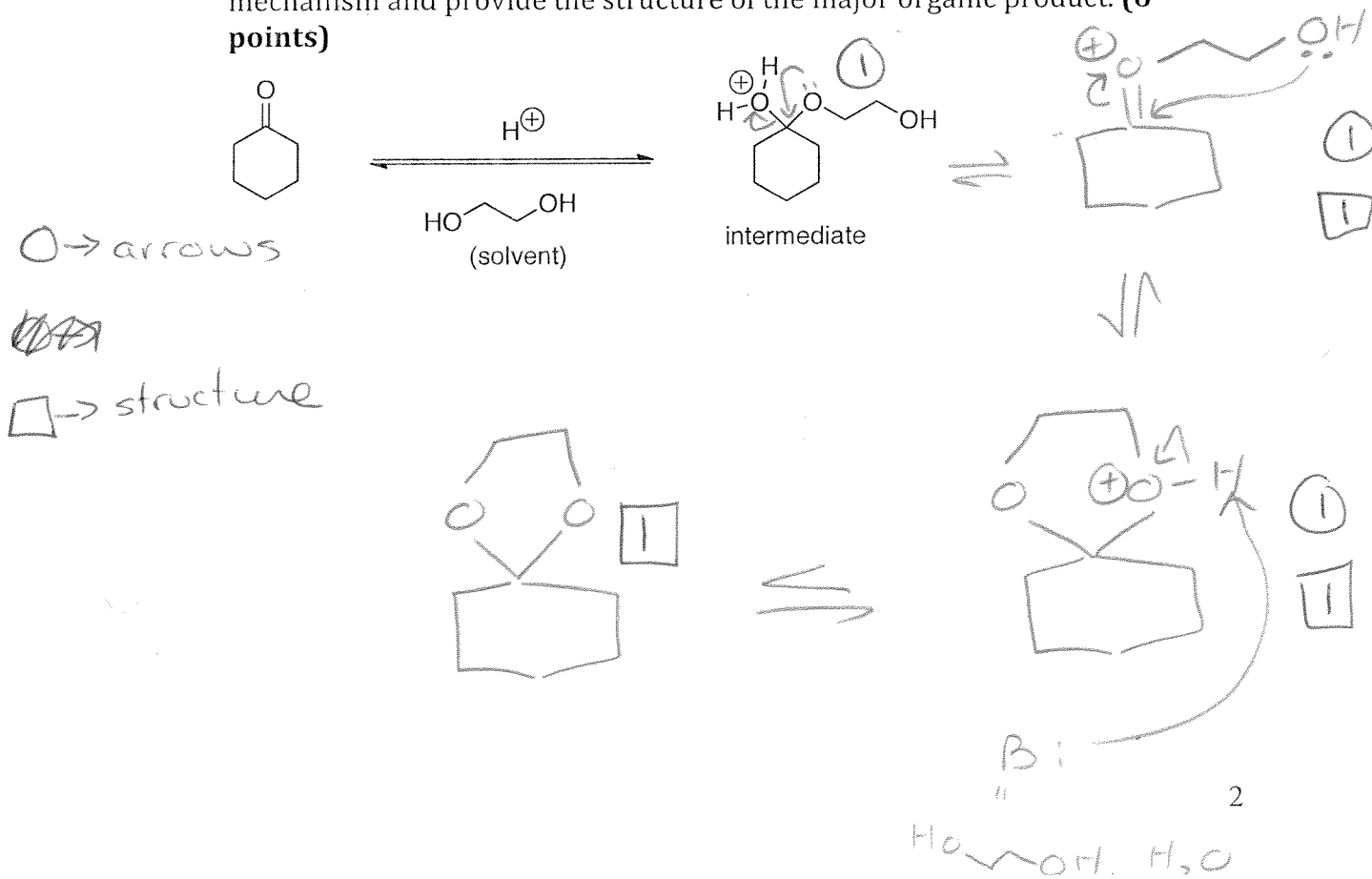
a. (2 points)



b. (2 points)

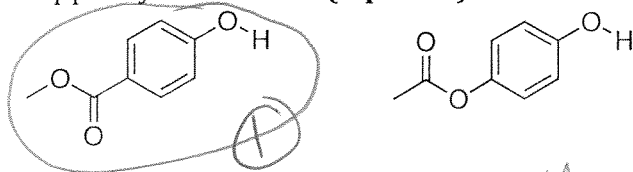


3. An intermediate in the following reaction is shown below. Complete the mechanism and provide the structure of the major organic product. (6 points)

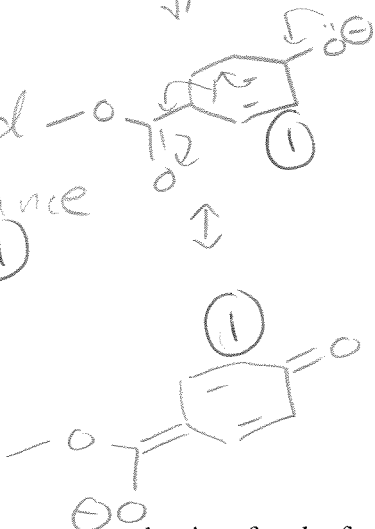


4.

- Circle the strongest acid of the pair. (1 point)
- Clearly justify your answer and include the key structures that support your answer. (5 points)



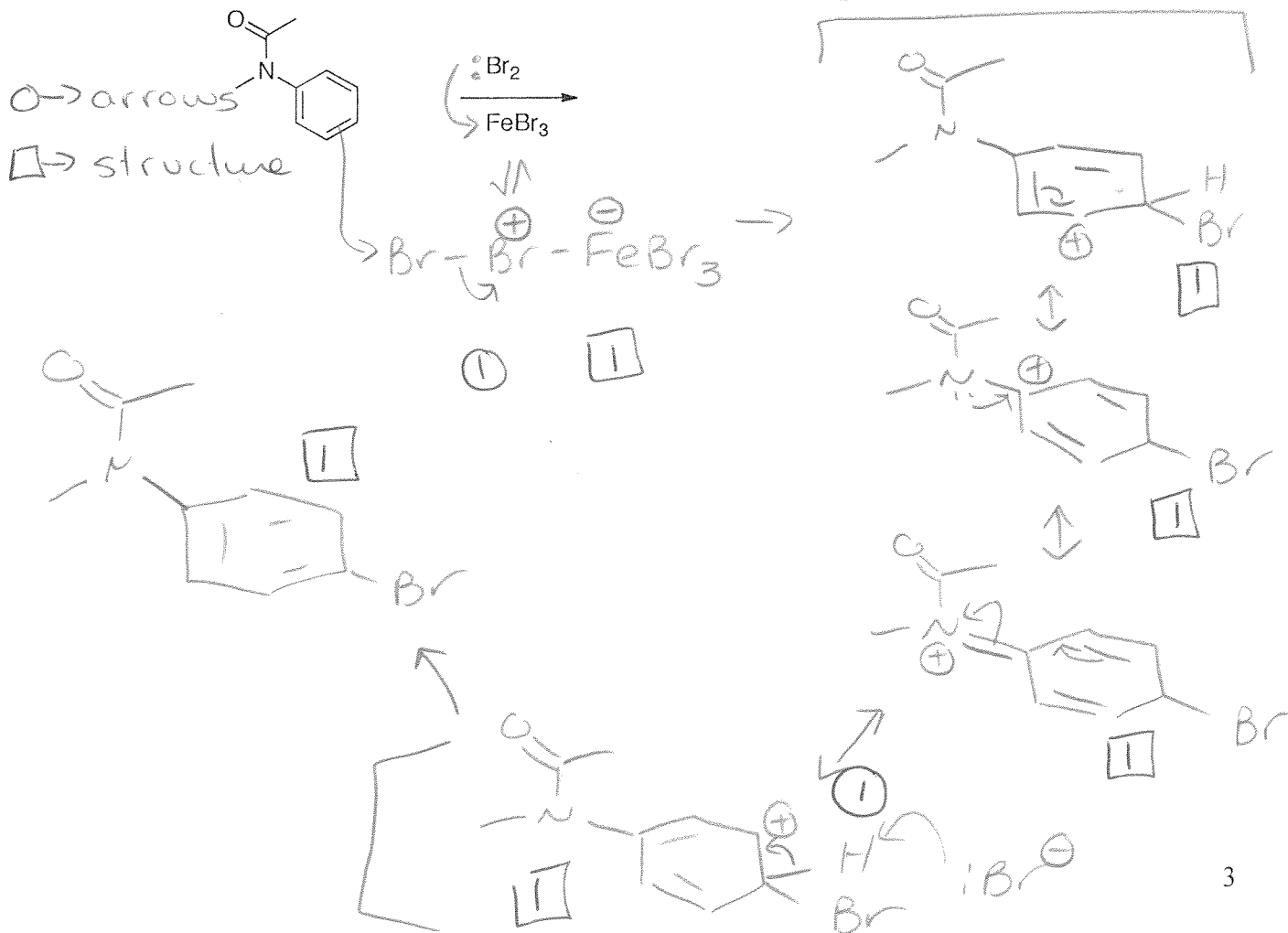
the c.b. is stabilized by resonance with the ester  
 lower E c.b.



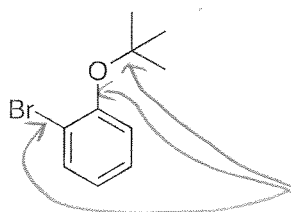
the c.b. is destabilized by resonance with the ester  
 higher E base



- Propose a mechanism for the formation of the major product of the following reaction. Please include resonance structures. (8 points)



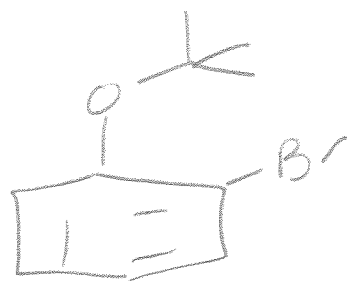
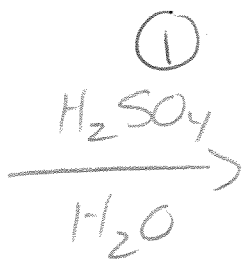
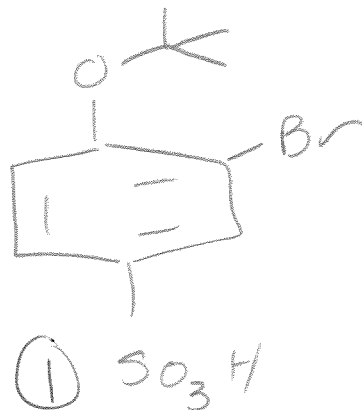
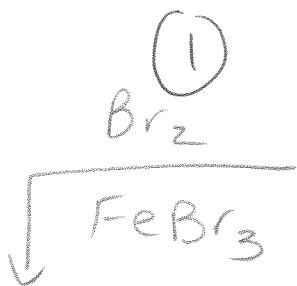
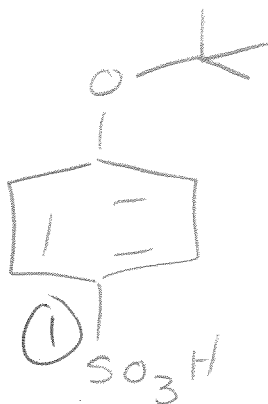
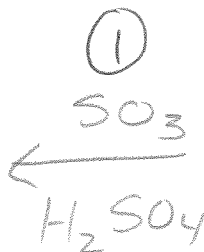
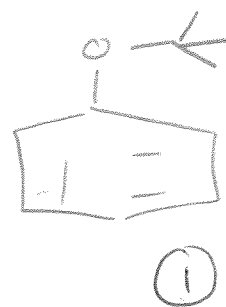
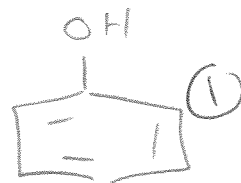
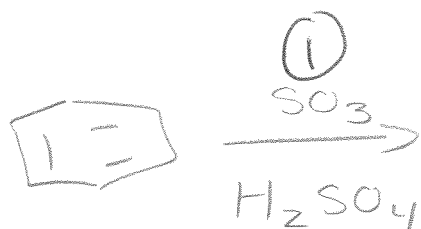
6. Propose a synthesis of the following compound starting from benzene. Include an analysis (bonds broken, bonds formed/groups added, regiochemistry, stereochemistry). It is not necessary to include mechanisms. (14 points)



Bonds broken:  $\pi$  (1)  
 " formed (2), etc.

Regiochem: ortho (1)

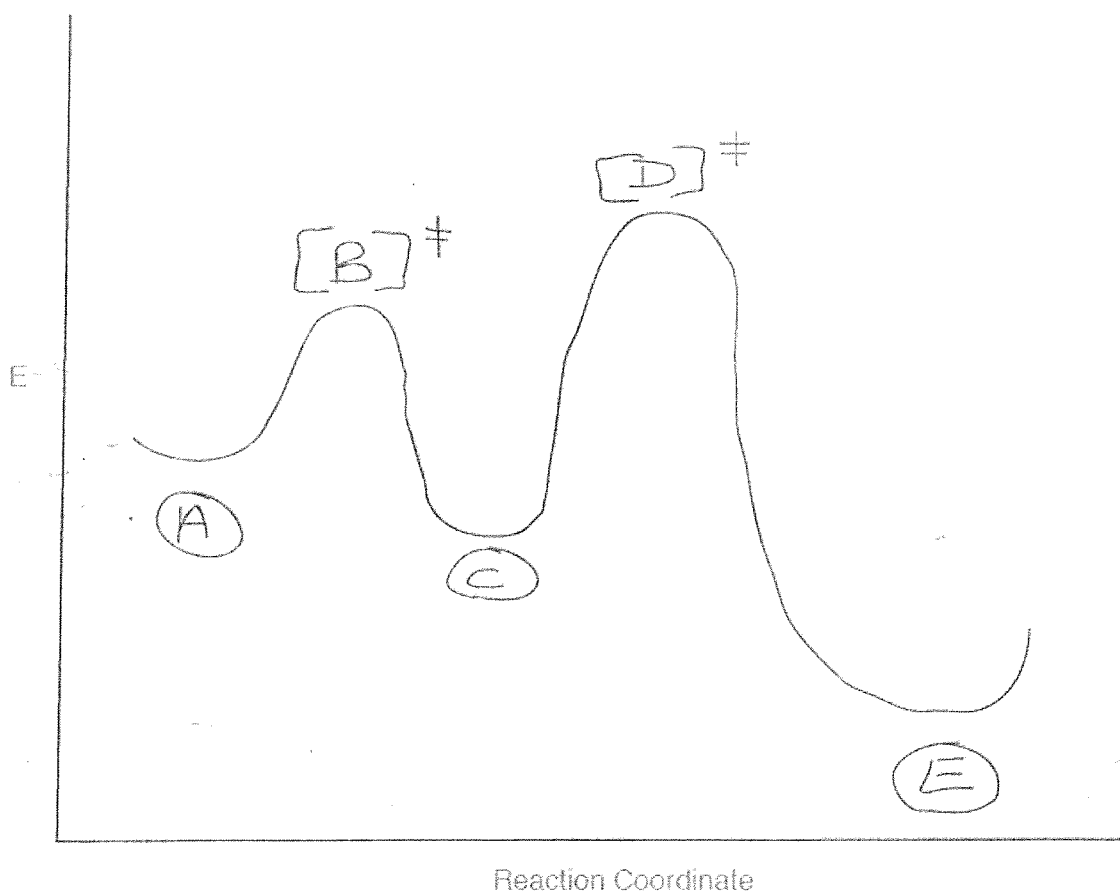
Stereochem: N/A -



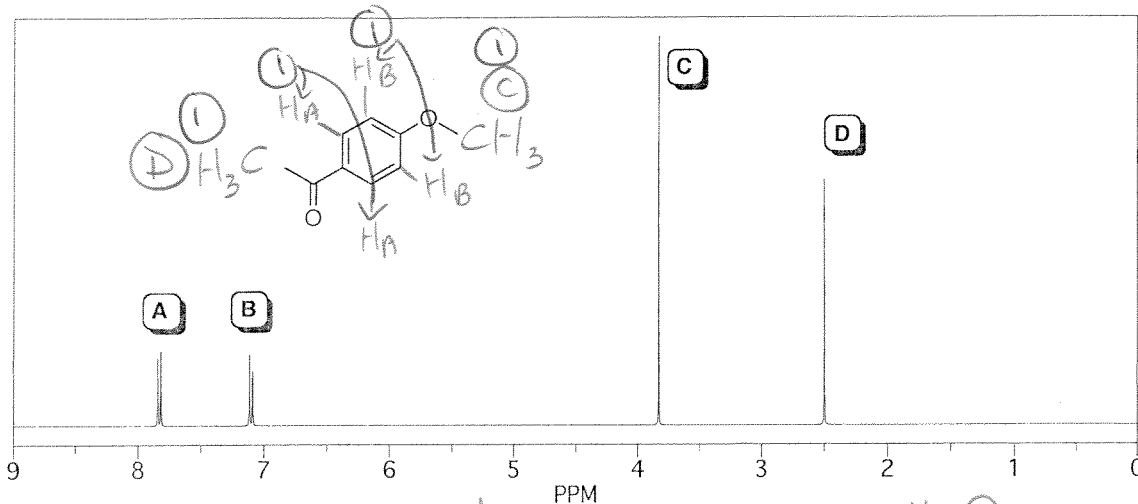
7. Consider the following reaction coordinate diagram, in which **C** is the starting material. (4 points)

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

[B]<sup>‡</sup> most closely resembles the species that is closest to it in energy (1)

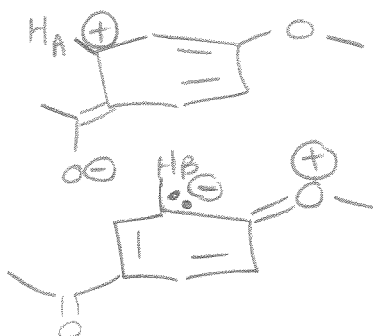


8. Assign each of the signals in the  $^1\text{H}$  NMR spectrum shown below to protons in the structure shown. For the aromatic signals, briefly explain your answer using structures as appropriate. (6 points)

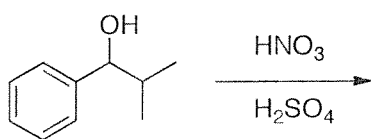


①  $\text{H}_A$ s are deshielded by resonance ( $\bar{u} \text{C}=\text{O}$ )

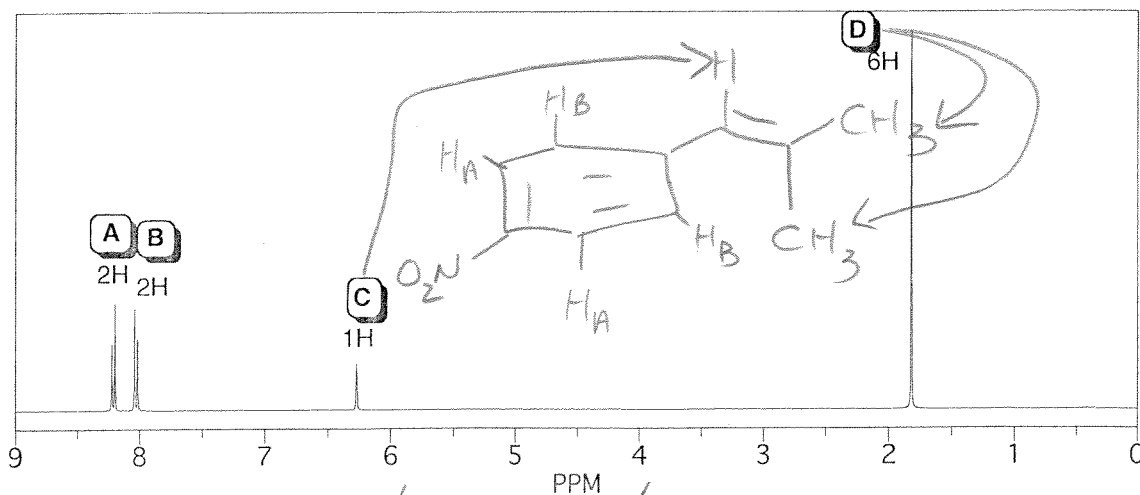
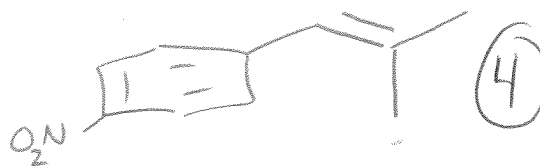
①  $\text{H}_B$ s are shielded by resonance ( $\bar{u} \text{OCH}_3$ )



9. Draw the major product of the following reaction. The  $^1\text{H}$  NMR spectrum for the major product is shown below. Part marks will be awarded for correctly assigning the NMR signals to structure in the product. (4 points)

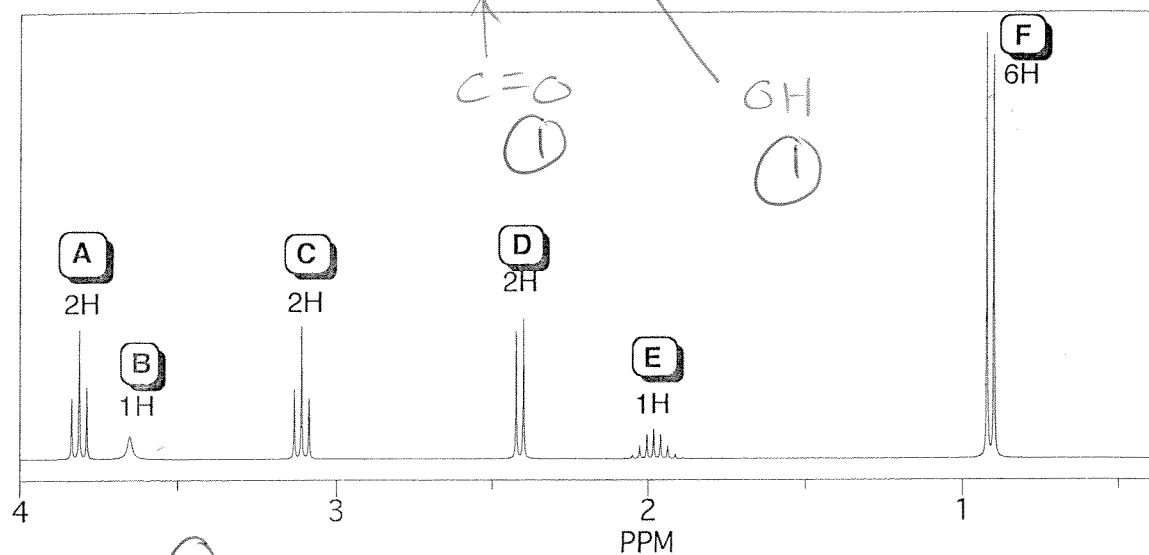


$\text{C}_{10}\text{H}_{11}\text{NO}_2$



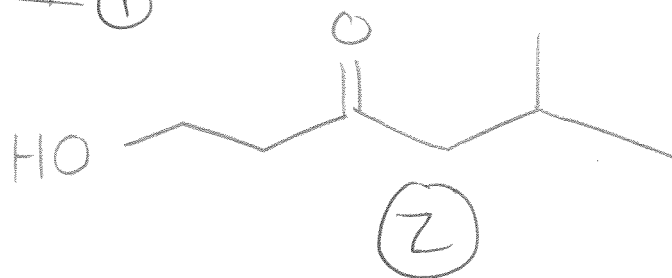
part marks: 1 pt per correctly assigned signal

10. What is the structure of the unknown compound whose molecular formula is  $C_7H_{14}O_2$ ? The  $^1H$  NMR spectrum of this compound is below. (12 points)  
 The IR shows the following peaks:  $3400\text{ cm}^{-1}$  (strong, broad),  $\sim 2940\text{ cm}^{-1}$  (multiple peaks, medium, sharp), and  $1715$  (strong, sharp).



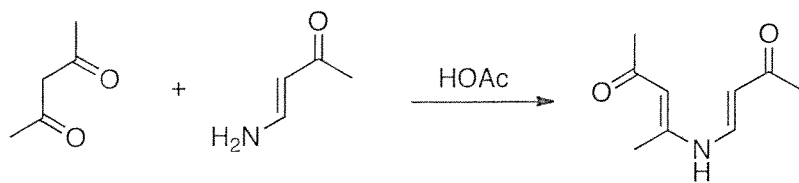
Signal	$\delta$ (ppm)	# H's	Multiplicity	Comments/Ideas
A	~3.8	2H	t	① $CH_2 - CH_2$ ←
B	~3.6	1H	(br)s	① OH
C	~3.2	2H	t	① $CH_2 - CH_2$ ←
D	~2.4	2H	d	① $CH_2 - CH$ ←
E	~2.0	1H	m	① $-CH$ ←
F	~0.9	6H	d	① $2 \times CH_3 - CH$ ←

$DU = 1$  ①



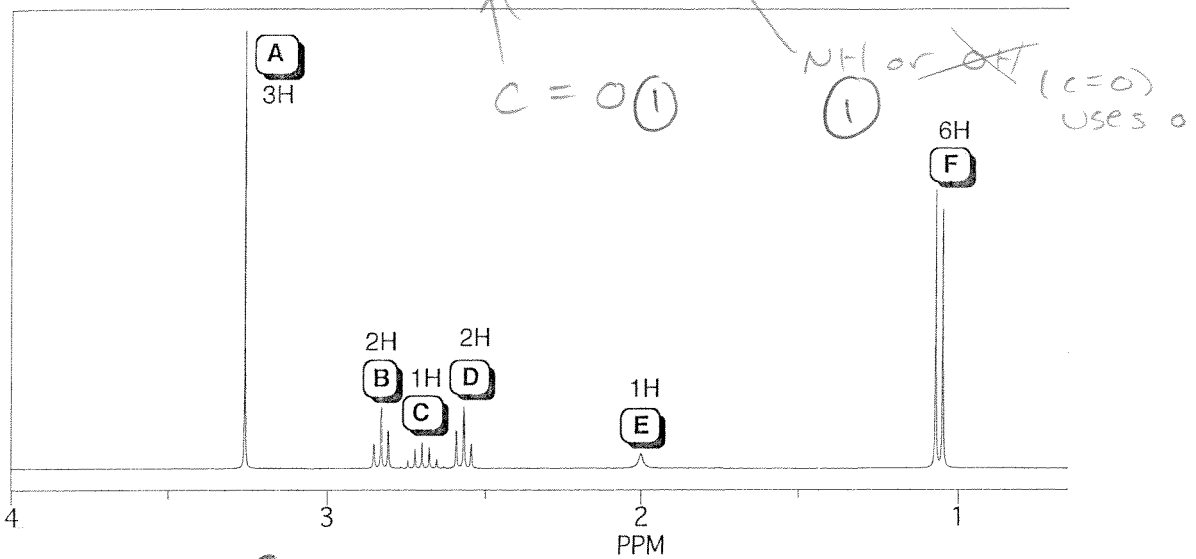
**BONUS! (3 points)**

Provide a mechanism for the following transformation:



(Eventually, a substituted pyridine is formed)

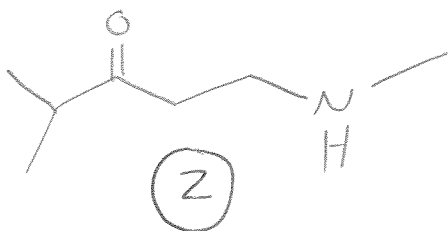
10. What is the structure of the unknown compound whose molecular formula is  $C_7H_{15}NO$ ? The  $^1H$  NMR spectrum of this compound is below. (12 points)  
 The IR shows the following peaks:  $3400\text{ cm}^{-1}$  (strong, broad),  $\sim 2940\text{ cm}^{-1}$  (multiple peaks, medium, sharp), and  $1715$  (strong, sharp).



Signal	$\delta$ (ppm)	# H's	Multiplicity	Comments/Ideas
A	~3.3	3H	s	$CH_3$ (1)
B	~2.8	2H	t	$CH_2 - CH_2$ (1)
C	~2.7	1H	m	$CH$ (1)
D	~2.6	2H	t	$CH_2 - CH_2$ (1)
E	~2.0	1H	(br)s	NH (1)
F	~1.1	6H	d	$2 \times CH_3 - CH$ (1)

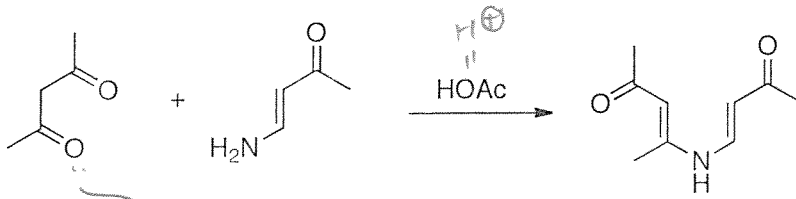
together  
together

$$DU = 1 \text{ (1)}$$



**BONUS! (3 points)**

Provide a mechanism for the following transformation:



(Eventually, a substituted pyridine is formed)

