

Sign Name Key Print Name _____
 (3 pts name print & sign, 3 pt scantron name) (100 pts, 11 pages, periodic table, equation sheet, scantron)

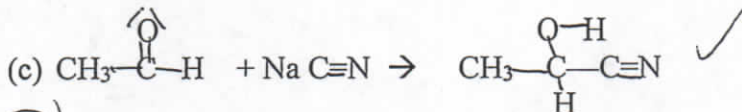
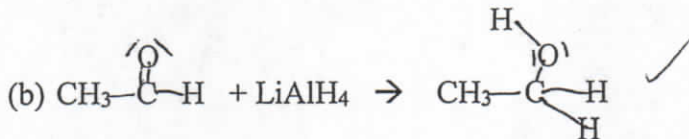
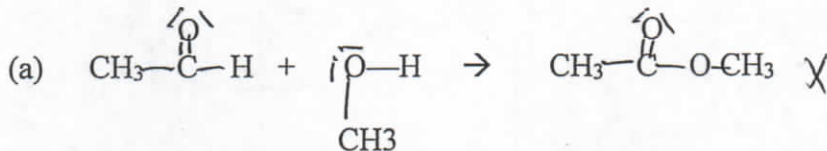
Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper – If you want me to grade something not in the space for the answer, clearly specify in writing. Telling me during the exam where to find the answer does not qualify because I will just vaguely remember someone telling me something during the exam not which one of 200 students told me what to grade on what page.) There is no partial credit for showing work in the multiple choice. In all questions on all parts of this exam, R is not equal to hydrogen but is an alkyl.

Assume standard workup in all reactions even if workup is not explicitly shown.

Please READ and FOLLOW directions. This is a **TIMED EXAM**. (ex: don't give me 5 structures if I only ask for one or you will lose points on this exam by **RUNNING OUT OF TIME**)

I. Multiple Choice (3 pts each, 27 pts) Choose the **one** best statement in each question.

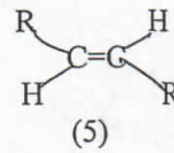
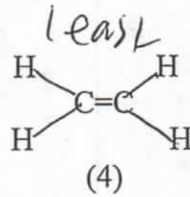
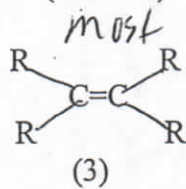
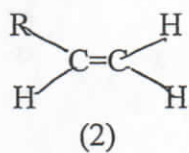
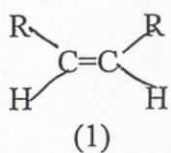
1. By "Nucleophilic Addition" choose the best reaction.



(d) (b) and (c) are correct.

(e) All except (d) are correct.

2. According to Zaitsev's (or sometimes spelled Saytzeff's) Rule, the most stable to least stable alkene is: Choose the one best statement. (R ≠ H)



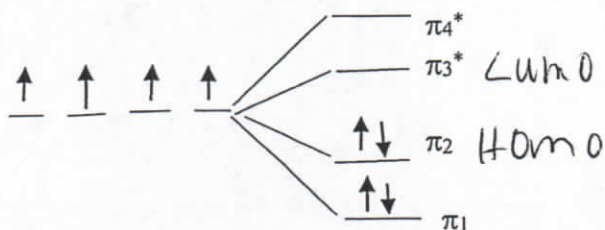
(a) Most stable (3) > (5) > (1) > (2) > (4) Least stable

(b) Most stable (3) > (4) > (5) > (1) > (2) least stable

(c) Most stable (4) > (2) > (1) > (5) > (3) least stable

(d) You can't tell which alkene is stable by looking at the structure. All alkenes are similarly stable

3. For UV - Vis spectra:



- a) LUMO is π_3^* ✓
 b) HOMO is π_4^*
 c) UV transitions measure $\pi_2 \rightarrow \pi_3^*$ ✓
 (d) (a) and (c) are correct
 e) (b) and (c) are correct

4. To generate an alcohol from an alkene, one may use which of the following reagents over the arrow.

(a) (1) $\text{Hg}(\text{OAc})_2$, THF/ H_2O (2) OH^- , NaBH_4 to give Markovnikov product without the possibility of rearrangement. ✓

(b) Alkene reaction with MCPBA followed by reaction of a Grignard followed by workup. ✓

(c) $\text{H}^+/\text{H}_2\text{O}$ to give Markovnikov product. ✓

(d) (1) $\text{BH}_3:\text{THF}$ (2) H_2O_2 , OH^- to give anti-Markovnikov product ✓

(e) All above statements are true.

5. Which of the following is an o,p activator? I am showing the part that attaches to the benzene ring.

(a) $\text{-}\overset{\text{H}}{\text{N}}\text{-H}_2$ o,p

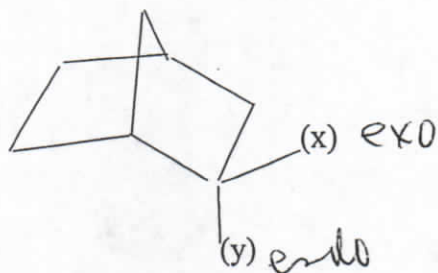
(b) $\text{-}\overset{\text{O}}{\text{N}}\text{-O}^-$ m

(c) $\text{-}\overset{\text{H}}{\text{O}}\text{-H}$ o,p

(d) (a) & (c) are o,p activators

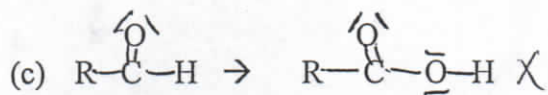
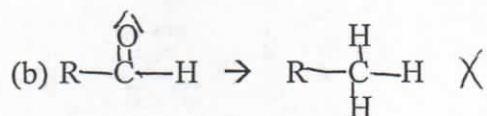
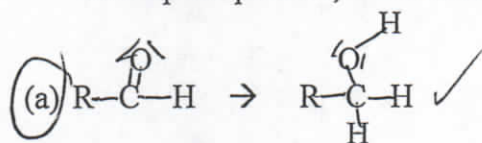
(e) None shown are o,p activators.

6. In the following molecule, which is endo/exo. Choose the best statement.



- (a) (x) is exo ✓
(b) (x) is endo
(c) (y) is endo ✓
(d) There is no exo / endo in this molecule.
(e) (a) and (c) are correct.

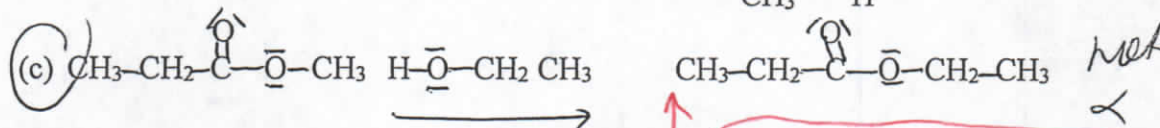
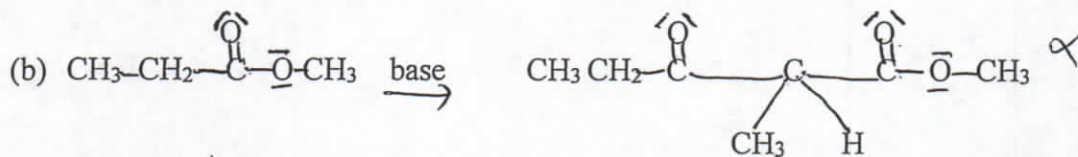
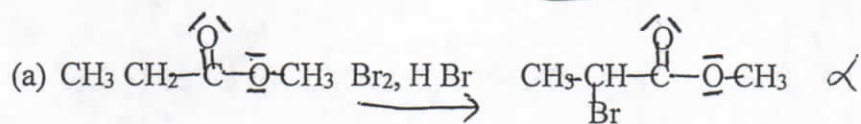
7. If you start with a ketone or aldehyde, and you reduce it using a reducing agent like LiAlH_4 and then work up the product, which of the following reactions are correct ?



(d) (a) and (b) are correct

(e) (a), (b) and (c) are correct.

8. Which of the following reactions is NOT a reaction of an α carbon ?

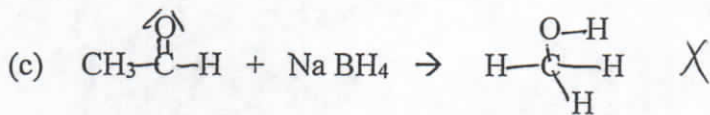
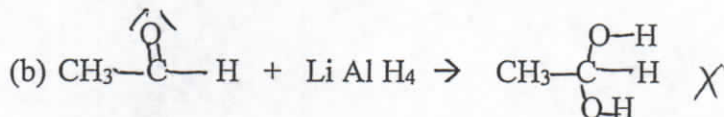
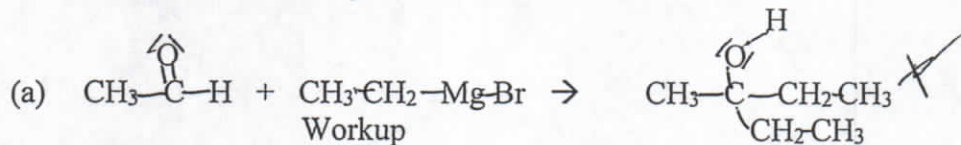


(d) (a) and (b) are α carbon reactions

(e) All of the above are α carbon reactions.

both are correct + were graded correct

9. Which of the following are incorrect ?



(d) All are correct.

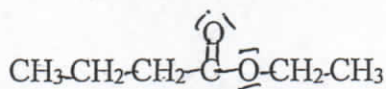
(e) All are incorrect.

II. Short Answers (42 pts)

A. Nomenclature: (2 pts each, 6 pts)

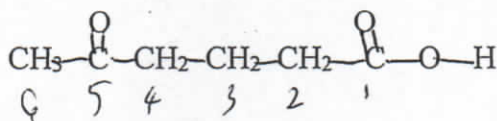
1. Given the structural formula shown below, give a valid name of the molecule.

a. name ethyl butanoate



~~butanoic acid~~
ethyl ~~ate~~

b. name 5-oxohexanoic acid



hexanoic acid

5-oxo

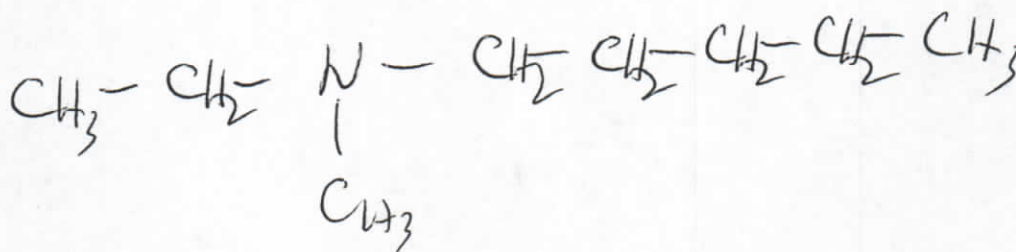
$\frac{1}{2}$ pt off
each wrong

bring up to $-\frac{1}{2}$

By A - $\frac{1}{2}$

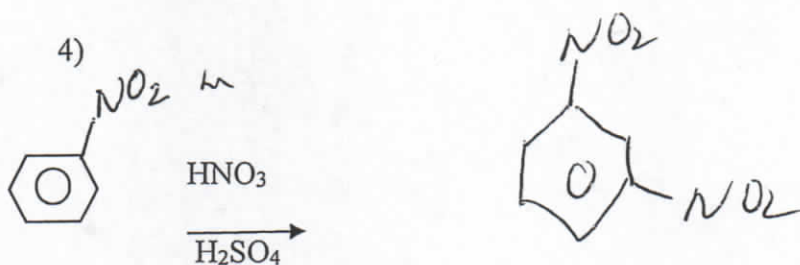
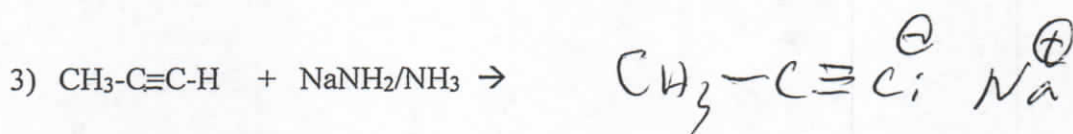
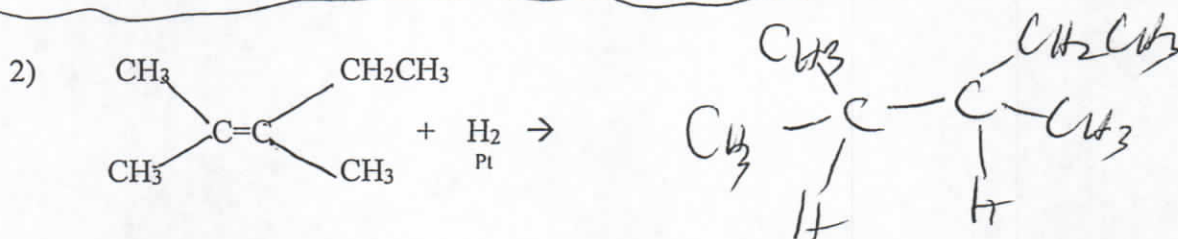
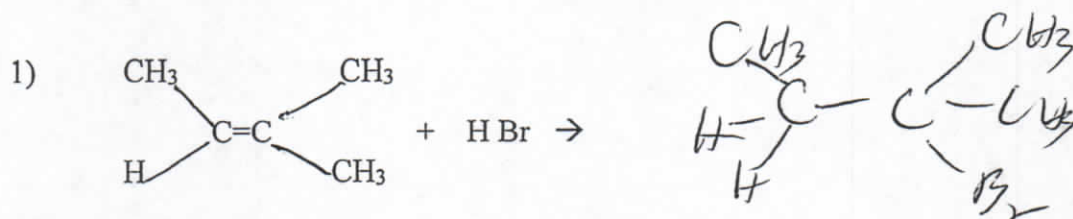
2. Given the following IUPAC name, draw a structural formula of the molecule (skeletal formula acceptable, condensed structure, Lewis Dot structure acceptable, molecular formula not acceptable - don't forget to show the hydrogens in your formula unless you are using the skeletal structure.)

N-ethyl-N-methyl pentanamine



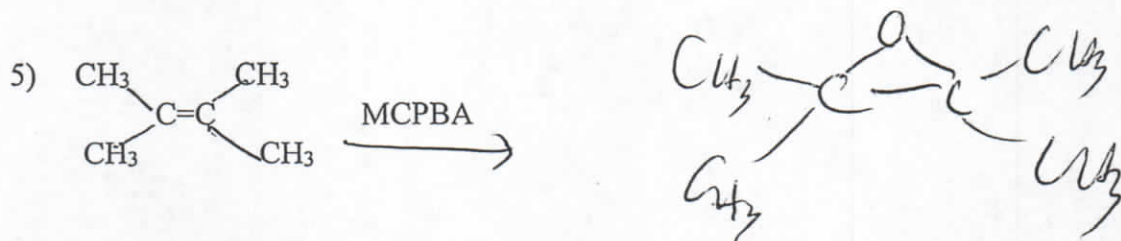
B. Reactions Part of Short Answers: (2 pts per reaction, 16 pts total)

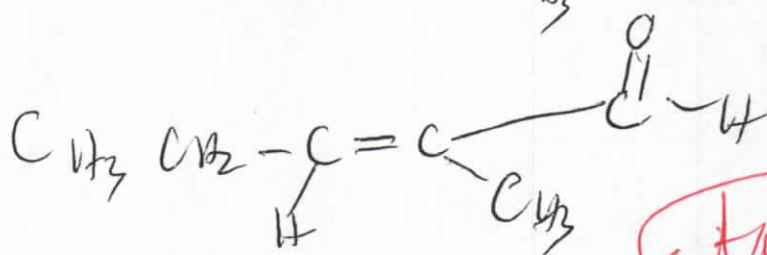
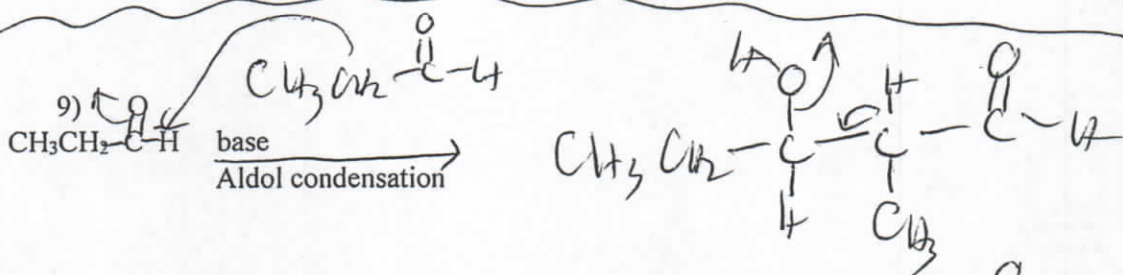
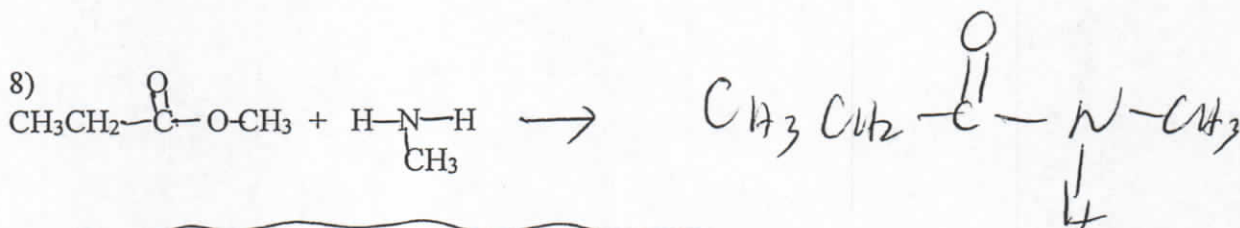
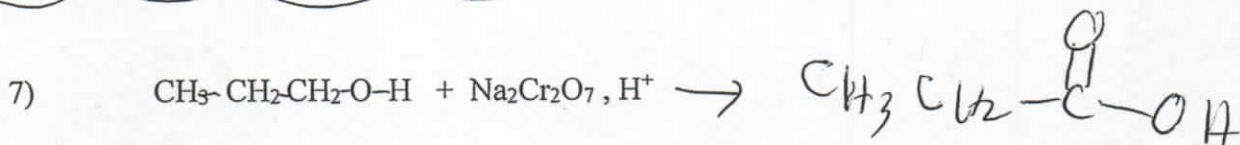
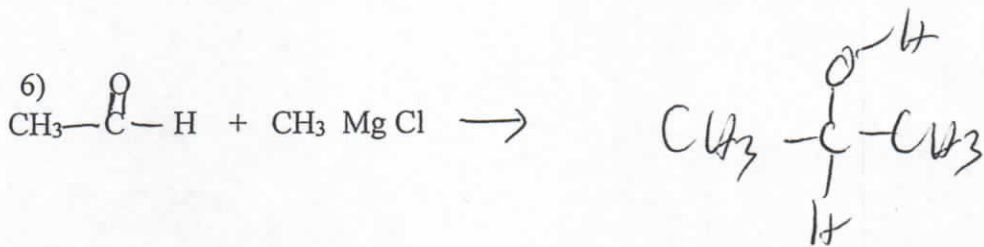
Given the following, what is the the expected organic product? **Choose to do 8** of the following reactions you want graded by circling the letter of the reaction you DO NOT WANT GRADED. If you do not choose, I will just grade the first **EIGHT**



2 pts each
NFE = not far enough, TF = too far - oxidation adding things -1

regio, stereo intermediate -1



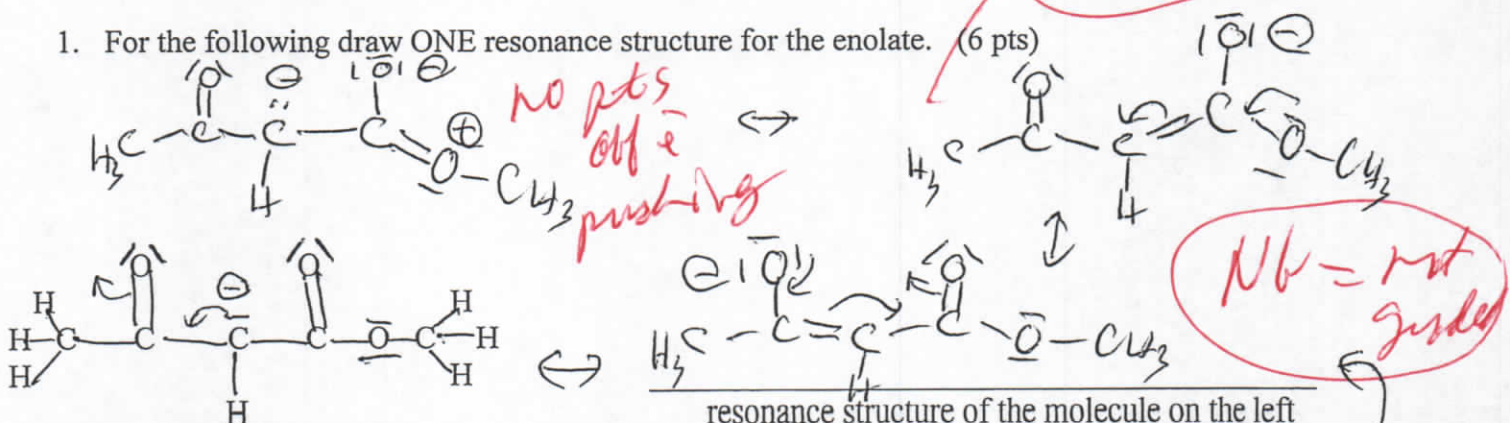


Wrong formula

karbon

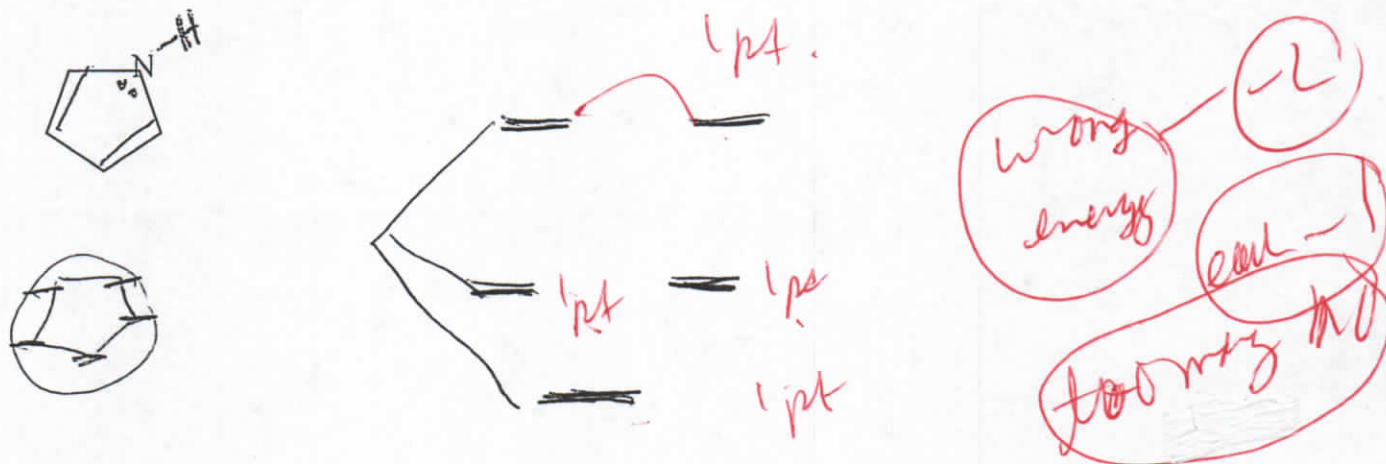
C. Short Answers part of Short Answers: (20 pts)

1. For the following draw ONE resonance structure for the enolate. (6 pts)



(show electron pushing arrows on the molecule on the left to give above)

2. The following (a,b) should be carried out on the molecule: (8 pts)



(a) Draw the expected MO (molecular orbital) diagram showing MO energy levels in the space above. (hint: Use the shorthand method.) (4 pts)

(b) Apply Huckel Rule equation of $4n+2 = \# \pi$ electrons, to the above molecule. Show work. Is the nitrogen lone pair included in your Huckel Rule calculation? [(yes) or (no)] (4 pts)

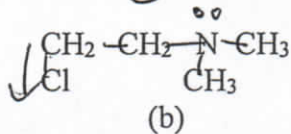
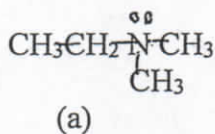
$$\# \pi e = 6e = 4n + 2$$

$$\frac{6-2}{4} = n = 1$$

Handwritten notes for part (b):
 - 1 pt (circled)
 - #e (circled)
 - 3 pt (circled)
 - mult. 1 (circled)
 - 1 (circled)

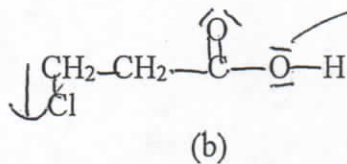
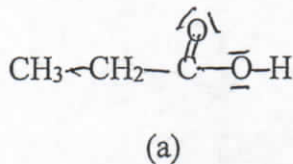
3. Given the following pairs of bases and acids: (6 pts total)

(1) Which base is a stronger base? [(a) or (b)] circle one. (3 pts)



larger e lone pair
better base

(2) Which acid is a stronger acid? [(a) or (b)] circle one. (3 pts)

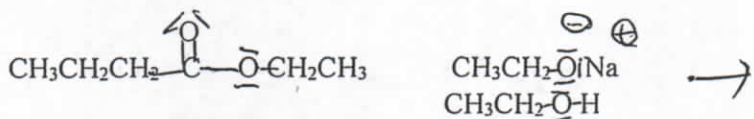


less charge on O, better acid

Part III. Long Answers (30 pts) Show work where applicable for full and partial credit.

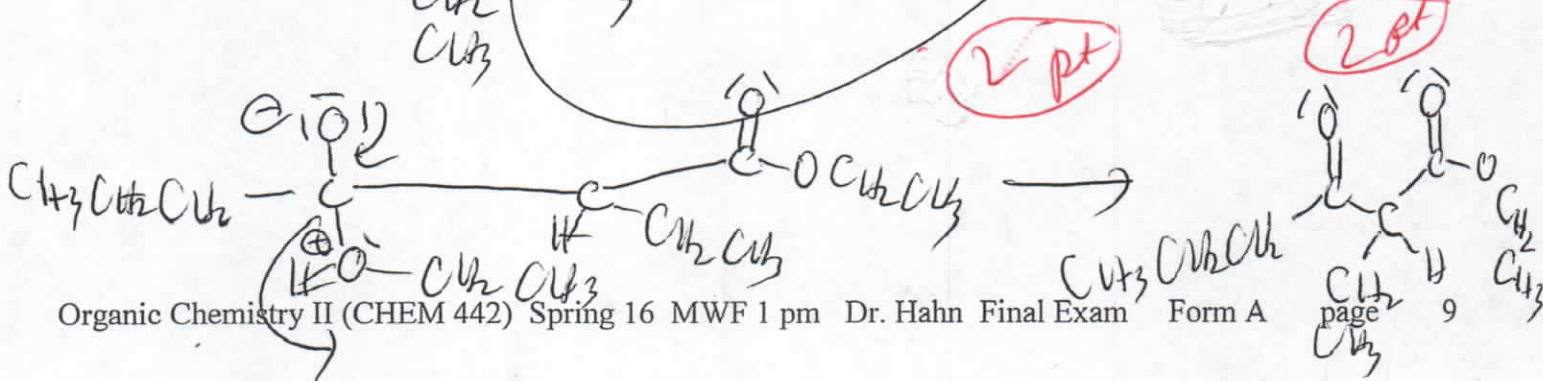
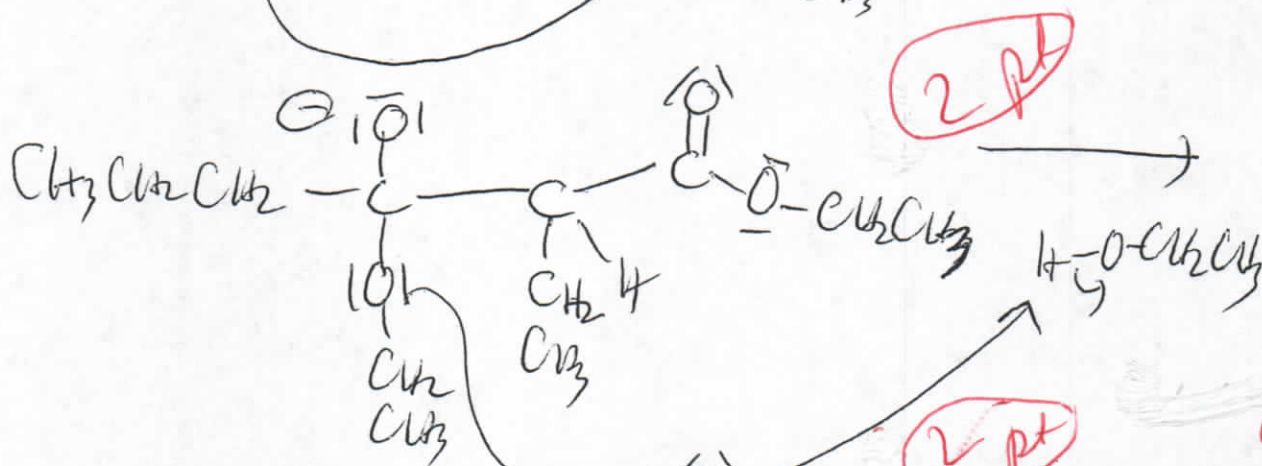
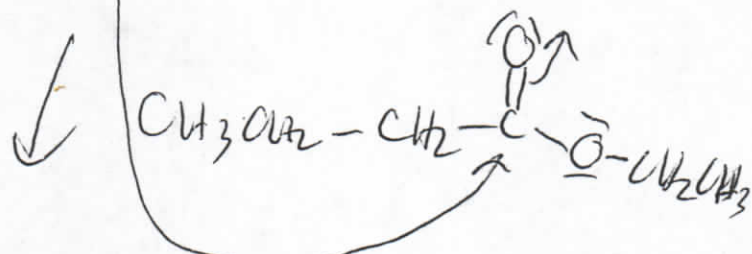
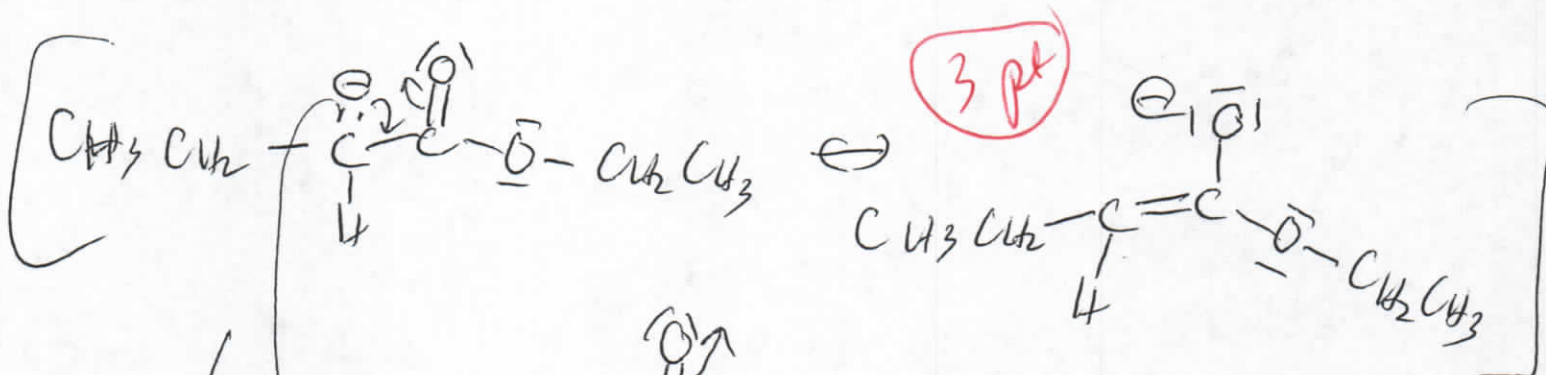
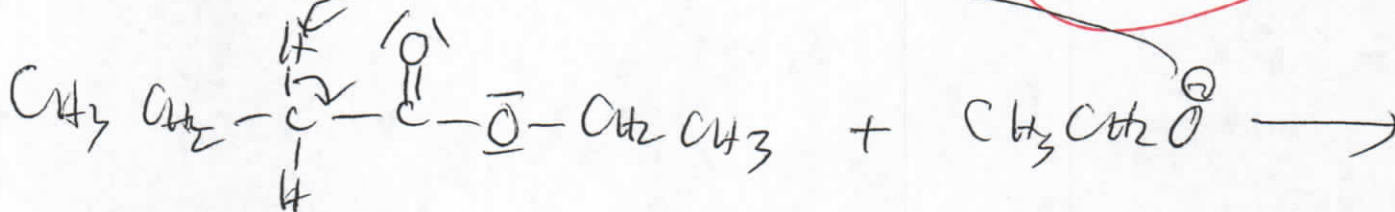
1. Show the following reaction mechanisms. (18 pts total)

a) Complete the following reaction mechanism for a Claisen Condensation. (9 pts)

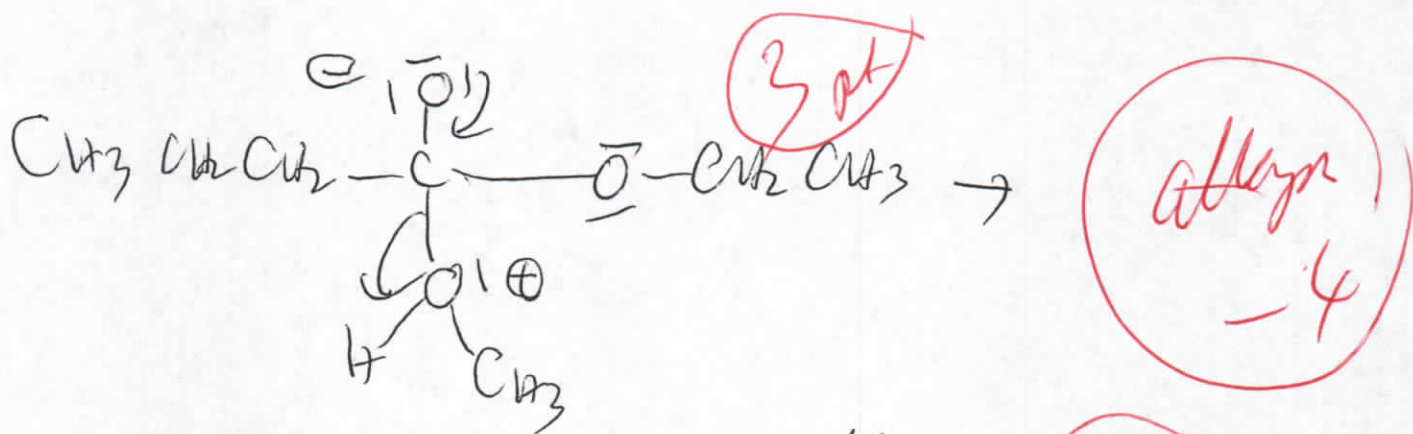
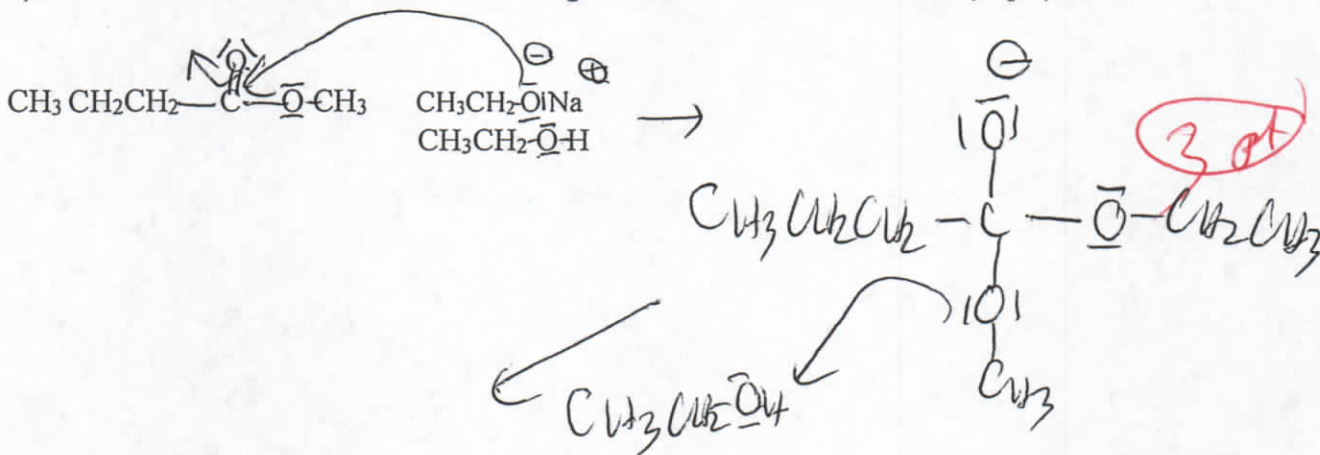


BA-6

Attempt - 4

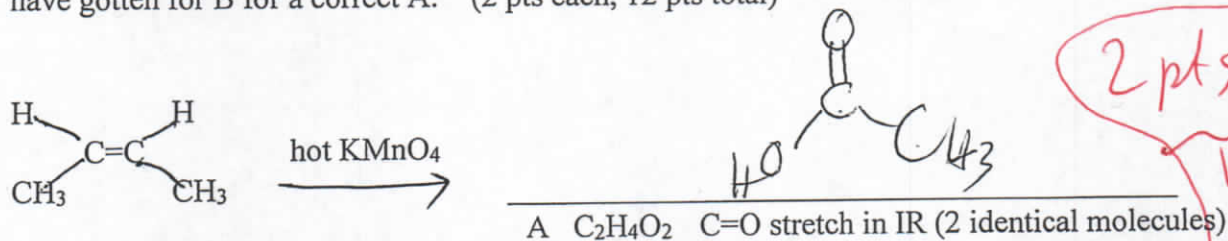


b) Show the reaction mechanism for a generalized transesterification. (9 pts)

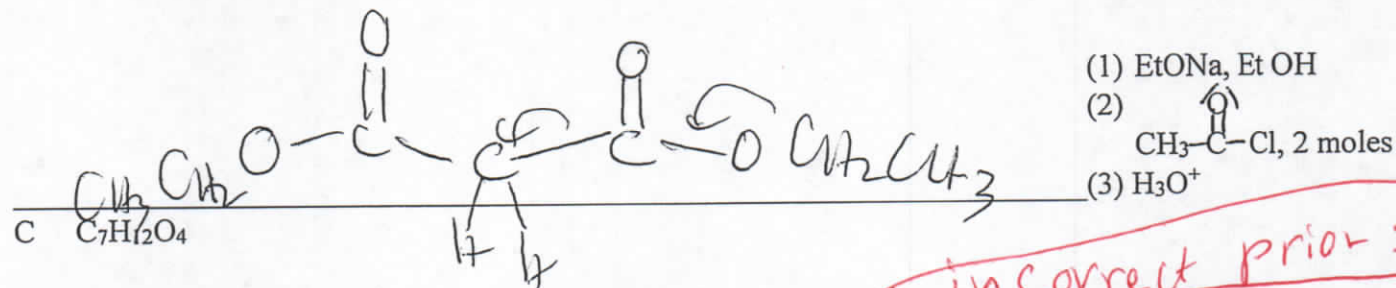
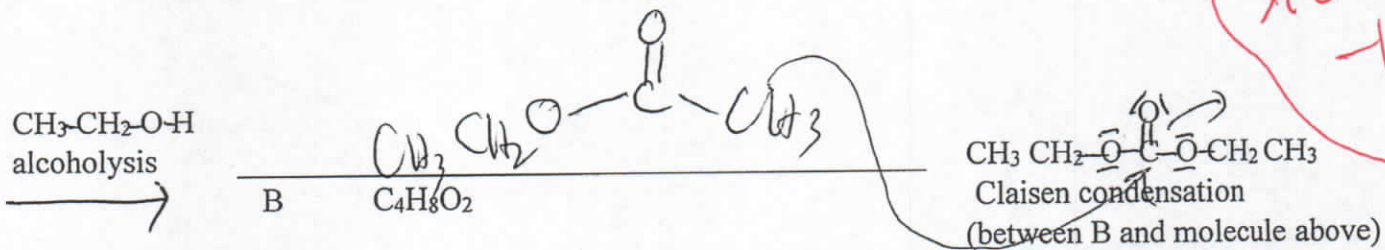


BA-6

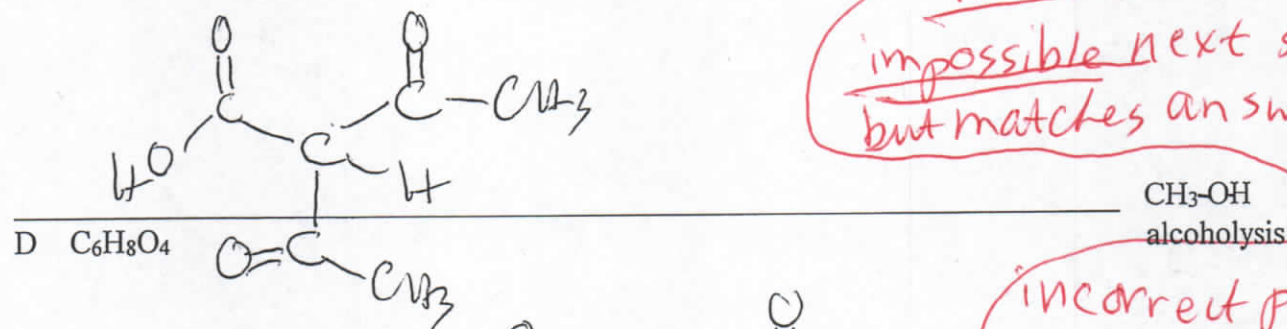
2 Complete the following synthesis by filling in the blank. NOTE on Grading: If you fill in part A with the wrong molecule and then do the next reaction to molecule B correctly you will get half credit for answering B correctly. If you fill in B with what you would have gotten if you got A correctly but which cannot possibly be generated from your wrong A, you will lose all credit even if it matches what you should have gotten for B for a correct A. (2 pts each, 12 pts total)



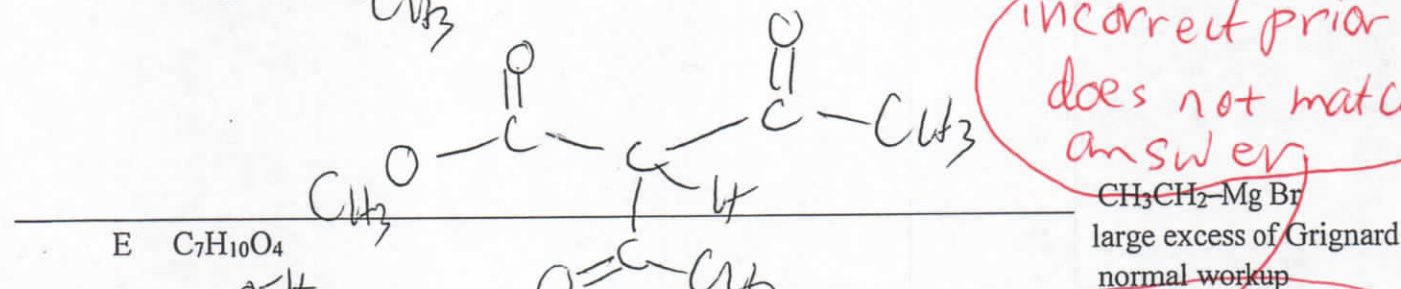
2 pts each
regio
stereo
-



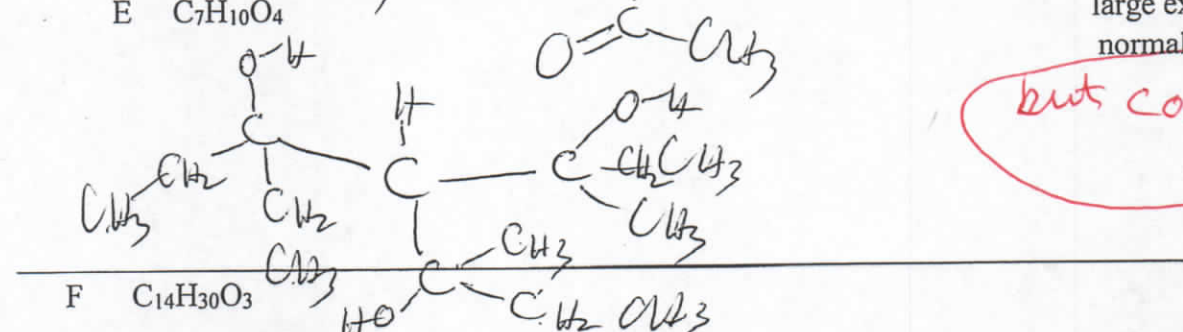
incorrect prior step
impossible next step
but matches answer -2



incorrect prior step
does not match answer



but correct rxn
-



Sign Name Key Print Name _____
 (3 pts name print & sign, 3 pt scantron name) (100 pts, 11 pages, periodic table, equation sheet, scantron)

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper – If you want me to grade something not in the space for the answer, clearly specify in writing. Telling me during the exam where to find the answer does not qualify because I will just vaguely remember someone telling me something during the exam not which one of 200 students told me what to grade on what page.) There is no partial credit for showing work in the multiple choice. In all questions on all parts of this exam, R is not equal to hydrogen but is an alkyl. (Color)

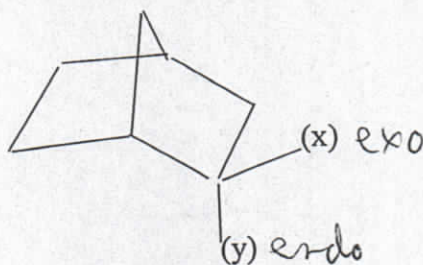
NA = not attempted

Assume standard workup in all reactions even if workup is not explicitly shown.

Please READ and FOLLOW directions. This is a **TIMED EXAM**. (ex: don't give me 5 structures if I only ask for one or you will lose points on this exam by **RUNNING OUT OF TIME**)

I. Multiple Choice (3 pts each, 27 pts) Choose the **one** best statement in each question.

1. In the following molecule, which is endo/exo. Choose the best statement.



NW = no work

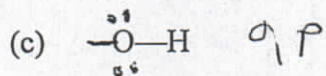
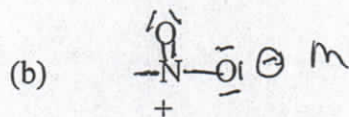
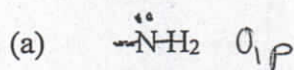
BA = bad attempt

- (a) (x) is exo
- (b) (x) is endo
- (c) (y) is endo
- (d) There is no exo / endo in this molecule.
- (e) (a) and (c) are correct.

2. To generate an alcohol from an alkene, one may use which of the following reagents over the arrow.

- (a) (1) $\text{Hg}(\text{OAc})_2$, THF/ H_2O (2) OH^- , NaBH_4 to give Markovnikov product without the possibility of rearrangement. ✓
- (b) Alkene reaction with MCPBA followed by reaction of a Grignard followed by workup. ✓
- (c) $\text{H}^+/\text{H}_2\text{O}$ to give Markovnikov product. ✓
- (d) (1) $\text{BH}_3:\text{THF}$ (2) H_2O_2 , OH^- to give anti-Markovnikov product ✓
- (e) All above statements are true.

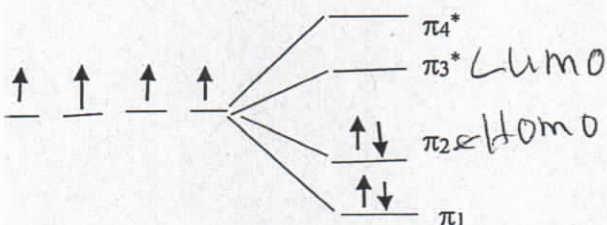
3. Which of the following is an o,p activator? I am showing the part that attaches to the benzene ring.



(d) (a) & (c) are o,p activators

(e) None shown are o,p activators.

4. For UV - Vis spectra:



a) LUMO is π_3^* ✓

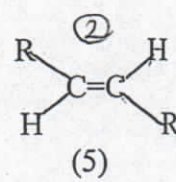
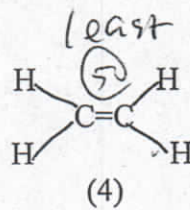
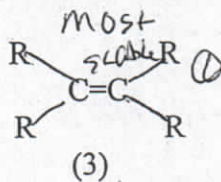
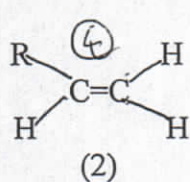
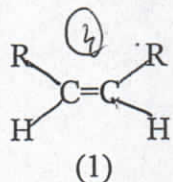
b) HOMO is π_4^*

c) UV transitions measure $\pi_2 \rightarrow \pi_3^*$ ✓

(d) (a) and (c) are correct

e) (b) and (c) are correct

5. According to Zaitsev's (or sometimes spelled Saytzeff's) Rule, the most stable to least stable alkene is: Choose the one best statement. ($\text{R} \neq \text{H}$)



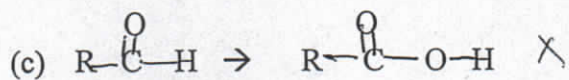
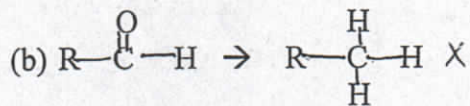
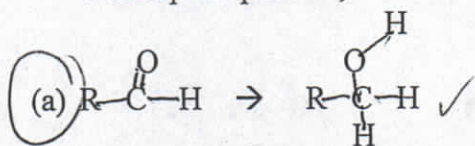
(a) Most stable (3) > (5) > (1) > (2) > (4) Least stable

b) Most stable (3) > (4) > (5) > (1) > (2) least stable

c) Most stable (4) > (2) > (1) > (5) > (3) least stable

d) You can't tell which alkene is stable by looking at the structure. All alkenes are similarly stable

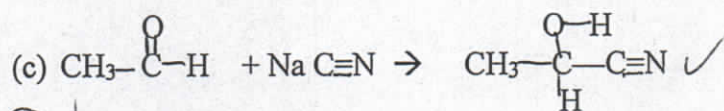
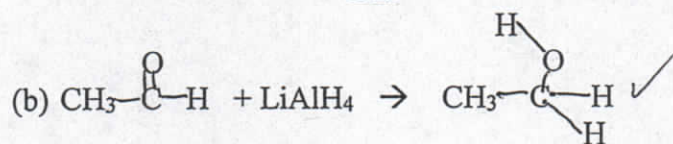
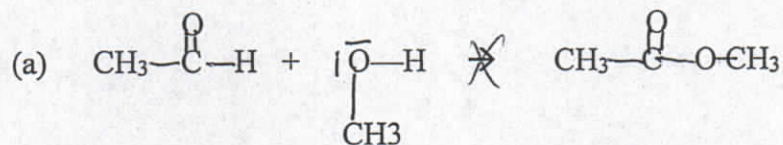
6. If you start with a ketone or aldehyde, and you reduce it using a reducing agent like LiAlH_4 and then work up the product, which of the following reactions are correct?



(d) (a) and (b) are correct

(e) (a), (b) and (c) are correct.

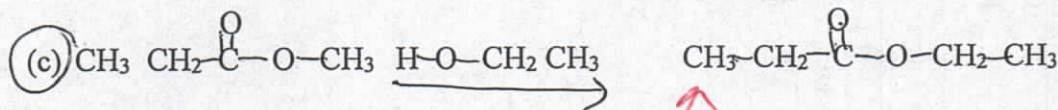
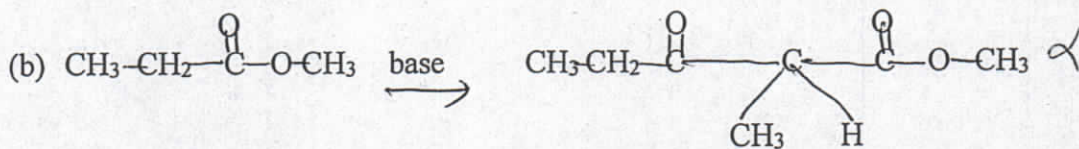
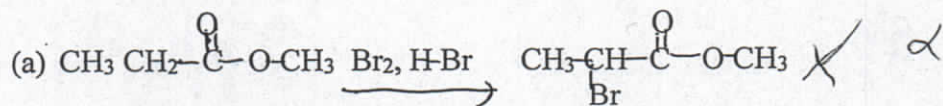
7. By "Nucleophilic Addition" choose the best reaction.



(d) (b) and (c) are correct.

(e) All except (d) are correct.

8. Which of the following reactions is NOT a reaction of an α carbon ?

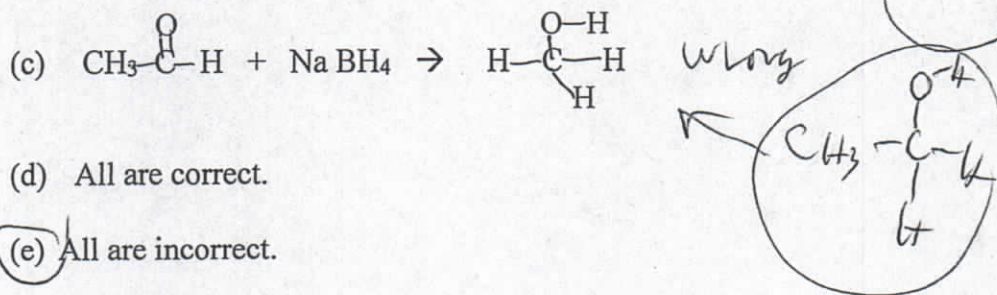
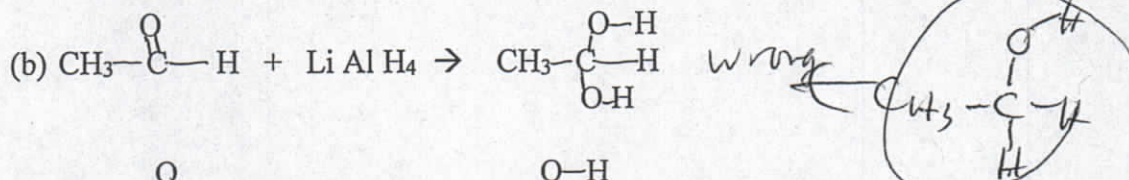
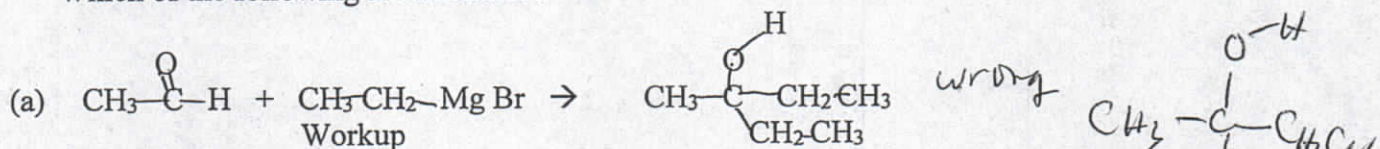


(d) (a) and (b) are α carbon reactions

(e) All of the above are α carbon reactions.

both are correct & were graded correct

9. Which of the following are incorrect ?



(d) All are correct.

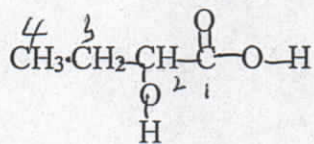
(e) All are incorrect.

II. Short Answers (42 pts)

A. Nomenclature: (2 pts each, 6 pts)

1. Given the structural formula shown below, give a valid name of the molecule.

a. name 2-hydroxy butanoic acid



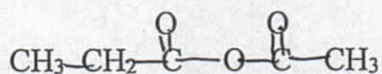
butanoic acid

2-hydroxy

1/2 pt off each wrong thing up to -1 1/2

BA - 1 1/2

b. name ethanoic propanoic



ethanoic

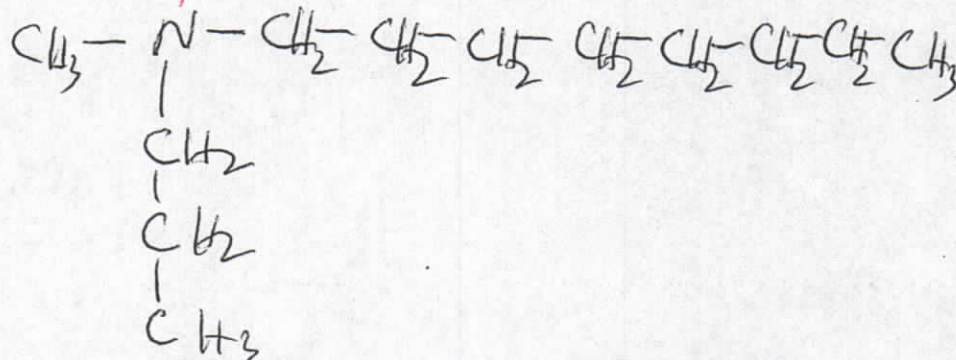
anhydride

propanoic

2. Given the following IUPAC name, draw a structural formula of the molecule (skeletal formula acceptable, condensed structure, Lewis Dot structure acceptable, molecular formula not acceptable - don't forget to show the hydrogens in your formula unless you are using the skeletal structure.)

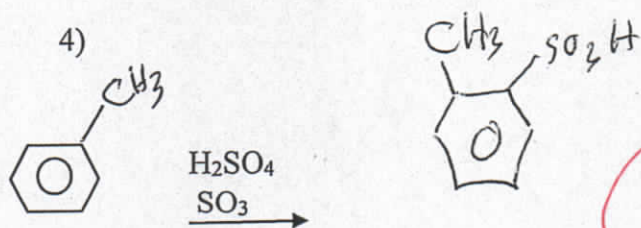
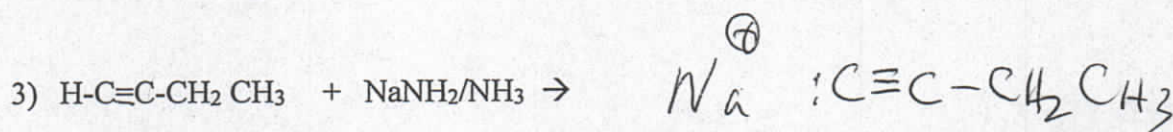
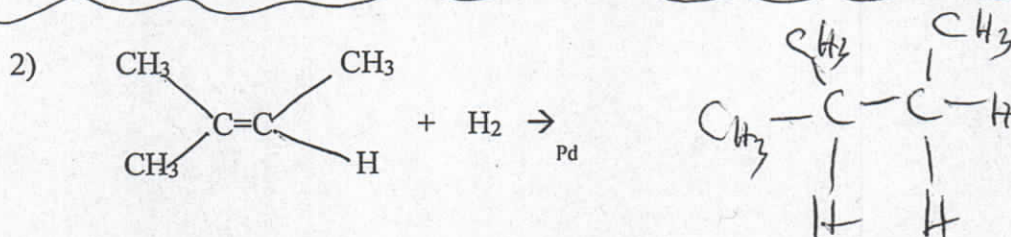
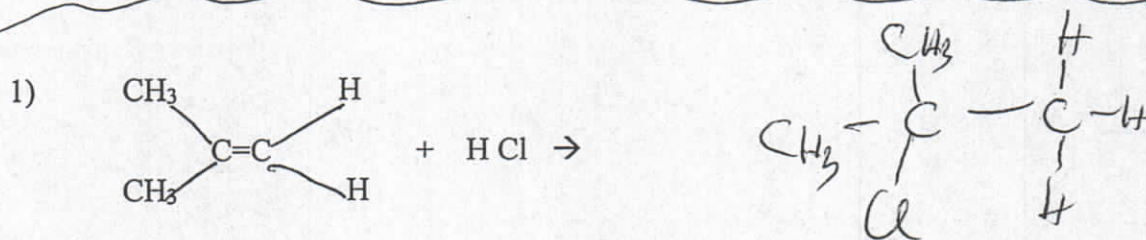
N-methyl-N-propyl octanamine

4 or 5 or 6 OK.



B. Reactions Part of Short Answers: (2 pts per reaction, 16 pts total)

Given the following, what is the the expected organic product? **Choose to do 8** of the following reactions you want graded by circling the letter of the reaction you DO NOT WANT GRADED. If you do not choose, I will just grade the first **EIGHT**

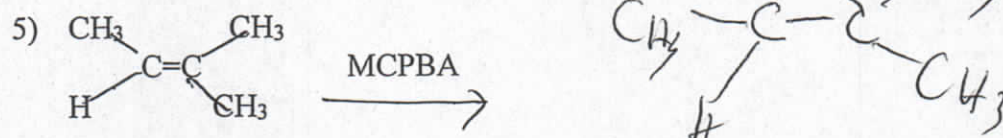


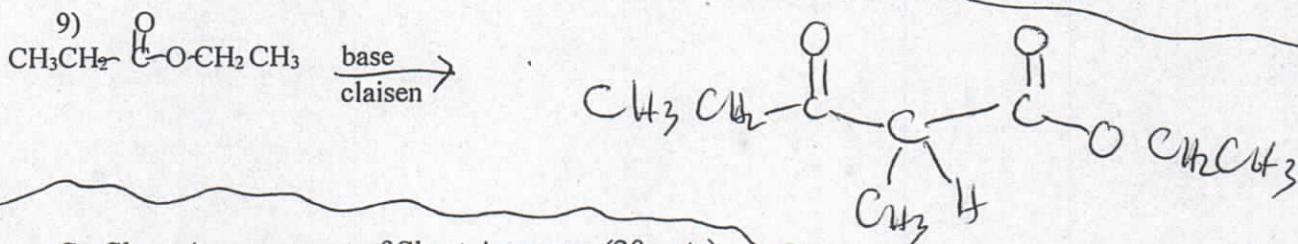
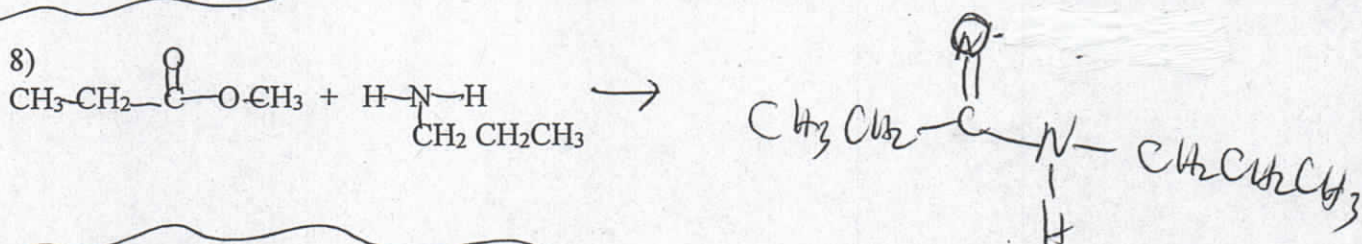
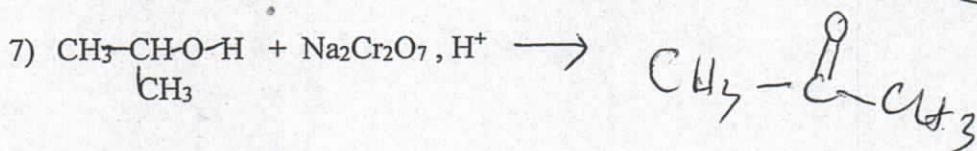
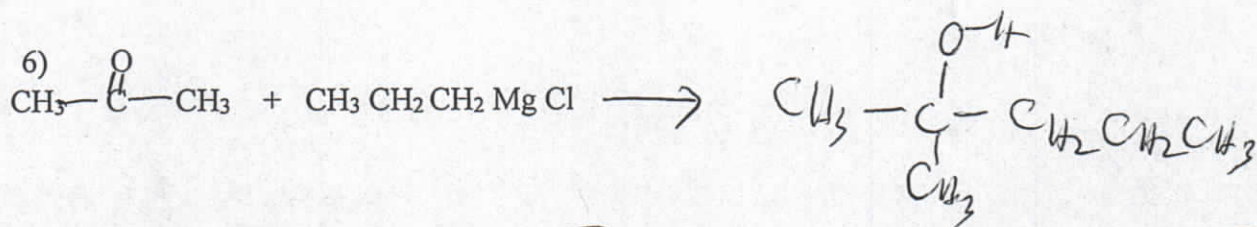
2 pts each

NFE = not far enough -1

TF = too far (oxidation adding thing)

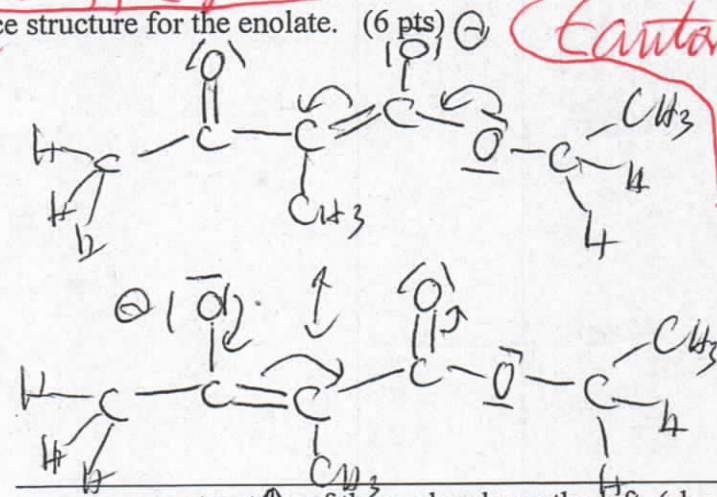
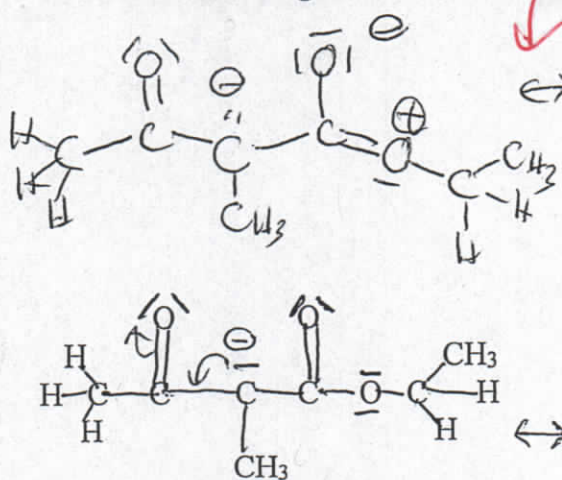
regio, stereo intermediates -1





C. Short Answers part of Short Answers: (20 pts)

1. For the following draw ONE resonance structure for the enolate. (6 pts)

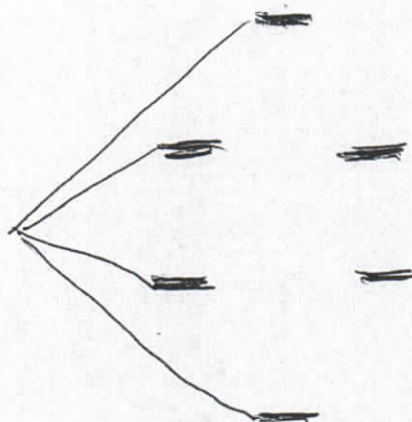
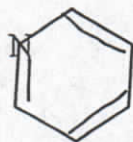


resonance structure of the molecule on the left (show electron pushing arrows on the molecule on the left to give resonance structure above)

no pts off e push

Eantomer - wrong formula 3

2. The following (a,b) should be carried out on the molecule: (8 pts)



1 pt wrong MO

wrong energy 2

too many
too few

(a) Draw the expected MO (molecular orbital) diagram showing MO energy levels in the space above. (hint: Use the shorthand method.) (4 pts)

(b) Apply Huckel Rule equation of $4n+2 = \# \pi$ electrons, to the above molecule. Show work. Is the nitrogen lone pair included in your Huckel Rule calculation? [(yes) or (no)] (4 pts)

$$\# \pi e = 6e = 4n + 2$$

$$\frac{6-2}{4} = n = \frac{4}{4} = 1$$

1 pt

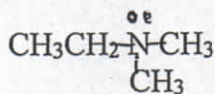
e - 1

3 pt

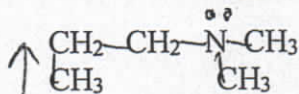
math - 1

3. Given the following pairs of bases and acids: (6 pts total)

(1) Which base is a stronger base? [(a) or (b)] circle one. (3 pts)



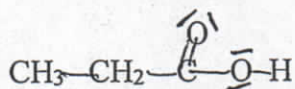
(a)



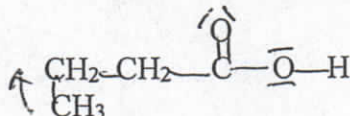
(b)

donate e density

(2) Which acid is a stronger acid? [(a) or (b)] circle one. (3 pts)

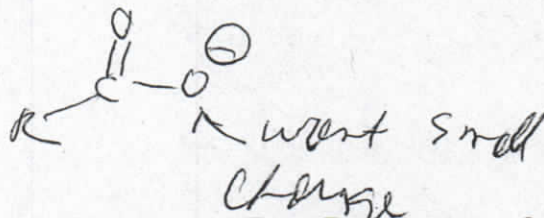


(a)



(b)

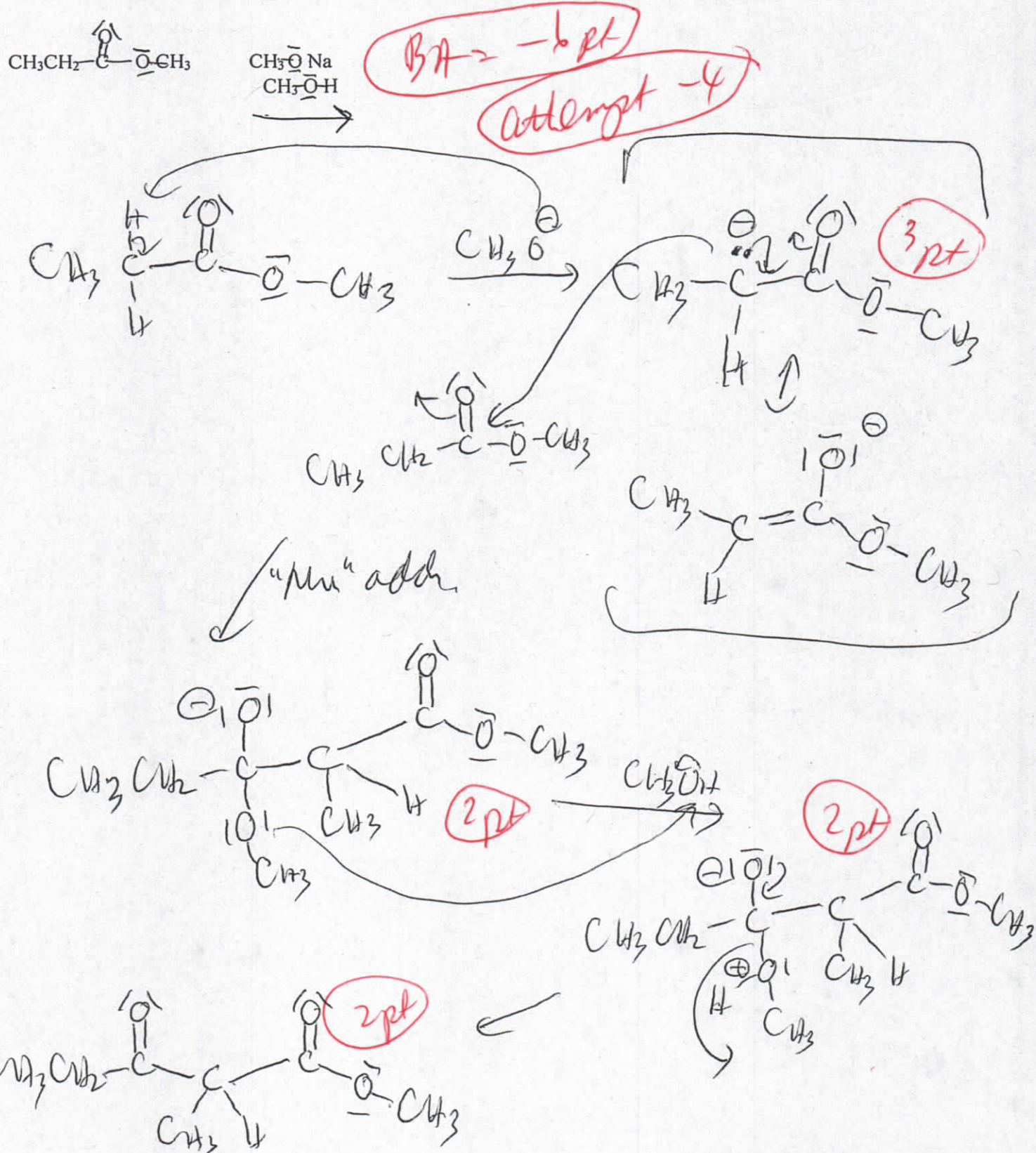
donate e



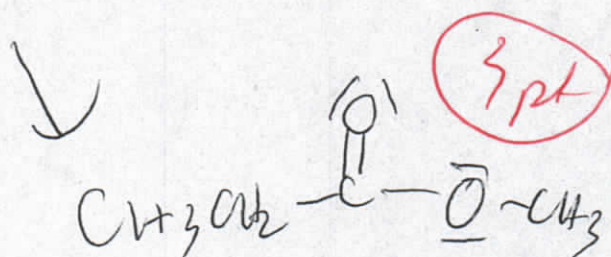
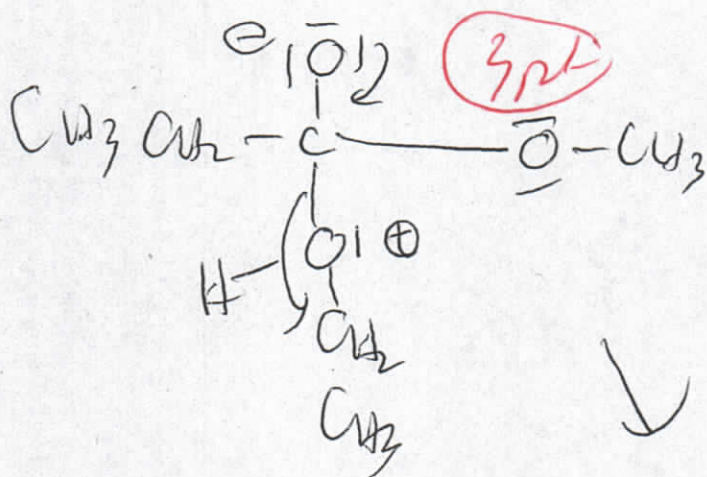
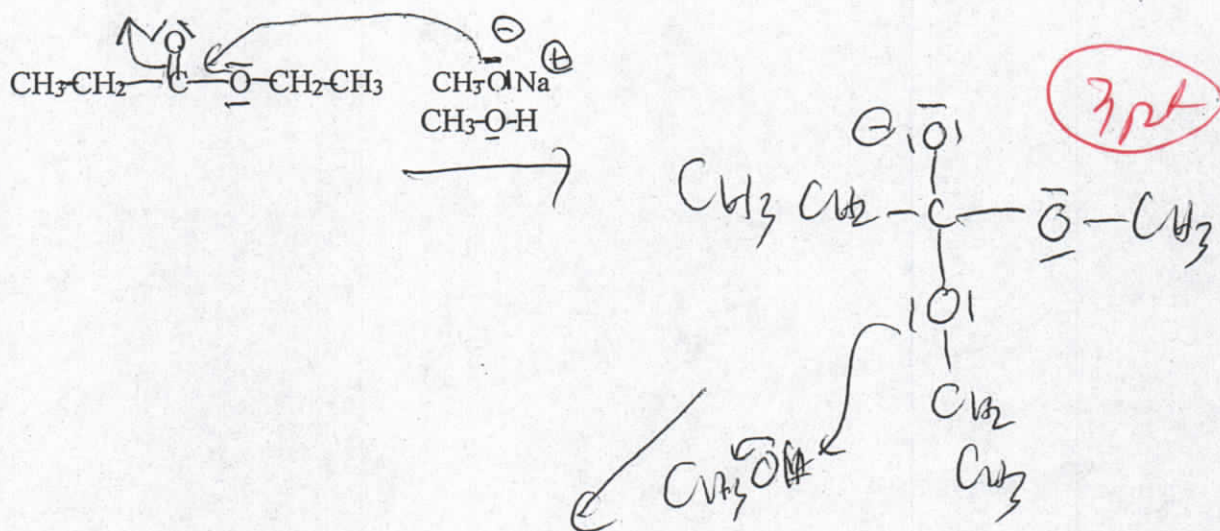
Part III. Long Answers (30 pts) Show work where applicable for full and partial credit.

1. Show the following reaction mechanisms. (18 pts total)

a) Complete the following reaction mechanism for a Claisen Condensation. (9 pts)

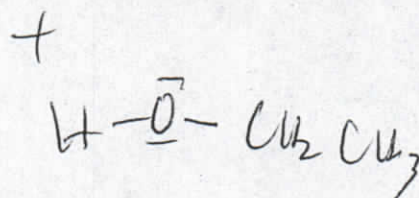


b) Show the reaction mechanism for a generalized transesterification. (9 pts)

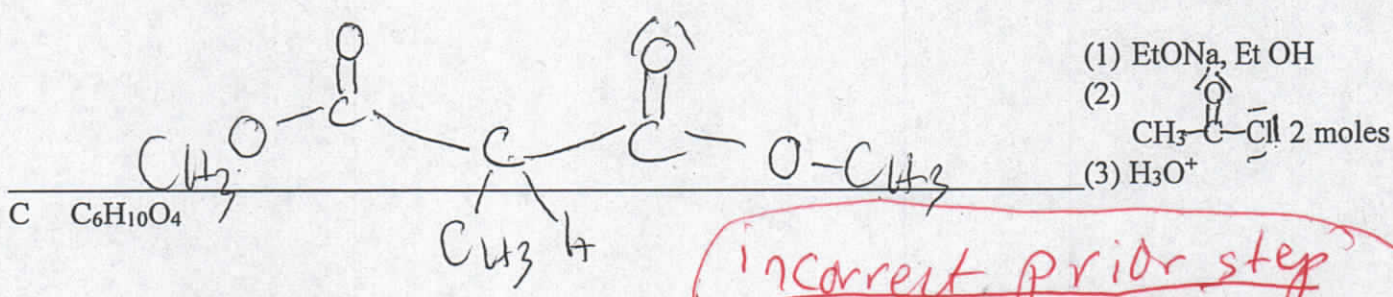
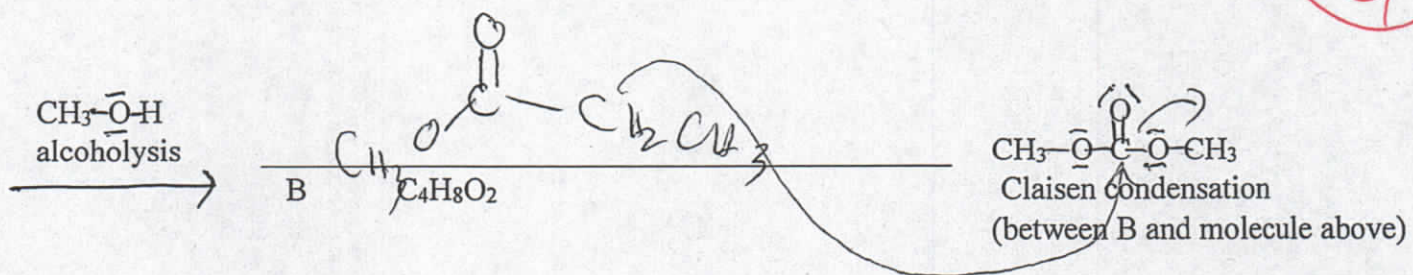
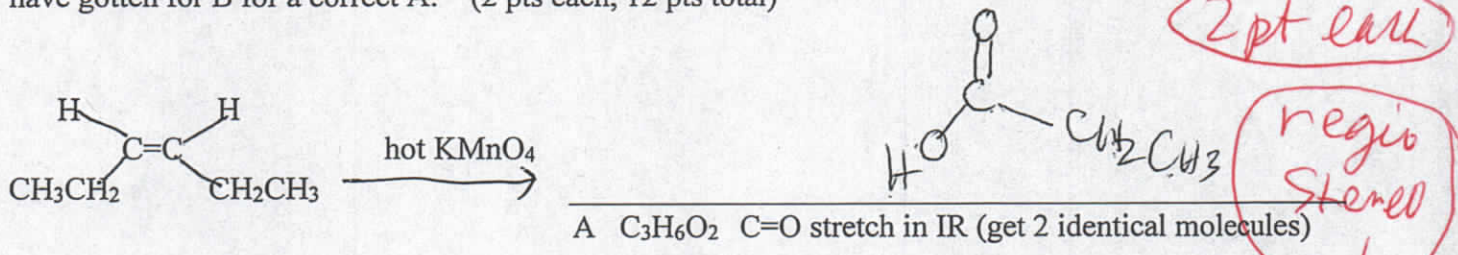


attempt - 4 pt

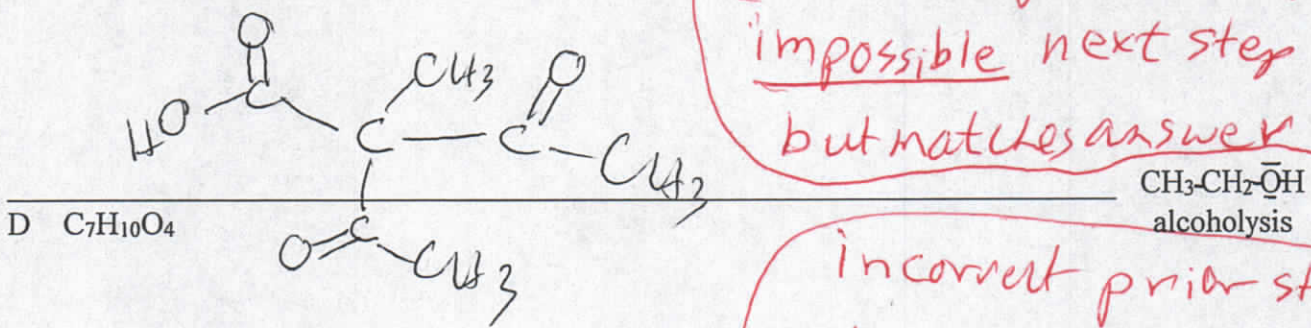
BA - 6 pt



2 Complete the following synthesis by filling in the blank. NOTE on Grading: If you fill in part A with the wrong molecule and then do the next reaction to molecule B correctly you will get half credit for answering B correctly. If you fill in B with what you would have gotten if you got A correctly but which cannot possibly be generated from your wrong A, you will lose all credit even if it matches what you should have gotten for B for a correct A. (2 pts each, 12 pts total)



incorrect prior step
 impossible next step
 but matches answer -2pt



incorrect prior step
 does not match -1pt
 answer but correct rxn

