

Name Key (print). Form A

Please show work on all problems for partial & full credit. You will receive no credit for illegible answers. You may lose points if you do not follow directions. This is a timed exam and must be completed in the time given. Any incomplete portions will receive a zero. Please use the back of the exam pages as scratch paper. Good Luck!!

- I. Multiple Choice (32 pts) Choose the best statement by circling ONE letter. (If the question specifically states select all, you should obviously select all.) (obviously no partial credit for multiple choice). (4 pts each number)

1 Which of the following are NOT an oxidizing reagent ?

- (a) $\text{Na}_2\text{Cr}_2\text{O}_7$. (b) PCC. (c) $\text{K}_2\text{Cr}_2\text{O}_7$. (d) NaBH_4 . (e) all of the above are oxidizing reagents.

2. For the following molecule which would represent the molecular ion peak ?



$$5(12) + 12(1) = 72$$

- (a) $m/z = 15$. (b) $m/z = 72$. (c) tallest peak in the mass spectrum at 57. (d) none of the above are true about molecular ion peaks.

3. Given the following molecules, choose the one terminal alkyne.

- (a) $\text{CH}_3\text{---C}\equiv\text{C---CH}_2\text{CH}_3$. (b) $\text{H---C}\equiv\text{C CH}_2\text{CH}_2\text{CH}_3$. (c) $\text{CH}_3\text{---C}\equiv\text{C---CH}_3$
 (d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}\equiv\text{CCH}_3$. (e) none of the molecules shown are terminal alkynes.

4. Which of the following is **NOT** a molecule which will react via nucleophilic substitution ?

(a) ester

(b) acid halide


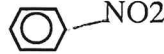
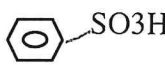
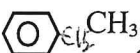
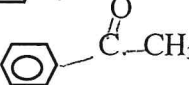
(c) ketone

(d) carboxylic acid

- 5 Circle the letter of all of the following molecules which is a primary alcohol ?

- (a) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{---C---OH} \\ | \\ \text{H} \end{array}$ (b) $\text{CH}_3\text{---CH}_2\text{---O---H}$ (c) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{---C---O---H} \\ | \\ \text{CH}_3 \end{array}$ (d) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{---C---CH}_2\text{---O---H} \\ | \\ \text{CH}_3 \end{array}$

6 In electrophilic aromatic substitution reactions, the benzene ring with 6 hydrogens (a H at each corner of the hexagon) substitutes a H via one of the following reactants. Circle the best statement.

- (a) $\text{FeCl}_3, \text{Cl}_2 \rightarrow$ 
- (b) $\text{HNO}_3, \text{H}_2\text{SO}_4 \rightarrow$ 
- (c) $\text{SO}_3, \text{H}_2\text{SO}_4 \rightarrow$ 
- (d) $\text{CH}_3\text{COCl}, \text{AlCl}_3 \rightarrow$ 
- (e) $\text{CH}_3\text{COCl}, \text{AlCl}_3 \rightarrow$ 
- (f) all of the above are correct

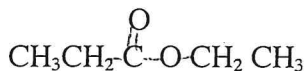
(g) Only (b), (c), (d) and (e) are correct

7. In naming carboxylic acid derivatives, one takes the name of the root carboxylic acid (propanoic acid) remove

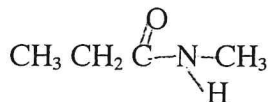
(a) ic acid and add yl chloride for the acid chloride. (propanoyl chloride). $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{Cl}$

(b) remove acid and then add anhydride. (propanoic ethanoic chloride). $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{O}\text{C}(=\text{O})\text{CH}_3$

(c) remove ic acid add --ate and then use N-alkyl for the alkyl group attached at the OR ester position (~~N~~-ethyl propanoate)



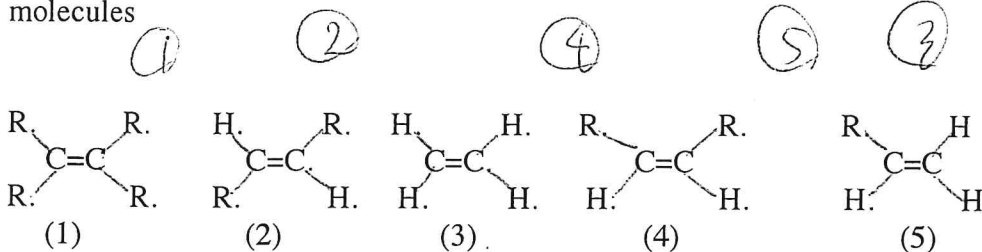
(d) remove ic acid add amide and then use N-alkyl for the alkyl group attached at the NR position (N-ethyl propanamide)



(e) all of the above are correct.

(f) Of the above (a), (b), and (d) are correct.

8. According to Zaitsev's Rule, which is the correct ordering of the stabilities for the following series of molecules



(a) most stable (1), (2), (3), (4), (5) least stable

(a) most stable (1), (2), (4), (5), (3) least stable

(a) most stable (5), (2), (3), (4), (1) least stable

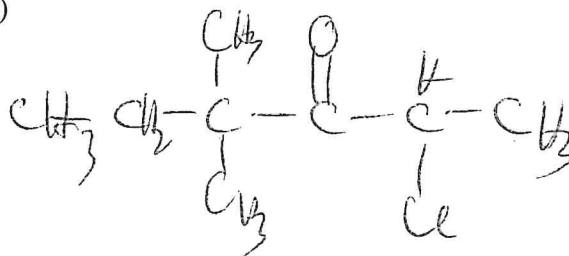
(a) most stable (1), (4), (2), (5), (3) least stable

II. Short Answers (37 pts)

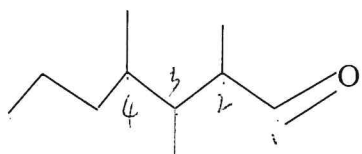
A. Nomenclature. (6 pts)

(a) Given the name, draw the molecule (2 pts)

2-chloro-4,4-dimethyl hexan-3-one



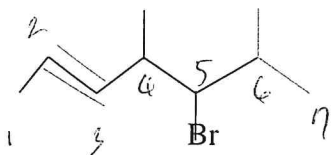
(b). The IUPAC name for the molecule shown is _____ (2 pts)



heptanal
2,3,4-trimethyl

2,3,4-trimethyl heptanal

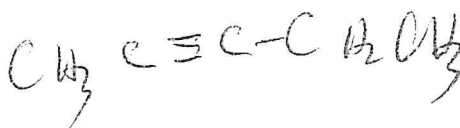
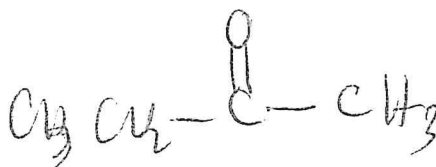
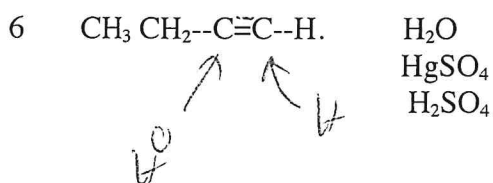
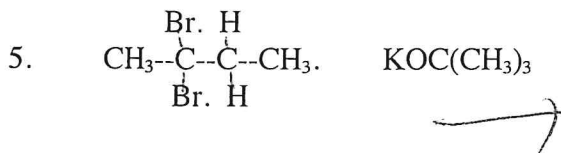
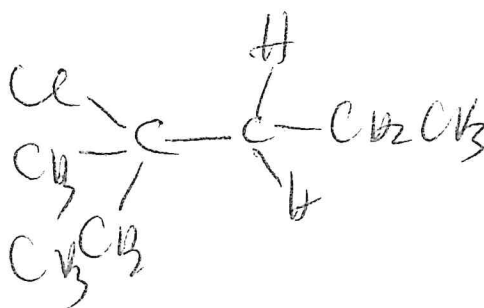
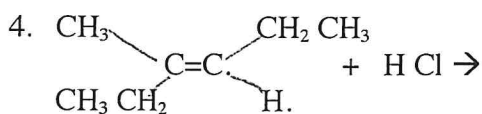
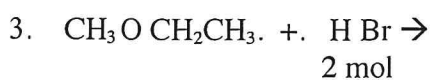
(c). The IUPAC name for the molecule shown is _____ (2 pts)

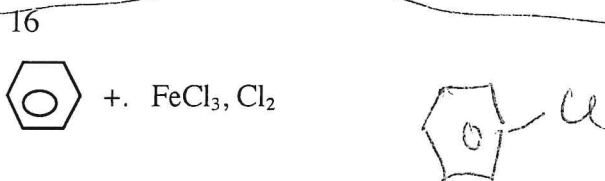
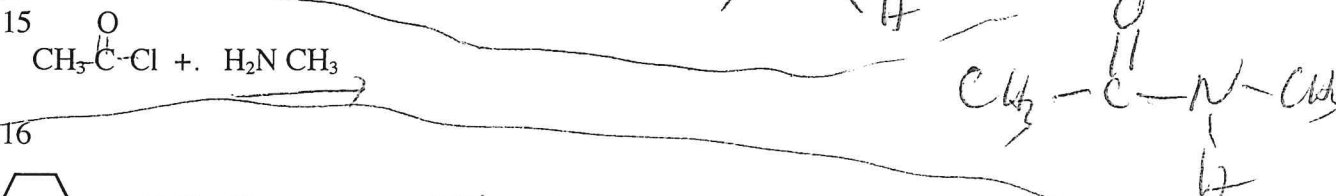
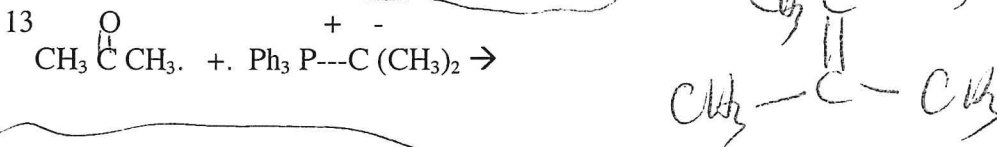
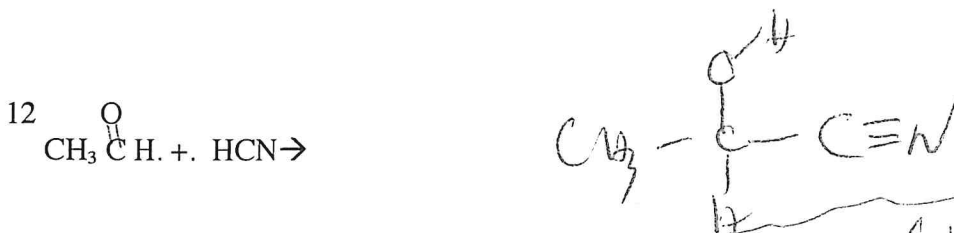
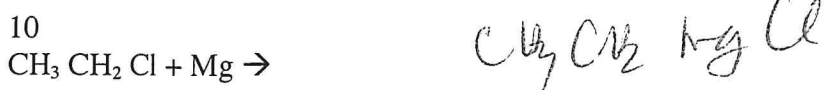
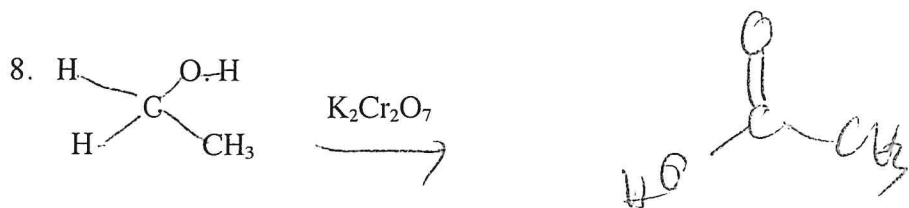


heptyne
↑
2

5-bromo-6-dimethyl hept-2-yne

B. Write the organic product of the following reaction. Do not balance the reaction. **(circle the number of the 10 you want graded. If you do not circle, I will just grade the first 10.** (2 pts each, 20 pts)





C. Short Answer: (24 pts)

1. give the IR expected peak for the molecule shown below (8 pts, 2 pts each blank)



2850-2960 C-H

C-O 1050-1150

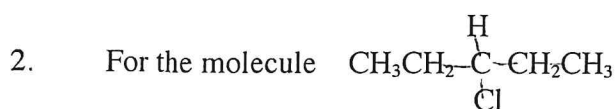
For the IR, give 2 expected peak and the parts of the molecule and its movement which is expected to cause the peak. (8. pts)

3400-3650 cm⁻¹ Caused by O-H alcohol

2100-2260 cm⁻¹ Caused by C≡C stretch

3300

H-C≡C



(a). (b). (c). (d) (e)

for proton NMR. (use the label shown above). (6 pts, 2 pts each)

(1) approximate chemical shift

order of peaks is: {c, b&d, a&e} or (a, e, b, d, c) (circle one)

(2) integration areas expected (give integration number for # hydrogens) circle all correct integrations. (each choice is defined by the { }

{(a) 3H} or {(e) 3 H} or {(b) & (c) 4 H} or {(a) & (e) 6 H}. or {(b) & (d) 4 H}

(3) show N values, the coupling equation and the expected coupling Circle either (Choice A) or (Choice B)(6 pts)

Choice A

(a & e) N=2, # peaks = 3

(b & d) N = 4, # peaks = 5

(c) N = 4, # peaks = 5

or

Choice B

(a) N=3, # peaks = 4

(b) N = 2, # peaks = 3

(c) N = 1, # peaks = 2

(d) N = 2, # peaks = 3

(e) N = 3, # peaks = 4

~~(b) N = 2, # peaks = 3~~

~~(c) N = 1, # peaks = 2~~

~~(d) N = 2, # peaks = 3~~

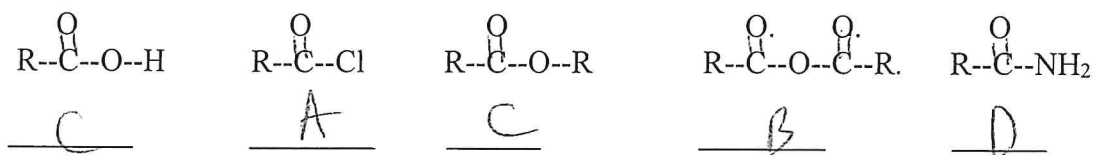
~~(e) N = 3, # peaks = 4~~

~~(b & d) N = 4, # peaks = 5~~

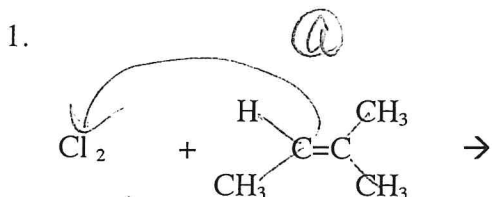
~~(c) N = 4, # peaks = 5~~

not
a choice

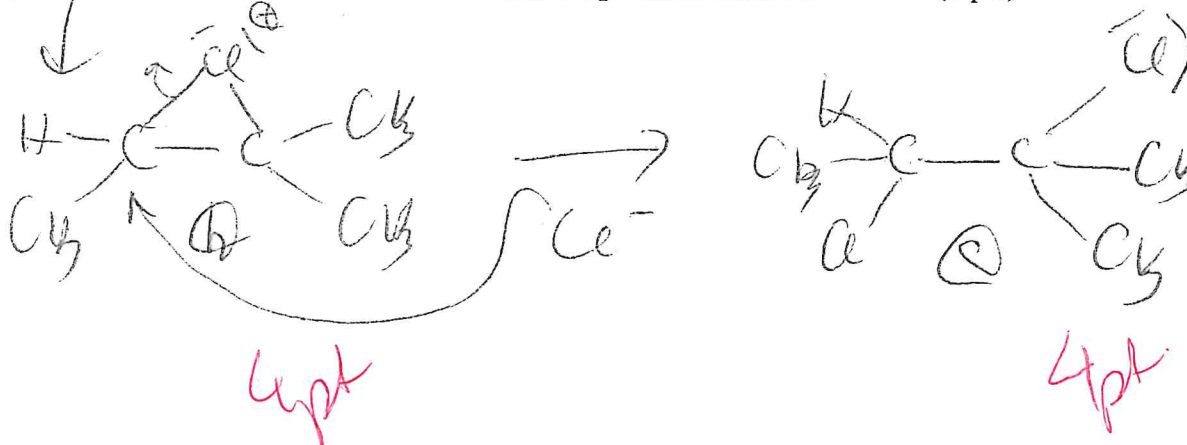
3. The order of reactivity of carboxylic acid derivatives is: Write **A for most reactive** to **D for least reactive**. (2 of the functional groups have about the same reactivity. (use the same letter for the 2 functional group with nearly the same reactivity) (10 pts, 2 pts each)



Part III. Long Answers (28 pts) Show work where applicable.



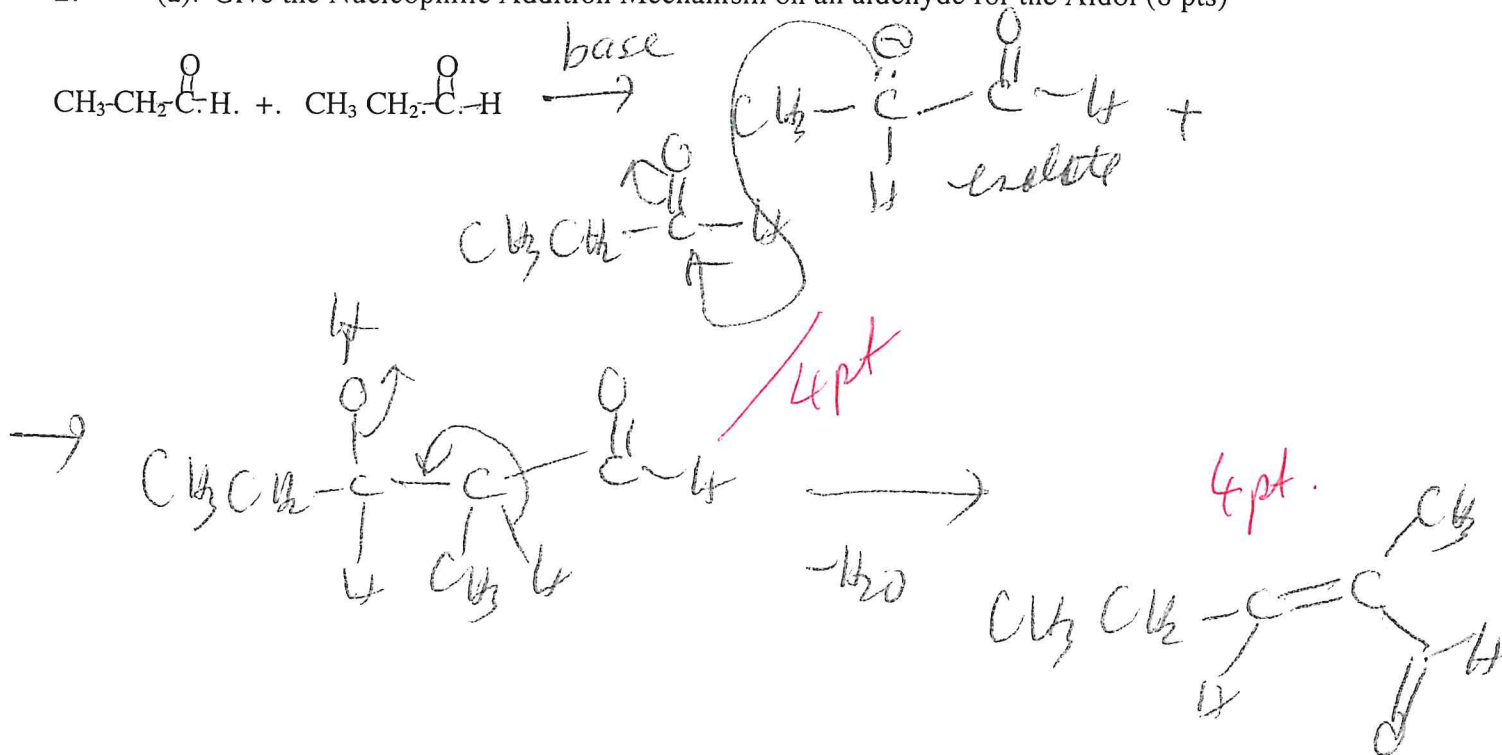
(a) Give the Reaction Mechanism for the **electrophilic addition** reaction: (8 pts)



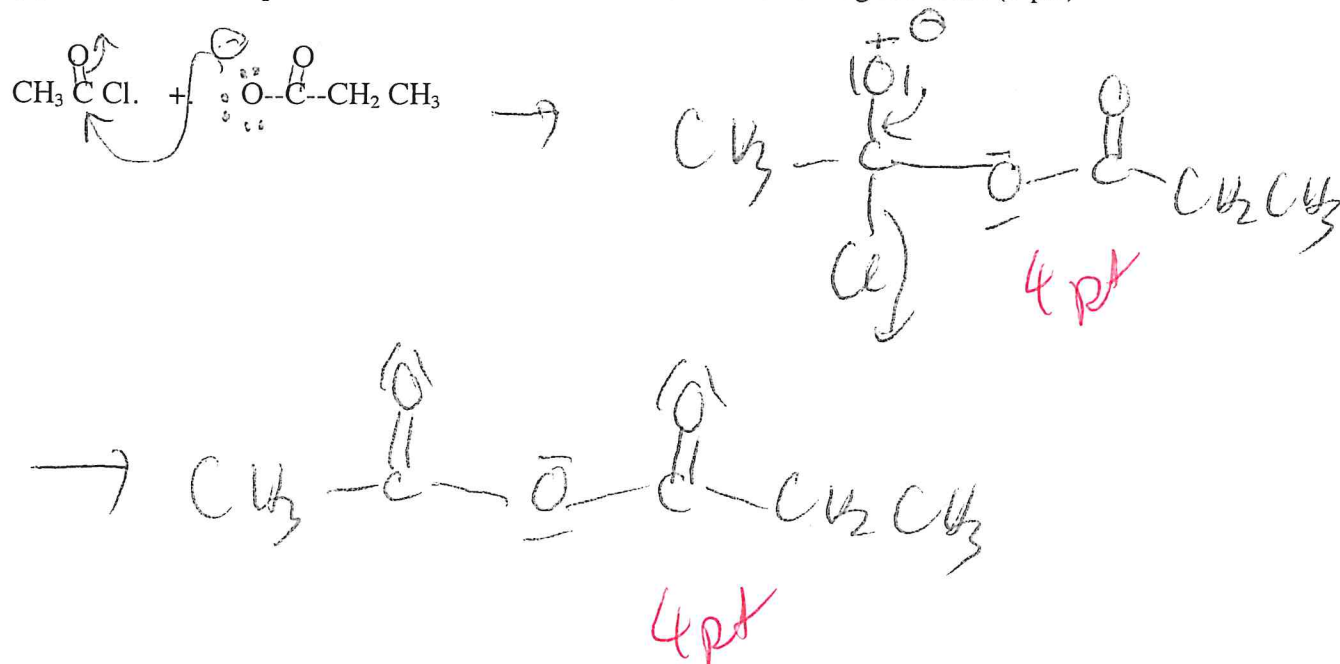
(b) Give the energy diagram and label your energy diagram to match your reaction mechanism that you gave above. (4 pts)



2. (a). Give the Nucleophilic Addition Mechanism on an aldehyde for the Aldol (8 pts)



(b) Give the Nucleophilic Substitution Mechanism for the following reaction. (8 pts)



Name Key (print). Form B

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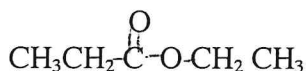
I. Multiple Choice (32 pts) Choose the best statement by circling ONE letter. (If the question specifically states select all, you should obviously select all.) (obviously no partial credit for multiple choice). (4 pts each number)

1. In naming carboxylic acid derivatives, one takes the name of the root carboxylic acid (propanoic acid) remove

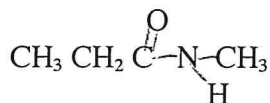
(a) ic acid and add yl chloride for the acid chloride. (propanoyl chloride). $\text{CH}_3\text{CH}_2\overset{\text{O}}{\parallel}\text{C}\text{Cl}$

(b) remove acid and then add anhydride. (propanoic ethanoic chloride). $\text{CH}_3\text{CH}_2\overset{\text{O}}{\parallel}\text{C}-\text{O}-\overset{\text{O}}{\parallel}\text{C}-\text{CH}_3$

(c) remove ic acid add --ate and then use N- alkyl for the alkyl group attached at the OR ester position (N-ethyl propanoate)



(d) remove ic acid add amide and then use N-alkyl for the alkyl group attached at the NR position (N-ethyl propanamide)

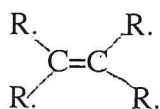


(e) all of the above are correct.

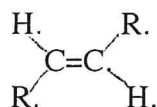
(f) Of the above (a), (b), and (d) are correct.

2. According to Zaitsev's Rule, which is the correct ordering of the stabilities for the following series of molecules

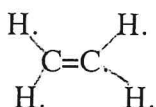
(1) > (2) > (4) > (5) > (3)



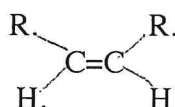
(1)



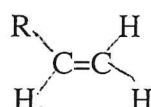
(2)



(3)



(4)



(5)

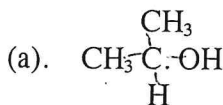
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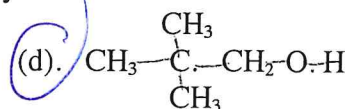
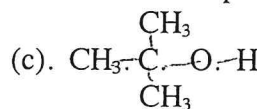
(a). most stable (5), (2), (3), (4), (1) least stable

(a). most stable (1), (4), (2), (5), (3) least stable

3 Circle the letter of all of the following molecules which is a primary alcohol ?



(b)



4 Which of the following are NOT an oxidizing reagent ?

- (a) $\text{Na}_2\text{Cr}_2\text{O}_7$. (b) PCC. (c) $\text{K}_2\text{Cr}_2\text{O}_7$. (d) NaBH_4 . (e) all of the above are oxidizing reagents.

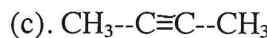
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- (a) $m/z = 15$. (b) $m/z = 72$. (c) tallest peak in the mass spectrum at 57. (d) none of the above are true about molecular ion peaks.

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- (e). none of the molecules shown are terminal alkynes.

7. Which of the following is NOT a molecule which will react via nucleophilic substitution ?

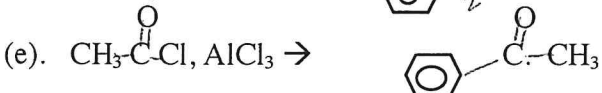
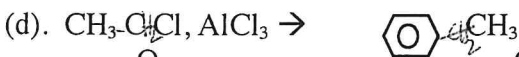
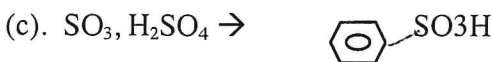
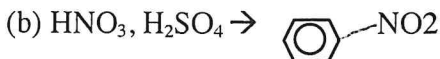
(a) ester

(b) acid halide

(c) ketone

(d). carboxylic acid

8 In electrophilic aromatic substitution reactions, the benzene ring with 6 hydrogens (a H at each corner of the hexagon) substitutes a H via one of the following reactants. Circle the best statement.



(f) all of the above are correct

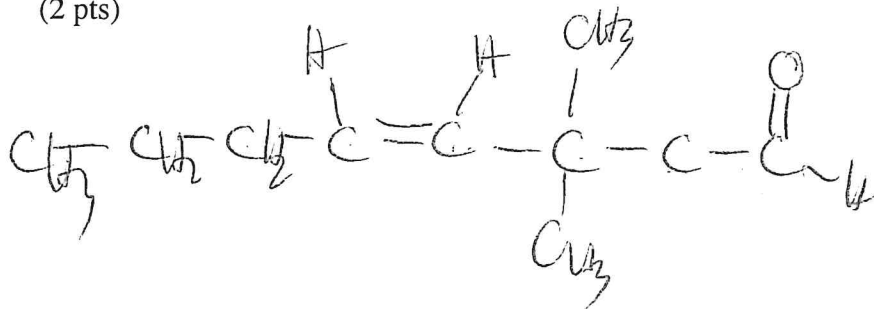
(g) Only (b), (c), (d) and (e) are correct

II. Short Answers (37 pts)

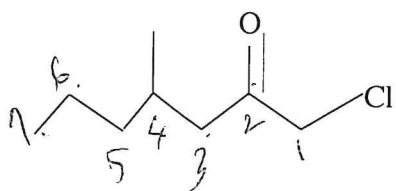
A. Nomenclature. (6 pts)

(a) Given the name, draw the molecule (2 pts)

Z-3,3-dimethyl oct-4-en-1-al



(b). The IUPAC name for the molecule shown is _____ (2 pts)

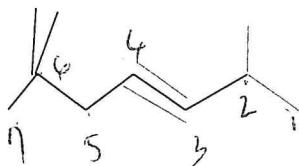


2-heptanone

1-chloro-4-methyl

1-chloro-4-methyl-2-heptanone

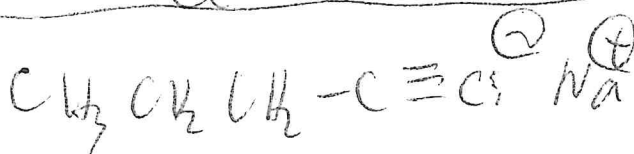
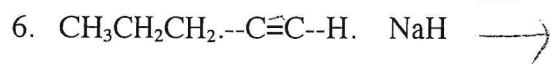
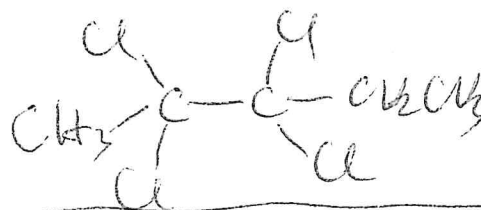
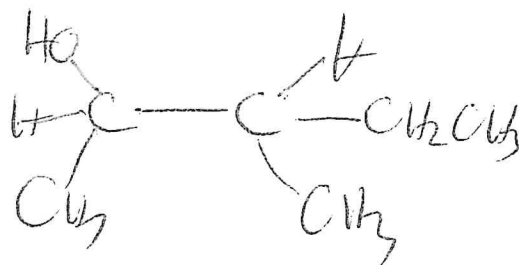
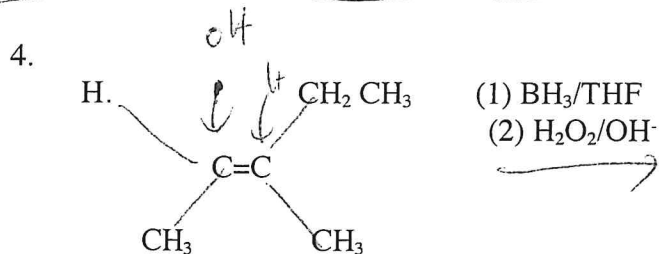
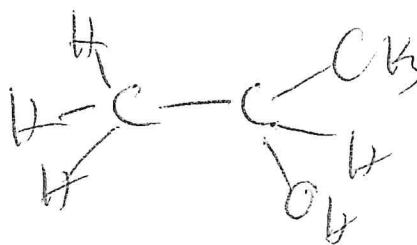
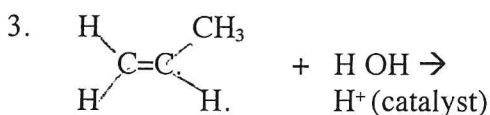
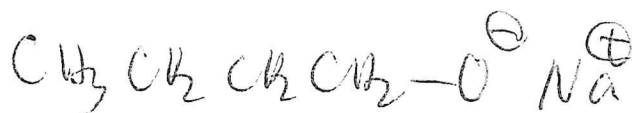
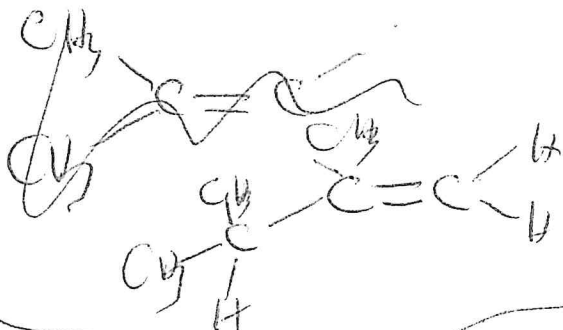
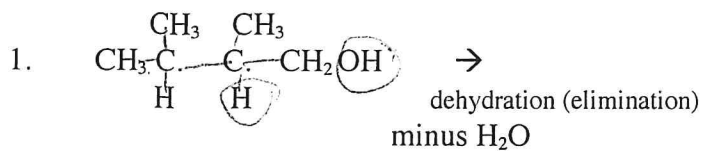
(c). The IUPAC name for the molecule shown is _____ (2 pts)

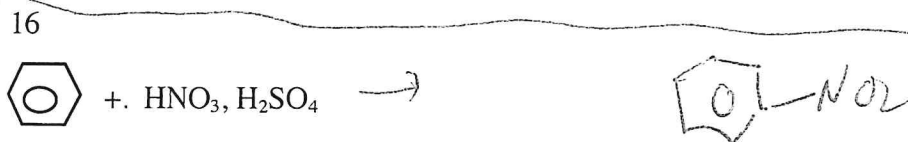
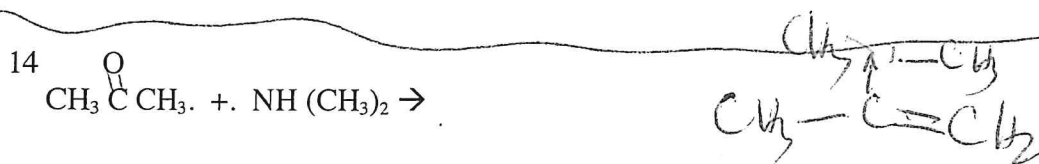
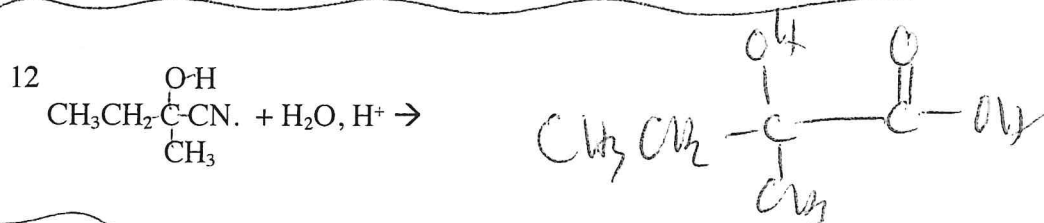
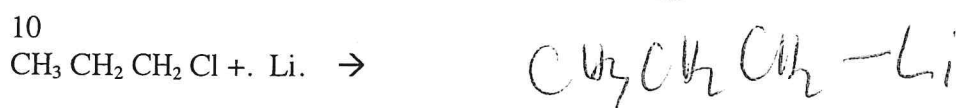
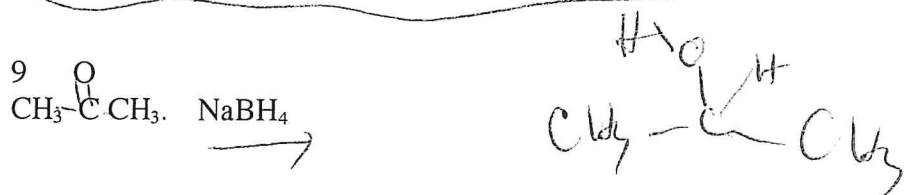
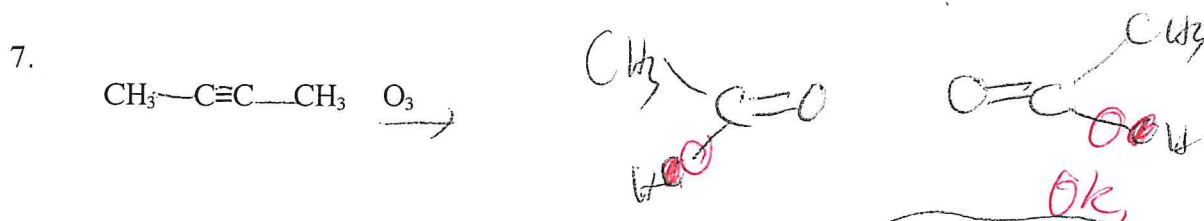


3-heptene

2,6,6-trimethyl

B. Write the organic product of the following reaction. Do not balance the reaction. (circle the number of the 10 you want graded. If you do not circle, I will just grade the first 10. (2 pts each, 20 pts)





C. Short Answer: (24 pts)

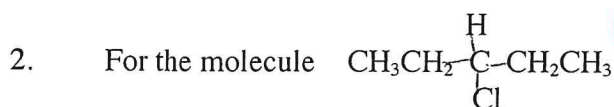
1. give the IR expected peak for the molecule shown below (8 pts, 2 pts each blank)



For the IR, give 2 expected peak and the parts of the molecule and its movement which is expected to cause the peak . (8. pts)

$2500-3100\text{ cm}^{-1}$ Caused by OH of carboxylic acid

$1680-1750\text{ cm}^{-1}$ Caused by C=O carbonyl



(a). (b). (c). (d) (e)

for proton NMR. (use the label shown above). (6 pts, 2 pts each)

(1) approximate chemical shift.

order of peaks is: [(a, e, b, d, c) or (c, b&d, a&e)]. (circle one)

(2) integration areas expected (give integration number for # hydrogens) circle all correct integrations (each choice is defined by the { }

{(b) & (c) 4 H} or {(a) & (e) 6 H} or {(a) 3H} or {(e) 3 H} or {(b) & (d) 4 H}

(3) show N values, the coupling equation and the expected coupling Circle either (Choice A) or (Choice B)(6 pts)

Choice A

or

Choice B

(a) ~~N=3~~, # peaks = 4

(b) N = 2, # peaks = 3

(c) N = 1, # peaks = 2

(d) N = 2, # peaks = 3

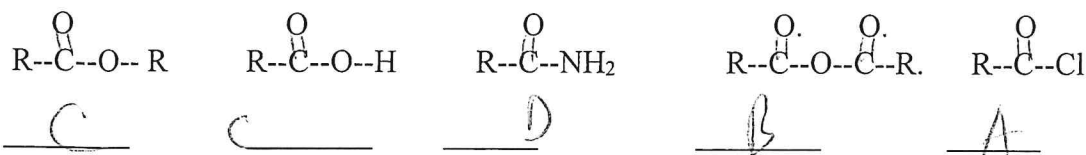
(e) N = 3, # peaks = 4

(a & e) N=2, # peaks = 3

(b & d) N = 4, # peaks = 5

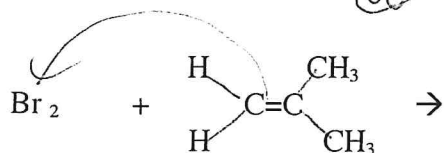
(c) N = 4, # peaks = 5

3. The order of reactivity of carboxylic acid derivatives is: Write **A for most reactive** to **D for least reactive**. (2 of the functional groups have about the same reactivity. (use the same letter for the 2 functional group with nearly the same reactivity) (10 pts, 2 pts each)

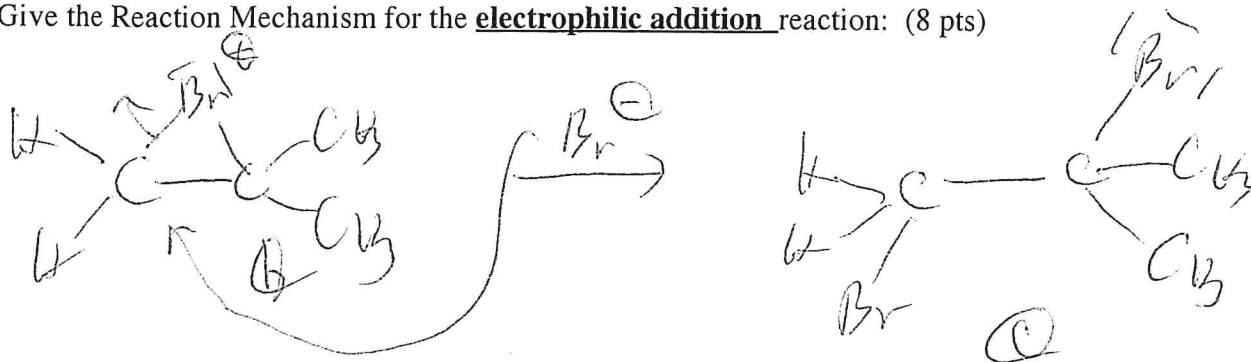


Part III. Long Answers (28 pts) Show work where applicable.

1.



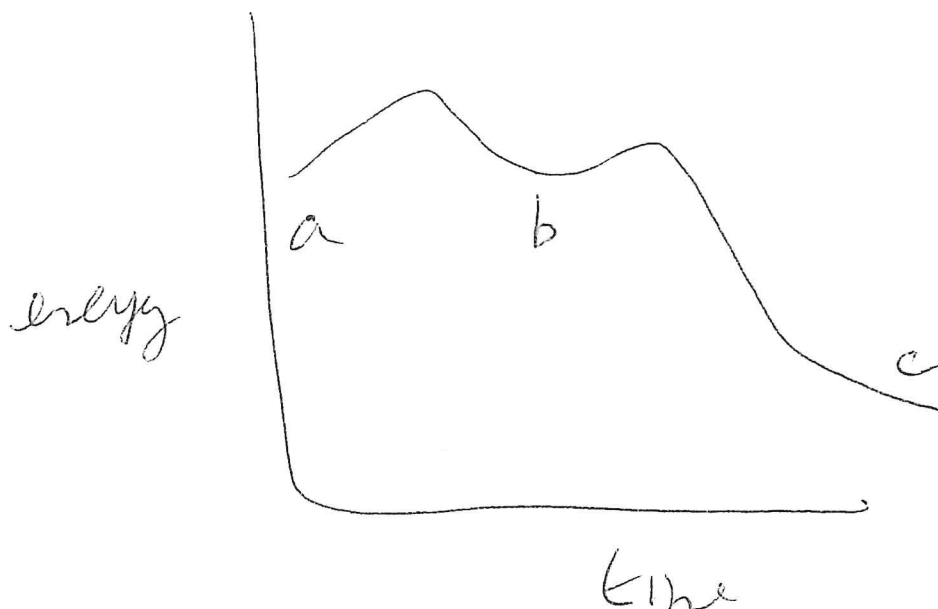
(a) Give the Reaction Mechanism for the electrophilic addition reaction: (8 pts)



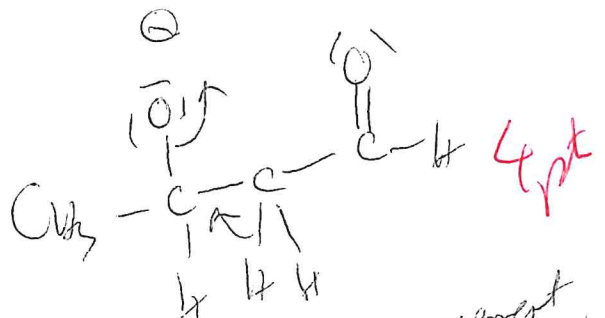
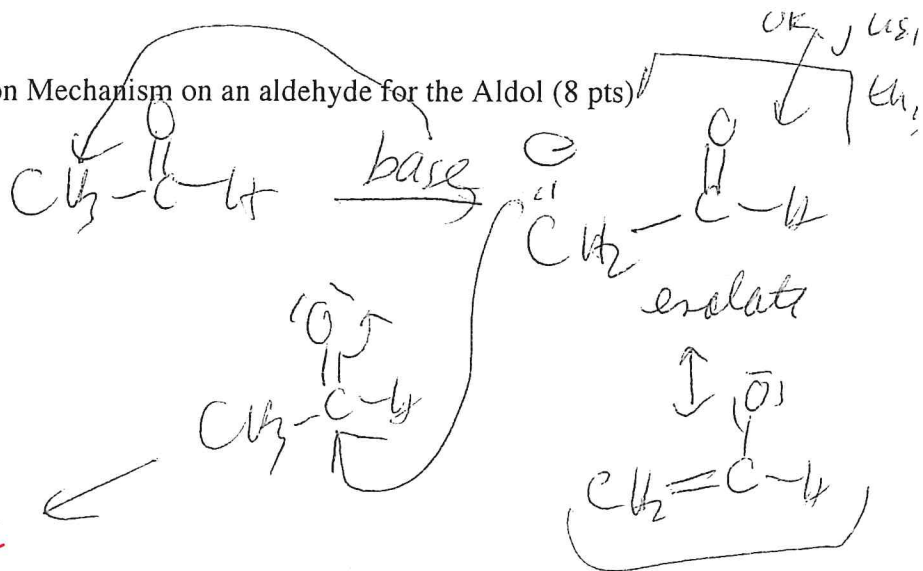
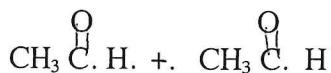
4

4

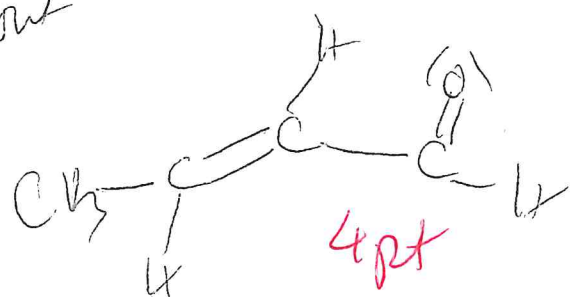
(b) Give the energy diagram and label your energy diagram to match your reaction mechanism that you gave above. (4 pts)



2. (a). Give the Nucleophilic Addition Mechanism on an aldehyde for the Aldol (8 pts)



same H+ movement steps ok to leave out
-H₂O



(b) Give the Nucleophilic Substitution Mechanism for the following reaction. (8 pts)

