Final Organic Chem II (CHEM 442) Fall 15 12/14/15Monday Dr. Hahn MWF12pm Form A Exam#
Sign Name Print Name
Sign Name Print Name (5 pt name above print & sign—If I can't tell who you are from NO NAME above, I have to go back to the exam taking map and hope that I can read your name on that or I may end up with an exam with no identity permanently), (5 pts scantron name – if you don't bubble in I get a grade with no name and I have to hold everyone's final grades until I figure out whose exam it is.)(100 pts,14 pages + scantron sheet, periodic table)
Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. I will only grade what I can read (obviously). I am not going to make up an answer for you based on writing I can't read. (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 250 students told me what to grade on what page.)
Circle answer on this form for backup to the scantron. There is no partial credit for showing work in the multiple choice. COLOR FORM
In all questions on all parts of this exam, R is not equal to hydrogen but is an alkyl.
 Multiple Choice (2 pts each, 26 pts) Choose the <u>one</u> best statement in each question.
1. UV spectroscopy measures the energy required to promote an electron from the molecular orbital to the molecular orbital.
(a) lowest occupied, lowest unoccupied (b) lowest occupied, highest unoccupied (c) highest occupied, higest unoccupied (d) highest occupied, lowest unoccupied (e) None of the above.
2. Choose the best reaction for carboxylic acid and carboxylic acid derivatives where [] is the nucleophile part of the carboxylic acid and carboxylic acid derivative.
(a) O
(b) O
(c) Q $R \rightarrow C \rightarrow \{ \} \rightarrow R \rightarrow$
(d) O $O-H$ $R-C-[I] + Li Al H4 \rightarrow R-C-II is reduction$
(e) All of the above reactions work for almost all carboxylic acid derivatives.
Organic Chemistry II Fall 2015 Dr. Hahn Final Exam Form A

- 3. What is the major difference between an antiaromatic and aromatic compounds.
 - (a) Aromatic compounds cannot have a charged atom in the structure,
 - (b) The structure must be cyclic for aromatic but not antiaromatic compounds.
 - (c) Antiaromatic compounds have at least a sp³ hybridized atom in the ring.
 - (d) Antiaromatic compounds can assume a chair like structure while aromatic compounds are nearly
 - (e) Only aromatic compounds follow Huckle's rule.
- 4. For the element As, circle the one incorrect statement.
 - a. The atomic mass is 75
 - b. The number of valence electrons is 5
 - C The number of electrons for a neutral atom is 5 d. The atomic number is 33
- 5. Circle the one statement below which is incorrect.
 - a) In an energy diagram, a transition state is in general between either the reactant & product or between the reactant and the intermediate.
 - b) An "Electrophile" loves electrons while a "Nucleophile" loves nuclei
 - in an energy diagram, an intermediate is always at the top of an energy hill.
 - A heterocylic arrow looks like →

6. Which of the following reactions does not show a syn product?

c.
$$CII_3$$
— $C\equiv C$ — CII_3 $Pt^\circ/CaCO_3$ H H $C=C$ CII_3 CII_3 CII_3

d.
$$CH_3$$
 CH_3 CH_3

7. What type of orbitals do the lone pair electrons on oxygen occupy in ethanol?

- (a) sp^3 (b) sp (c) π (d) p (e) σ
- 8. What descriptive term is applied to the type of diene represented by 1,5-octadiene?
 - (a) Isolated diene
 - (b) Conjugated dicne
 - (c) Alkynyl diene
 - (d) Cumulated diene
 - (e) None of the above

9. Which of the following are valid ways to make ketone and aldehydes

(b)
$$CH_3$$
— C — O — H $K_2Cr_2O_7, H^+$ CH_3 C = O CH_3

10. Put in order of most stable to least stable carbocation by choosing the one best choice:

- a) Most stable carbocation to least stable carbocation is (4) > (2) > (1) > (3)
- b) Most stable carbocation to least stable carbocation is (2) > (1) > (3) > (4)
- (c) Most stable carbocation to least stable carbocation is (3) > (1) > (2) > (4)d) Most stable carbocation to least stable carbocation is (1) > (2) > (3) > (4)

Which of the following are ways to get a carboxylic acid? Choose the best statement.]]. (R not equal H)

(c) R-C
$$\pm$$
N $H_2O_1H^+$

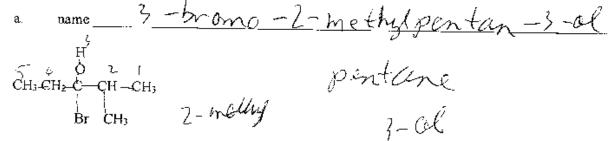
- (d)(a) and (c) will produce carboxylic acid.
- All of the above results in a carboxylic acid. (e)

12. Which of the following is an α hydrogen?

13. For the Markovnikov's electrophilic reaction of H Cl to the alkene below the alkene the product would be:

$$\begin{array}{ccc} CH_{3} & H & \\ CH_{3} & C+C & + & HCI & \rightarrow \end{array}$$

- Ц. Short Answers (36
- A. Nomenclature: (2 pts each, 6 pts)
- Given the structural formula shown below, give the IUPAC name of the molecule. 1.



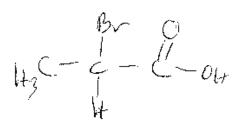
name hethyl butanoate

H2CH2G-O-CH3 butanoate

Dutanoate

O CH₃-CH₂-CH₂-C ←O-CH₃

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



B. Reactions: Show the Organic Product for the following reactions by giving the structural formula of the product. (skeletal formula, condensed structure, Lewis Dot structure are all acceptable. Molecular Formula, abbreviations are <u>not</u> acceptable.) DO <u>NOT</u> SHOW MECHANISMS. (2 pts each, 10 pts)

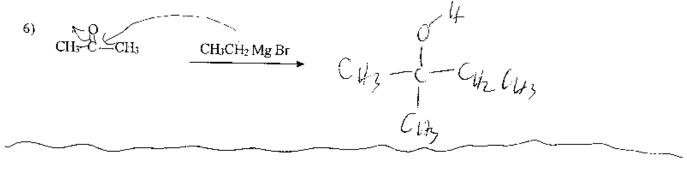
<u>Circle the number of the 5 reaction which you want counted</u>. If you do not choose, I will just grade the first 5 reactions. I <u>will not</u> grade all the reactions and give you points on only your best 5 reactions.

3)
$$NO_2$$
 NO_2 NO_3/H_2SO_4 NO_2

Organic Chemistry [1 Fall 2015 Dr. Hahn

Final Exam

Form A



CH₃ CH₃

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

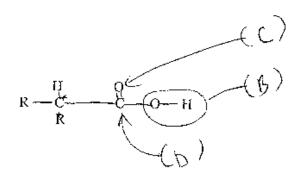
1. Given the following molecule, fill in the parenthesis with the letter of the functional group.

(A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid anhydride (You may use all the letters or none of the letters and may use the same letter multiple times) (3 pts each, 6 pts total)

$$\frac{1}{N}$$

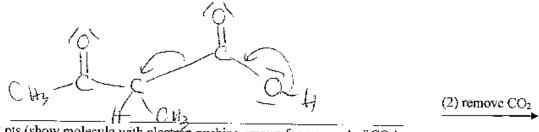
Label the following with a letter per parenthesis. You may use each letter one time, or multiple times. (A) acidic hydrogen (B) Leaving group (C) reacts with H⁺ (D) reacts with nucleophile (E) acts as nucleophile

(Some of the parenthesis may have more than one correct answer but if you fill the parenthesis with ONE correct letter, that is sufficient. If you fill the parenthesis with one correct and some incorrect answers, you will lose some points.) (2 pts each, 8 pts total)

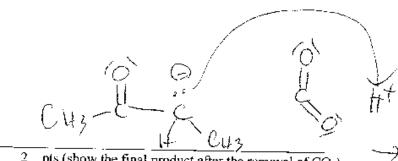


3. Complete the mechanism of the removal of CO₂ in the acetoacctic acid synthesis or malouic acid synthesis. (note: before you get to remove the CO2 you will have to do a reaction) Show electron pushing arrows. (note: this step is the acetoacetic acid synthesis or malonic acid synthesis half way into the synthesis) (6 pts total)

2 pts (after reaction with H₃O⁺)



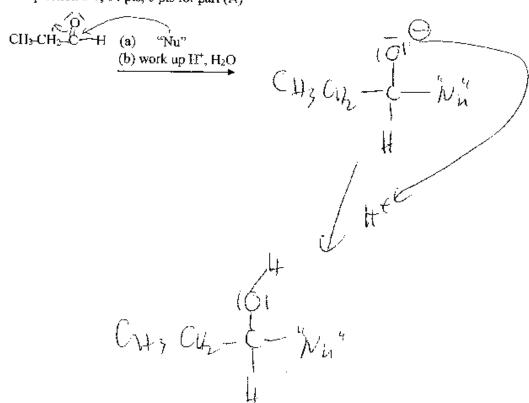
2 pts (show molecule with electron pushing arrows for removal of CO₂)



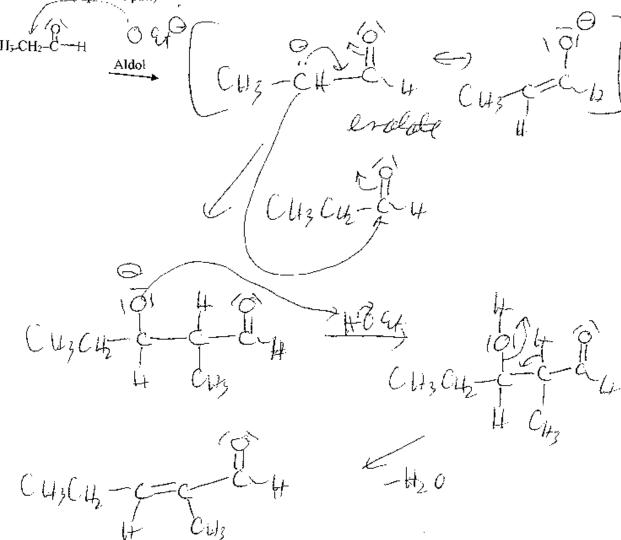
pts (show the final product after the removal of CO2)

Part III. Long Answers (38 pts) Show work where applicable.

I. (A) Keeping in mind the general reaction mechanism of the addition of a nucleophile to a ketone or aldehyde, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (total pts for question # 1, 14 pts, 6 pts for part (A)



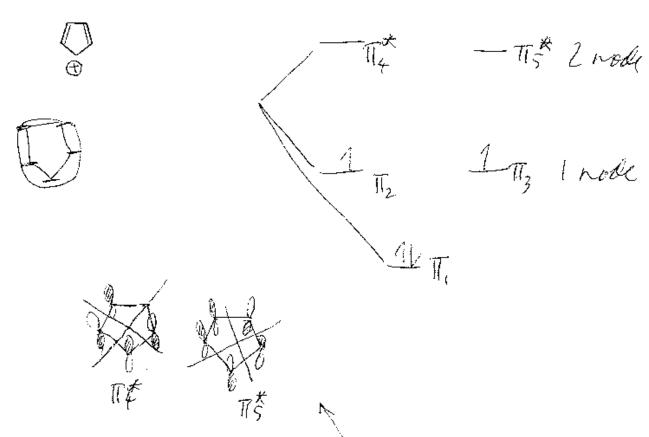
(B) Show the Aldol Condensation Reaction mechanism. The stuff over the arrow is: NaOEt, EtOH and remove water (6 pts this part)



(C) Explain in a sentence or two the relationship between the reaction mechanism which you showed in the step A & B above. (4 pts).

A+B are both "No" addition mechanism Bjust has a larger nucleyelile tha

2 (a) Draw the MO energy diagram for cyclopentadine cation in the space given. (5 pts this letter, 15 pts total)



- (b) Show the p orbital atomic orbital combination for the highest π^* MO in your energy diagram above in part (a) by the MO which matches. Represent the math sign of your p orbital lobes by shading in one of the lobes in all of the p orbitals. Show the nodes. (3 pts)
- (c) Fill your MO energy diagram [which you drew above in (a)] with the appropriate number of electrons for the cyclopentadiene cation. Use up and down arrows to represent electrons. (3 pts)
- (d) Show a Huckel rule explanation of the stability/instability of your cyclopentadiene cation (Huckel Rule is $4\pi+2=\#\pi$ electrons) (3 pts)

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

3. Complete the following synthesis by filling in the blank. I have provided some hints to help you come up with the answers. NOTE: The way I grade this is for you to fill in reasonable molecules based on the immediate prior molecule. i.e. 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. (There is no way that you can come up with this answer except perhaps by guessing.) (3 pts each, 9 pts total)

$$\frac{\text{CH}_{3} \text{CH}_{2} \text{CH}_{2} \text{CH}_{2} \text{CH}_{2} \text{CH}_{3}}{\text{B}} = \frac{\text{C}_{7} \text{H}_{14} \text{O}_{2}}{\text{(IR C=O stretch)}} = \frac{\text{(a) LiAiII}_{4}}{\text{(b) H}_{3} \text{O}^{+}}$$

Final Organic Chem II (CHEM 442) Fall 15 12/14/15Monday Dr. Hahn MWF12pm Form B Exam#	
Sign Name Print Name	_
(5 pt name above print & sign - If I can't fell who you are from NO NAME above, I have to go back to the	ne
exam taking map and hope that I can read your name on that or I may end up with an exam with no identi-	ity
permanently), (5 pts scantron name - if you don't bubble in I get a grade with no name and I have to hold	1
everyone's final grades until I figure out whose exam it is 3(100 pts. 14 pages+ scantron sheet, periodic ta	able'

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. <u>I will only grade what I can read (obviously)</u>. I am not going to make up an answer for you based on writing I can't read. (use back of exam for scratch paper – If you want me to grade something not in the space for the answer, <u>clearly specify in writing</u>. 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 250 students told me what to grade on what page.)

Circle answer on this form for backup to the scantron. 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.

- I. Multiple Choice (2 pts each, 26 pts) Choose the one best statement in each question.
- 1. Which of the following is an α hydrogen?

2. Put in order of most stable to least stable carbocation by choosing the one best choice:

- a. Most stable carbocation to least stable carbocation is $(4) \ge (2) \ge (1) \ge (3)$
- b. Most stable carbocation to least stable carbocation is (1) > (2) > (3) > (4)
- c. Most stable carbocation to least stable carbocation is (2) > (1) > (3) > (4)
- Most stable carbocation to least stable carbocation is (3) > (1) > (3) > (4)

3. Which of the following reactions does <u>not</u> show a <u>syn</u> product?

a.
$$CH_3$$
— $C=C$ — CH_3 $Pt^{\circ}/CaCO_3$. H $C=C$ CH_3 CH_3

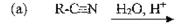
b.
$$CH_3$$
 CH_3 CH_3

c.
$$CH_3$$
 CH_3 CH_3 CH_3 CH_3 CH_3 CH_3 CH_3 CH_3

4. What type of orbitals do the lone pair electrons on oxygen occupy in ethanol?

- (a) σ (b) sp^3 (c) sp (d) π (e)
- 5. What descriptive term is applied to the type of diene represented by 1,5-octadiene?
 - (a) Conjugated diene
 - (b) Cumulated diene
 - (c))Isolated diene
 - (d) Alkynyl diene
 - (e) None of the above

6. Which of the following are ways to get a carboxylic acid? Choose the best statement. (R not equal H)



- (b) LiAlH₄ CO_2
- (c) H Weak oxidizing agent
- (d) (a) and (b) will produce carboxylic acid.
- (e) All of the above results in a carboxylic acid.

7. What is the major difference between an antiaromatic and aromatic compounds.

- (a) Aromatic compounds cannot have a charged atom in the structure.
- (b) The structure must be cyclic for aromatic but not antiaromatic compounds.
- (c) Antiaromatic compounds have at least a sp³ hybridized atom in the ring.
- (d) Antiaromatic compounds can assume a chair like structure while aromatic compounds are nearly flat.
- (e) Only aromatic compounds follow Huckle's rule.

8. For the element As, circle the one incorrect statement.

- (a.) The number of electrons for a neutral atom is 5
- b. The atomic number is 33
- c. The atomic mass is 75
- d. The number of valence electrons is 5

9. For the Markovnikov's electrophilic reaction of H Cl to the alkene below the alkene the product would be:

$$CH_{3} \longrightarrow H \qquad H Cl \rightarrow$$

10. Which of the following are valid ways to make ketone and aldehydes

$$(d) \quad \overset{H}{\underset{R}{\longleftarrow}} C = C \overset{R}{\underset{R}{\longleftarrow}} \qquad \overset{O_3 \text{ or } OsO_4}{\underset{R}{\longleftarrow}} \qquad \overset{R}{\underset{R}{\longleftarrow}} C = O \qquad O = C \overset{H}{\underset{R}{\longleftarrow}}$$

11. Circle the one statement below which is incorrect.

(a) An "Electrophile" loves electrons while a "Nucleophile" loves nuclei

(b) In an energy diagram, an intermediate is always at the top of an energy hill

(c) In an energy diagram, a transition state is in general between either the reactant & product or between the reactant and the intermediate.

(d) A heterocylic arrow looks like →

UV spectroscopy measures the energy required to promote an electron from the ____ molecular orbital to the _____ molecular orbital.

(a) lowest occupied, highest unoccupied

Lumo -> Homo

(b) highest occupied, lowest unoccupied

(c) highest occupied, higest unoccupied

(d) Lowest occupied, lowest unoccupied

(e) None of the above.

Choose the best reaction for carboxylic acid and carboxylic acid derivatives where [] is the nucleophile part of the carboxylic acid and carboxylic acid derivative.

(a)
$$\begin{array}{ccc} O & O & O \\ R-C-[&] + R'OH \rightarrow & R-C-OR' is alcoholysis \end{array}$$

(c)
$$Q$$
 $R = C = [] + R^2 = N = H \rightarrow R = C = N = R^2$ is aminolysis R^2

(d) O O-H R-C-[] + Li Al H4
$$\rightarrow$$
 R-C-H is reduction

All of the above reactions work for almost all carboxylic acid derivatives.

- H. Short Answers (36 pts)
- A. Nomenclature: (2 pts each, 6 pts)
- Given the structural formula shown below, give the IUPAC name of the molecule,

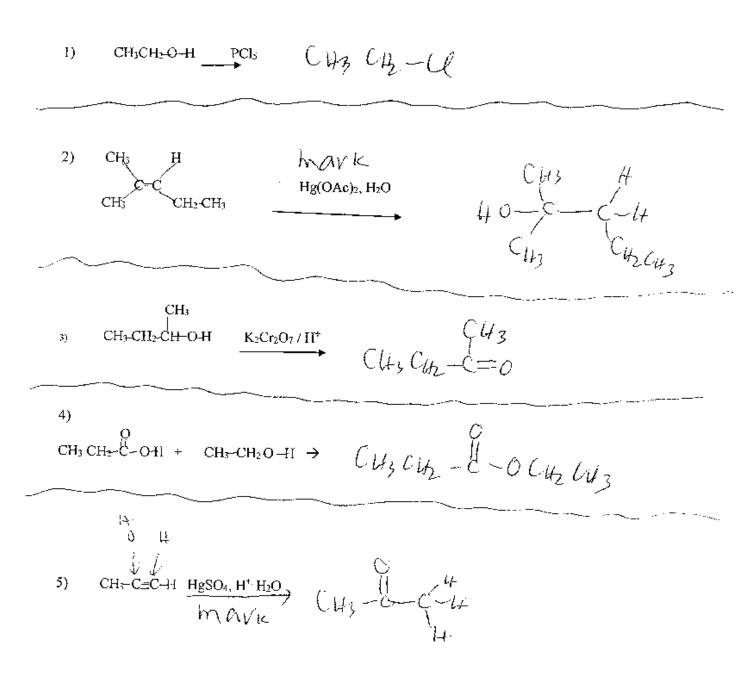
CH3-CH2-CH-CH3 2,5-e poky pertane

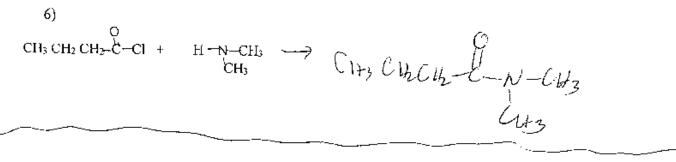
Given the following name, draw a structural formula of the molecule (skeletal formula acceptable, 2. condensed structure, Lewis Dot structure acceptable, molecular formula, abbreviations not acceptable - don't forget to show the hydrogens in your formula unless you are using the skeletal structure.)

pent-1-en-3-one

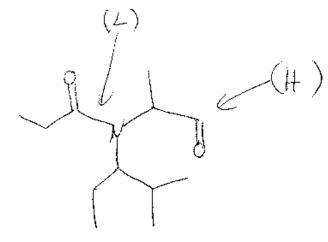
B. Reactions: Show the Organic Product for the following reactions by giving the structural formula of the product. (skeletal formula, condensed structure, Lewis Dot structure are all acceptable. Molecular Formula, abbreviations are <u>not</u> acceptable.) DO <u>NOT</u> SHOW MECHANISMS. (2 pts each, 10 pts)

Circle the number of the 5 reaction which you want counted. If you do not choose, I will just grade the first 5 reactions. I will not grade all the reactions and give you points on only your best 5 reactions.



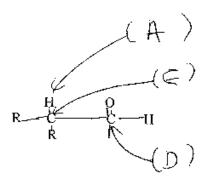


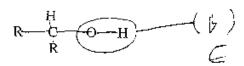
- B. Short Answers part of Short Answers: (20 pts)
- 1. Given the following molecule, fill in the parenthesis with the letter of the functional group.
- (A) alkene (B) alkyne (C) arene (D) alkyl balide (E) alcohol (F) ether (G) amine (H) aldehyde (l) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid anhydride (You may use all the letters or none of the letters and may use the same letter multiple times) (3 pts each, 6 pts total)



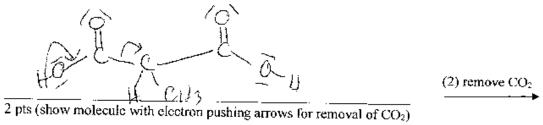
Label the following with a letter per parenthesis. You may use each letter one time, or multiple times. (A) acidic hydrogen (B) Leaving group (C) reacts with H⁺ (D) reacts with nucleophile (E) acts as nucleophile

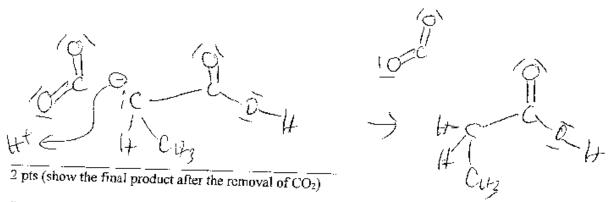
(Some of the parenthesis may have more than one correct answer but if you fill the parenthesis with ONE correct letter, that is sufficient. If you fill the parenthesis with one correct and some incorrect answers, you will lose some points.) (2 pts each, 8 pts total)





3. Complete the mechanism of the removal of CO₂ in the acetoacetic acid synthesis or malonic acid synthesis. (note: before you get to remove the CO2 you will have to do a reaction) Show electron pushing arrows. (note: this step is the acetoacetic acid synthesis or malonic acid synthesis half way into the synthesis) (6 pts total)





Organic Chemistry II Fall 2015 Dr. Hahn Final Exam

Form B

Part III. Long Answers (38 pts) Show work where applicable.

(A) Keeping in mind the general reaction mechanism of the addition of a nucleophile to carboxylic acid derivative, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (total pts for question # 1, 14 pts, 6 pts for part (A)

CHy-6-10E1] "Nu"

CHy-6-10E1] "Nu"

CHy-6-10II

CHy-6-10II

CHy-6-10II

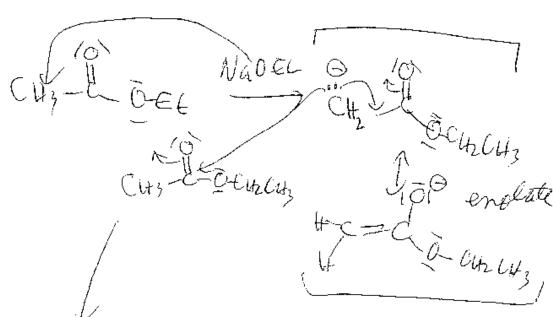
FEL

CHy-6-10II

THE

(B) Show the Claisen Condensation Reaction Mechanism. The stuff over the arrow is: NaOEt, EtOH (6 pts)

O CH₂-C-{OEt]

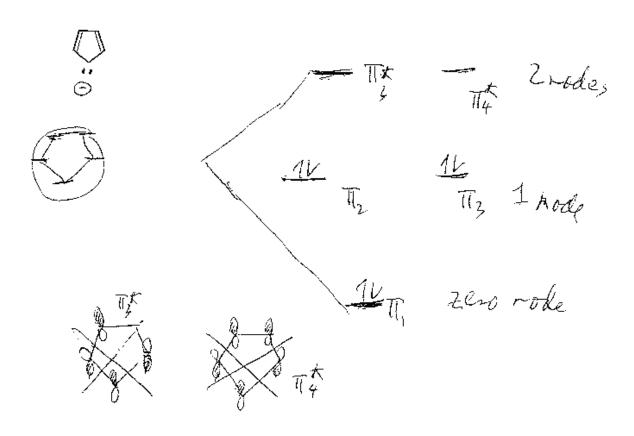


(C) Explain in a sentence or two the relationship between the reaction mechanism which you showed in the step (A) above and step (B) (4 pts).

A+B are some mechanism Except B has a large huckeophile

Custo Company

2 (a) Draw the MO energy diagram for cyclopentadine anion in the space given. (5 pts this letter, 15 pts total)



- (b) Show the p orbital atomic orbital combination for the highest π^* MO in your energy diagram above in part (a) by the MO which matches. Represent the math sign of your p orbital lobes by shading in one of the lobes in all of the p orbitals. Show the nodes. (3 pts)
- (c) Fill your MO energy diagram [which you drew above in (a)] with the appropriate number of electrons for the cyclopentadiene anion. Use up and down arrows to represent electrons. (3 pts) $\frac{1}{2}$
- (d) Show a Huckel rule explanation of the stability/instability of your cyclopentadiene anion (Huckel Rule is $4n+2-\#\pi$ electrons) (3 pts)

$$6e = 4n + 2$$
 aromatic
 $6-2 = 4n$
 $\frac{4}{4} = h = 1$

Complete the following synthesis by filling in the blank. I have provided some hints to help you come up with the answers. NOTE: The way I grade this is for you to fill in reasonable molecules based on the immediate prior molecule. i.e. 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. (There is no way that you can come up with this answer except perhaps by guessing.) (3 pts each, 9 pts total)

Claiser

Organic Chemistry II Fall 2015 Dr. Hahn

Final Exam

Form B

Sign Name _____ Print Name

(5 pt name above print & sign – If I can't tell who you are from NO NAME above, I have to go back to the exam taking map and hope that I can read your name on that or I may end up with an exam with no identity permanently), (5 pts scantron name – if you don't bubble in I get a grade with no name and I have to hold everyone's final grades until I figure out whose exam it is.)(100 pts,14 pages + scantron sheet, periodic table)

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Circle answer on this form for backup to the scantron. There is no partial credit for showing work in the multiple choice.

COLOR FORM

In all questions on all parts of this exam, R is not equal to hydrogen but is an alkyl.

- Multiple Choice (2 pts each, 26 pts) Choose the one best statement in each question.
- I. UV spectroscopy measures the energy required to promote an electron from the _____ molecular orbital to the _____ molecular orbital.
 - (a) lowest occupied, lowest unoccupied
 - (b) lowest occupied, highest unoccupied
 - (c) highest occupied, higest unoccupied
 - (d) highest occupied, lowest unoccupied
 - (e) None of the above.
- 2. Choose the best reaction for carboxylic acid and carboxylic acid derivatives where [] is the nucleophile part of the carboxylic acid and carboxylic acid derivative.

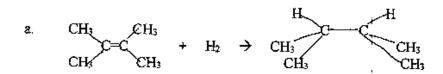
(b) O O R-C-[] + HO-H
$$\rightarrow$$
 R-C-O-H is hydrolysis

(c)
$$R = C - [] + R = N + H \rightarrow R = C - N - R$$
 is aminolysis R

(e) All of the above reactions work for almost all carboxylic acid derivatives.

- 3. What is the major difference between an antiaromatic and aromatic compounds.
 - (a) Aromatic compounds cannot have a charged atom in the structure.
 - (b) The structure must be cyclic for aromatic but not antiaromatic compounds.
 - (c) Antiaromatic compounds have at least a sp3 hybridized atom in the ring.
 - (d) Antiaromatic compounds can assume a chair like structure while aromatic compounds are nearly flat.
 - (e) Only aromatic compounds follow Huckle's rule.
- For the element <u>As</u>, circle the one incorrect statement.
 - a. The atomic mass is 75
 - b. The number of valence electrons is 5
 - c. The number of electrons for a neutral atom is 5
 - d. The atomic number is 33
- 5. Circle the one statement below which is incorrect.
 - a) In an energy diagram, a transition state is in general between either the reactant & product or between the reactant and the intermediate.
 - b) An "Electrophile" loves electrons while a "Nucleophile" loves nuclei
 - c) In an energy diagram, an intermediate is always at the top of an energy hill.
 - d) A heterocylic arrow looks like →

6. Which of the following reactions does **not** show a syn product?



- b. CH₃-C≡C-CH₃ Na°/NH₃ H CH₃
 CH₃ CH₄
- c. $CH_3-C\equiv C-CH_3$ $Pt^{\circ}/CaCO_3$ H C=C CH_3 CH_3

d.
$$CH_3$$
 CH_3 CH_3

- 7. What type of orbitals do the lone pair electrons on oxygen occupy in ethanol?
 - (a) sp³ (b) sp
- (c) π (d) p
- (e) σ
- 8. What descriptive term is applied to the type of diene represented by 1,5-octadiene?
 - (a) Isolated diene
 - (b) Conjugated diene
 - (c) Alkynyl diene
 - (d) Cumulated diene
 - (e) None of the above

9. Which of the following are valid ways to make ketone and aldehydes

(b)
$$CH_3$$
— C — O — H $K_2Cr_2O_7, H^+$ CH_3 — C = O 1 CH_3

$$(d) \qquad \stackrel{H}{\underset{R}{\longleftarrow}} C = C \qquad \stackrel{R}{\underset{R}{\longleftarrow}} \qquad \underbrace{O_3 \text{ or } O_5O_4} \qquad \stackrel{R}{\underset{R}{\longleftarrow}} C = O \qquad O = C \qquad \stackrel{H}{\underset{R}{\longleftarrow}}$$

(e) All are correct

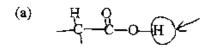
10. Put in order of most stable to least stable carbocation by choosing the one best choice:

- a) Most stable carbocation to least stable carbocation is (4) > (2) > (1) > (3)
- b) Most stable carbocation to least stable carbocation is (2) > (1) > (3) > (4)
- c) Most stable carbocation to least stable carbocation is (3) > (1) > (2) > (4)
- d) Most stable carbocation to least stable carbocation is (1) > (2) > (3) > (4)

11. Which of the following are ways to get a carboxylic acid? Choose the best statement. (R not equal H)

- (d) (a) and (c) will produce carboxylic acid.
- (e) All of the above results in a carboxylic acid.

Which of the following is an a hydrogen? 12,



For the Markovnikov's electrophilic reaction of H CI to the alkene below the alkene the product 13, would be:

- Short Answers (36 11.
- A. Nomenclature: (2 pts each, 6 pts)
- ì. Given the structural formula shown below, give the IUPAC name of the molecule.
- a.

b.

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

B. Reactions: Show the Organic Product for the following reactions by giving the structural formula of the product. (skeletal formula, condensed structure, Lewis Dot structure are all acceptable. Molecular Formula, abbreviations are <u>not</u> acceptable.) DO <u>NOT</u> SHOW MECHANISMS. (2 pts each, 10 pts)

Circle the number of the 5 reaction which you want counted. If you do not choose, I will just grade the first 5 reactions. I will not grade all the reactions and give you points on only your best 5 reactions.

Organic Chemistry II Fall 2015 Dr. Hahn

Final Exam:

- B. Short Answers part of Short Answers: (20 pts)
 - 1. Given the following molecule, fill in the parenthesis with the letter of the functional group.
- (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid anhydride (You may use all the letters or none of the letters: and may use the same letter multiple times) (3 pts each, 6 pts total)

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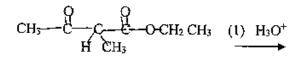
Final Exam

Form A

- 2. Label the following with a letter per parenthesis. You may use each letter one time, or multiple (A) acidic hydrogen (B) Leaving group (C) reacts with H⁺ (D) reacts with nucleophile (E) acts as nucleophile

(Some of the parenthesis may have more than one correct answer but if you fill the parenthesis with ONE correct letter, that is sufficient. If you fill the parenthesis with one correct and some incorrect answers, you will lose some points.) (2 pts each, 8 pts total)

3. Complete the mechanism of the removal of CO₂ in the acetoacetic acid synthesis or malonic acid synthesis. (note: before you get to remove the CO₂ you will have to do a reaction) Show electron pushing arrows. (note: this step is the acetoacetic acid synthesis or malonic acid synthesis half way into the synthesis) (6 pts total)



2 pts (after reaction with H₃O^{*})

(2) remove CO₂

2 pts (show molecule with electron pushing arrows for removal of CO₂)

2 pts (show the final product after the removal of CO₂)

Part III. Long Answers (38 pts) Show work where applicable.

1. (A) Keeping in mind the general reaction mechanism of the addition of a nucleophile to a ketone or aldehyde, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (total pts for question # 1, 14 pts, 6 pts for part (A)

CH₂-CH₂-C —H (a) "Nu"

(b) work up H⁺, H₂O

(B) Show the Aldol Condensation Reaction mechanism. The stuff over the arrow is: NaOEt, EtOH and remove water.(6 pts this part)

O CH₃ CH₂—C—H

Aldol

(C) Explain in a sentence or two the relationship between the reaction mechanism which you showed in the step A & B above. (4 pts).

2 (a) Draw the MO energ pts total)	y diagram for c	yclopentadi	ne cation	in the space	given. (5 pts	this letter, 15
\bigcirc		:				
		· .				
		·				
		.				
(b) Show the p orbital atomic opart (a) by the MO which mate	hes. Represen	t the math s	highest π'	* MO in you rr p orbital lo	r energy diag	ram above in ag in one of the
lobes in all of the p orbitals. S (c) Fill your MO energy diagrathe cyclopentadiene cation. Use	m [which you d up and down a	liew above arrows to re	present ek	ectrons. (3 p	ts)	
(d) Show a Huckel rule explans is $4n+2 = \# \pi$ electrons) (3 pts) $n = \underline{\hspace{1cm}}$	tion of the stab	i ∦t y/instabi	lity of you	r cyclopent:	adiene cation	(Huckel Rule
Organic Chemistry II Fall 2015	Dr. Hahn	Final Ex	1 773	Form A		12

Form A

13

3. Complete the following synt come up with the answers. based on the immediate prior do the next reaction to molecy you fill in B with what you we generated from your wrong a (There is no way that you can pts total)	NOTE: The way I g r molecule. i.e. If yo cule B correctly you v would have gotten if y A. you will have all or	rade this is for you fill in part A would get half credition got A corrected the confection of the con	ou to fill in rest with the wrong it for answering tly but which o	esonable molecumolecule and the grant possibly be annot possibly be	iles ien If pe
О О СН₃ СН₂-О-С-СН₂-С-О-СН₂-СН₃	EtO Na CH3CH2Ci Et OH (1 mol)	H ₃ O ⁺ A	C ₄ H ₈ O ₂ (IR	C=O & O-H stre	etch)
CH ₂ -CH ₂ -CH ₂ -OH B C ₇ H ₁₄ O ₂ (IR C=O stretch)		a) LiAlH4 b) H3O*		
			•		
C C ₄ H ₁₀ O (IR O-H stretch) Organic Chemistry II Fall 2015 Dr.	Hahn Final Exa	m Form 2	Ą	1	14

(5 pt name above print & sign – If I can't tell who you are from NO NAME above, I have to go back to the exam taking map and hope that I can read your name on that or I may end up with an exam with no identity permanently), (5 pts scantron name – if you don't bubble in I get a grade with no name and I have to hold everyone's final grades until I figure out whose exam it is (100 pts, 14 pages+ scantron sheet, periodic table)

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. I will only grade what I can read (obviously). I am not going to make up an answer for you based on writing I can't read. (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 250 students told me what to grade on what page.)

Circle answer on this form for backup to the scantron. 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.

- I. Multiple Choice (2 pts each, 26 pts) Choose the one best statement in each question.
- 1. Which of the following is an α hydrogen?

2. Put in order of most stable to least stable carbocation by choosing the one best choice:

- a. Most stable carbocation to least stable carbocation is (4) > (2) > (1) > (3)
- b. Most stable carbocation to least stable carbocation is (1) > (2) > (3) > (4)
- c. Most stable carbocation to least stable carbocation is (2) > (1) > (3) > (4)
- d. Most stable carbocation to least stable carbocation is (3) > (1) > (2) > (4)

3. Which of the following reactions does <u>not</u> show a <u>syn</u> product?

a.
$$CH_3 - C \equiv C - CH_3 - Pt^o/CaCO_3$$
, quinoline $CH_3 - CH_3 - CH_3$

b.
$$CIL_3$$
 CH_3 CH_3

c.
$$CH_3$$
 CH_3 CH_3

d.
$$CH_3-C=C-CH_3$$
 Na°/NH_3 H $C=C$

4. What type of orbitals do the lone pair electrons on oxygen occupy in ethanol?

- (a) σ
- (b) sp^3
- (c) sp
- (d) π (e) p

5. What descriptive term is applied to the type of diene represented by 1,5-octadiene?

- (a) Conjugated diene
- (b) Cumulated dienc
- (c) Isolated diene
- (d) Alkynyl diene
- (e) None of the above

- 6. Which of the following are ways to get a carboxylic acid? Choose the best statement. (R not equal H)
- (a) R-C \equiv N $\underline{H_2O}$, $\underline{\Pi}^+$
- (b) LiAlH₄ CO₂
- (c) H II weak oxidizing agent
- (d) (a) and (b) will produce carboxylic acid.
- (e) All of the above results in a carboxylic acid.
- What is the major difference between an antiaromatic and aromatic compounds.
 - (a) Aromatic compounds cannot have a charged atom in the structure.
 - (b) The structure must be cyclic for aromatic but not antiaromatic compounds.
 - (c) Antiaromatic compounds have at least a sp3 hybridized atom in the ring.
 - (d) Antiaromatic compounds can assume a chair like structure while aromatic compounds are nearly flat.
 - (e) Only aromatic compounds follow Huckle's rule.
- For the element <u>As</u>, eircle the one incorrect statement.
 - a. The number of electrons for a neutral atom is 5
 - b. The atomic number is 33
 - c. The atomic mass is 75
 - d. The number of valence electrons is 5

9. For the Markovnikov's electrophilic reaction of H Cl to the alkene below the alkene the product would be:

b)
$$CH_3$$
 H CH_3 H

10. Which of the following are valid ways to make ketone and aldehydes

(b)
$$CII_3$$
-- C = C -- H BH_3/THF CFI_3 -- CH_2 - C -- II

(c)
$$CH_3$$
— C O — H $K_2Cr_2O_7$, H^4 CH_3 — C = O CH_3

$$(d) \qquad H \qquad R \qquad Q_3 \text{ or } OsO_4 \qquad R \qquad C=O \qquad O=C \qquad R$$

(c) All are correct

- Circle the one statement below which is incorrect. 11.
 - (a) An "Electrophile" loves electrons while a "Nucleophile" loves nuclei
 - (b) In an energy diagram, an intermediate is always at the top of an energy hill
 - (c) In an energy diagram, a transition state is in general between either the reactant & product or between the reactant and the intermediate.
 - (d) A heterocylic arrow looks like →
- UV spectroscopy measures the energy required to promote an electron from the _____ molecular orbital to the _____ molecular orbital.
 - (a) lowest occupied, highest unoccupied
 - (b) highest occupied, lowest unoccupied
 - (c) highest occupied, higest unoccupied
 - (d) lowest occupied, lowest unoccupied
 - (e) None of the above.
- Choose the best reaction for carboxylic acid and carboxylic acid derivatives where [] is the nucleophile part of the carboxylic acid and carboxylic acid derivative.
- (a) O $R-C-[] + R'OH \rightarrow R-C-O-R' is alcoholysis$
- (b) Q $R-C-[] + HO-H \rightarrow R-C-O-H$ is hydrolysis
- (c) $R - C - [J + R^2 N - H \rightarrow R - C - N - R' \text{ is aminolysis}]$
- $\begin{array}{c} O \\ R-C-[\end{array} \begin{array}{c} O-H \\ R-C-[\end{array} \begin{array}{c} O-H \\ AI H4 \end{array} \rightarrow \begin{array}{c} C-H \\ R-C-H \end{array}$ is reduction (d)
- (e) All of the above reactions work for almost all carboxylic acid derivatives.

- 11. Short Answers (36 pts)
- A. Nomenclature: (2 pts each, 6 pts)
- 1. Given the structural formula shown below, give the IUPAC name of the molecule.
- a. name ______

b. name______

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

pent-1-en-3-one

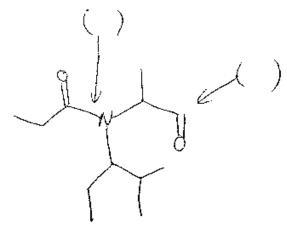
Reactions: Show the Organic Product for the following reactions by giving the structural formula of the product. (skeletal formula, condensed structure, Lewis Dot structure are all acceptable. Molecular Formula, abbreviations are <u>not</u> acceptable.) DO <u>NOT</u> SHOW MECHANISMS. (2 pts each, 10 pts)

Circle the number of the 5 reaction which you want counted. If you do not choose, I will just grade the first 5 reactions. 1 will not grade all the reactions and give you points on only your best 5 reactions.

O CH₃ CH₂ CH₂ C -Cl + H-N-CH₃
$$\longrightarrow$$
 CH₃

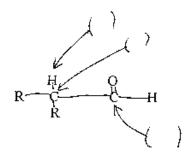
7)
$$CH_{7}CH_{-}C_{-}O_{-}H$$
 (1) $Br_{2}PBr_{3}$ (2) $H_{2}O_{-}$

- B. Short Answers part of Short Answers: (20 pts)
- 1. Given the following molecule, fill in the parenthesis with the letter of the functional group.
- (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid anhydride (You may use all the letters or none of the letters and may use the same letter multiple times) (3 pts each, 6 pts total)



2. Label the following with a letter per parenthesis. You may use each letter one time, or multiple times. (A) acidic hydrogen (B) Leaving group (C) reacts with H⁺ (D) reacts with nucleophile (E) acts as nucleophile

(Some of the parenthesis may have more than one correct answer but if you fill the parenthesis with ONE correct letter, that is sufficient. If you fill the parenthesis with one correct and some incorrect answers, you will lose some points.) (2 pts each, 8 pts total)



$$\begin{array}{c} H \\ R - C - O - H \end{array}$$

3. Complete the mechanism of the removal of CO₂ in the acetoacetic acid synthesis or malonic acid synthesis. (note: before you get to remove the CO2 you will have to do a reaction) Show electron pushing arrows. (note: this step is the acetoacetic acid synthesis or malonic acid synthesis half way into the synthesis) (6 pts total)

2 pts (after reaction with H₃O⁺)

2 pts (show molecule with electron pushing arrows for removal of CO₂)

² pts (show the final product after the removal of CO₂)

Part III. Long Answers (38 pts) Show work where applicable.

(A) Keeping in mind the general reaction mechanism of the addition of a nucleophile to carboxylic acid derivative, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (total pts for question # 1, 14 pts, 6 pts for part (A)

(B) Show the Claisen Condensation Reaction Mechanism. The stuff over the arrow is: NaOEt, EtOH (6 pts)

O CH₂---C---[O Et]

(C) Explain in a sentence or two the relationship between the reaction mechanism which you showed in the step (A) above and step (B) (4 pts).

2 (a) Draw the MO energy diagram for cyclopentadine anion in the space given. (5 pts this letter, 15 pts total)
(b) Show the p orbital atomic orbital combination for the highest π^* MO in your energy diagram above in
part (a) by the MO which matches. Represent the math sign of your p orbital lobes by shading in one of the lobes in all of the p orbitals. Show the nodes. (3 pts)
(c) Fill your MO energy diagram [which you drew above in (a)] with the appropriate number of electrons for the cyclopentadiene anion. Use up and down arrows to represent electrons. (3 pts)
(d) Show a Huckel rule explanation of the stability/instability of your cyclopentadiene anion (Huckel Rule is $4n+2=\#\pi$ electrons) (3 pts)
n =

O CH₃-CH₂-C-O-H CH₃-CH₂-O-H A C₃H₁₀O₂ (IR C-O stretch)

(a) CH₃ MgBr / THF (b) H₂O⁺ C C₀H₂₀O₂ (IR O-H stretch)