Exam III Organic Chemistry II (CHEM 442) Fall 15	12/2/15 Dr. Hahn	MWF12pm Form A	Exam#	~
Sign Name Key	Print Name			
(1 pt name above print & sign, 1 pts scantron name)	(100 pts, 13 pages	+ seantron sheet) (color	

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. Telting 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.

- Multiple Choice (2 pts each, 24 pts) Choose the one best statement in each question.
- 1. Which of the following are <u>not</u> exceptions to most carboxylic acid and carboxylic acid derivatives reactions (and do not do the standard reactions of carboxylic acid derivatives)? Or choose the best statement.

(a)
$$R = \frac{1}{2} - 0 - H + NID \rightarrow R = \frac{0}{2} - 0 NH4$$

(b)
$$R = 0 - NH_2 + R = 0 - H \rightarrow NR$$

(c)
$$Q$$
 $R = C = O = H + R'' M_H X \rightarrow R = - H$

(d) All of the above are exceptions to the standard reactions of carboxylic acid and carboxylic acid derivatives

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

(b)
$$CH_3 - \begin{picture}(100,0) \put(0,0){\line(1,0){100}} \put(0,0){\l$$

$$(d) \qquad \begin{matrix} H \\ R \end{matrix} C = C \begin{matrix} R \\ R \end{matrix} \qquad \underbrace{O_3 \text{ or } O_8O_4}_{R} \qquad \begin{matrix} R \\ R \end{matrix} = O \qquad O = C \begin{matrix} H \\ R \end{matrix}$$

3. Which of the following is an <u>incorrect reactions</u> or which is the best statement?

(a)
$$R \longrightarrow R' + O - R'' \rightarrow R \longrightarrow R' - C \longrightarrow R''$$

(b)
$$R-C-R' + OHF \rightarrow R-C-OH$$

(c)
$$R = R' R'' MgX \rightarrow R = R'' R - R''$$

(d) All above reactions are correct.

- 4. Choose the one incorrect statement or choose the best statement.
- (a) R-C-OR' is a Ketal
- (b) R = C O R' is an acetal
 - Q-II (e) R-C-O-R' is a hemiacotal
- (d) R—G—O-R' is a hemiketal
- (e) All above statements are correct.
- 5. Which of the following are ways to get a carboxylic acid? Choose the best statement. (R not equal U)
- (a) LiAlH₄ CO₂
- (b) H S wak oxidizing agent was oxidizing agent
- (c) R-C \equiv N H_2O, H^3
- (d) (a) and (e) will produce carboxylic acid.
- (e) All of the above results in a carboxylic acid.

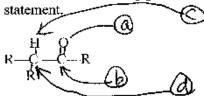
Which of the following is corr	ectí
--	------

- (a) CH₃—CH₂—CH₃ is the carboxylic acid derivative, acetic anhydride
- (b) CH₃—C—O-CH₂CH₃ is ethyl acetate
- (c) CH₃ C±N is acetonitrile
- (d) (b) & (e) are correct
- (c) All are correct.

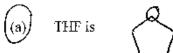
7. Choose the one best statement:

- (a) Epoxide is a 3 ring ether which is especially reactive because the oxygen in cpoxides are sp³ hybridized and have ring strain because of the 60° structure around the sp³ hybridized oxygen.
- (b) Epoxides react with acidic and basic water to form alcohols due!
- (c) Epoxides react with Grignards and organolithium to form dios alcahol
- (d) All above statements are true.
- 8. Choose the one best statement.
- (a) Ethers are very stable to a lot of reactions.
- (b) Ethers react with acidic water to form alcohol.
- (c) Ethers form peroxides when left under air for an extended time. Ether peroxides explode.
- All statements above are true.
- (e) Only (a) and (b) are true.

In the following generalized drawing of ketone, which of the following are incorrect or is the best 9.



- Reacts with II as the first step of reaction mechanisms. (a)
- (b) Reacts with nucleophile.
- (c) Is an acidic hydrogen.
- Carbon after removal of acidic hydrogen, acts as a nucleophile. (d)
- All statements above are true.
- 10. For nomenclature choose the one best statement.
- Aldehyde has a suffix "al" but has a profix "oxo" (a)
- (b) Ketone has a suffix "one" but has a prefix "formyl"
- Alcohol has a suffix "ol" but has a prefix "hydroxy". (c)
- (d) (a) and (b) are true.
- All statements above are correct.
- Circle the best statement about common (non IUPAC) names: 11.



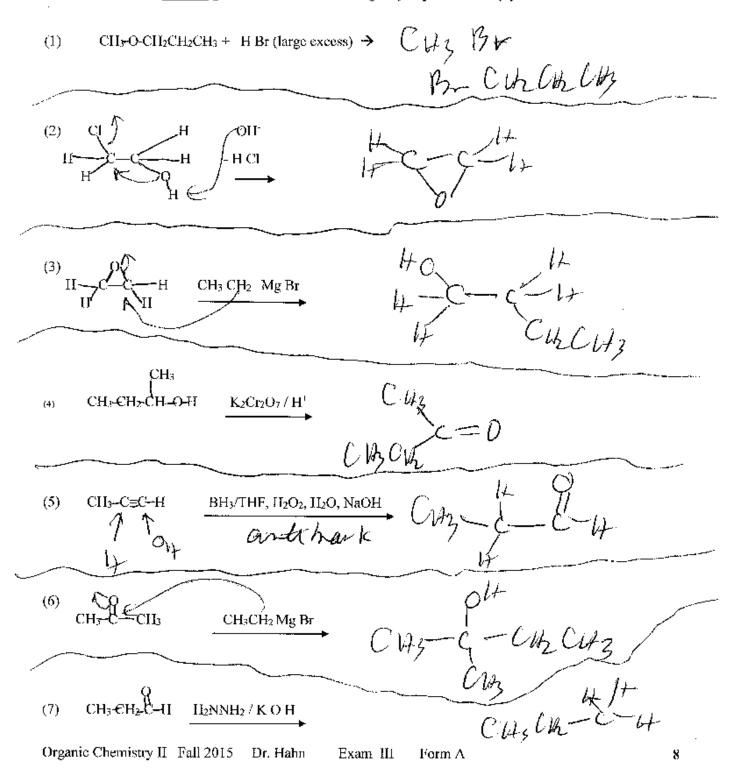
- Formaldehyde is (b)
- (c)
- (d) None of the above are correct.

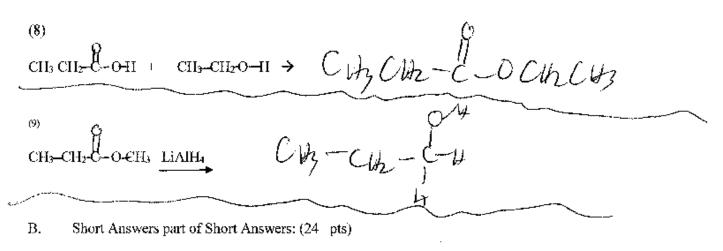
- 12. Choose the best reaction for carboxylic acid and carboxylic acid derivatives where | | is the nucleophile part of the carboxylic acid and carboxylic acid derivative.
- (a) $R = C = [-] + R'OH \rightarrow R = C = O-R'$ is alcoholysis
- (c) $R = C [-1] + R = N + H \rightarrow R = C N + R'$ is aminolysis R'
- (d) R—C—[] + Li Al H4 \rightarrow R—C—H is reduction
- All of the above reactions work for almost all carboxylic acid derivatives.

II.	Short Answers (44 pts)
Λ.	Nomenclature: (2 pts each, 3 pts)
1.	Given the structural formula shown below, give the IUPAC name of the molecule.
a.	name pertangy branide
СНъ.	name pertangl branide CH2-CH2-CH2-CH2-CH2-CH2-CH2-CH2-CH2-CH2-
b.	name N-ethy - N-gropy heptanamid
СН₃-С	CH2-CIL-CIL-CH2-CH2-CH3-CH3-CH3-CH3-CH3-CH3-CH3-CH3-CH3-CH3
	N-ethy N-grosy
	Given the following name, draw a structural formula of the molecule (skeletal formula acceptable, nsed structure, Lewis Dot structure acceptable, molecular formula not acceptable - don't forget to show drogens in your formula unless you are using the skeletal structure.)
a.	ethyl propyl ether
	CHICK O - CHICKS
b.	3-ethoxy hexane
	3-ethoxy hexane CLT

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 is **not** acceptable.) DO **NOT** SHOW MECHANISMS. (2 pts each, 12 pts)

<u>Circle the number of the 6 reaction which you want counted</u>. If you do not choose, I will just grade the first 6 reactions. I <u>will not</u> grade all the reactions and give you points on only your best 6 reactions.





- 1. To make the ether CH₂O-CH₂CH₃ the following are two possible ways. (5 pts total)
 - (1) Which is the better reaction? (a) or (b)] (circle one) (3 pts)
- a) CH₃ CI + CH₃CH₂ O⁺

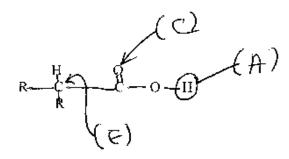
S_N2 (Williamson Ether Synthesis)

b) CH₃ O H + CH₃CH₂ OH H⁺/- H₂O

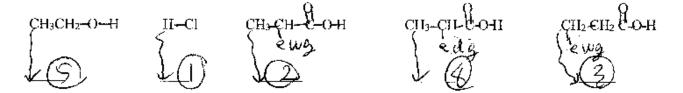
S_N2 dehydration of alcohol

(2) Explain briefly, (2 pts)

Cho Ora Ch Chy O Chy Chy O Chy Chy Ch-O-Chy Chy 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 (6 pts, 2 pts each)



3. Put the following acids in order from <u>strongest acid (1)</u> to <u>weakest acid (5)</u> (edg = electron donating group, ewg = electron withdrawing group) (5 pts, 1 pt each)

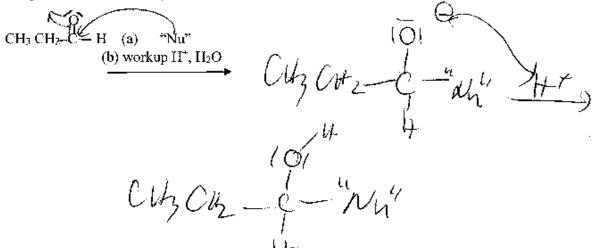


4. Put the following carboxylic acid derivative from the <u>most reactive (1)</u> to <u>least reactive (4)</u> carboxylic acid derivative. (8 pts)

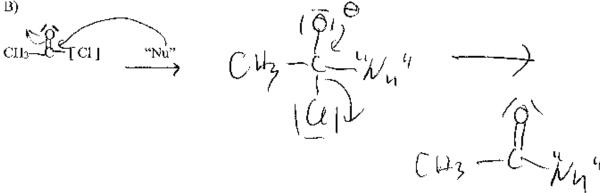


Part III. Long Answers (32 pts) Show work where applicable.

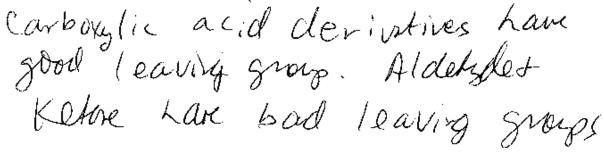
1. (A) Keeping in mind the general reaction mechanism of the addition of a nucleophile to a ketone or aldehyde, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (total pts for question # 1, 22 pts, 8 pts for part (A)



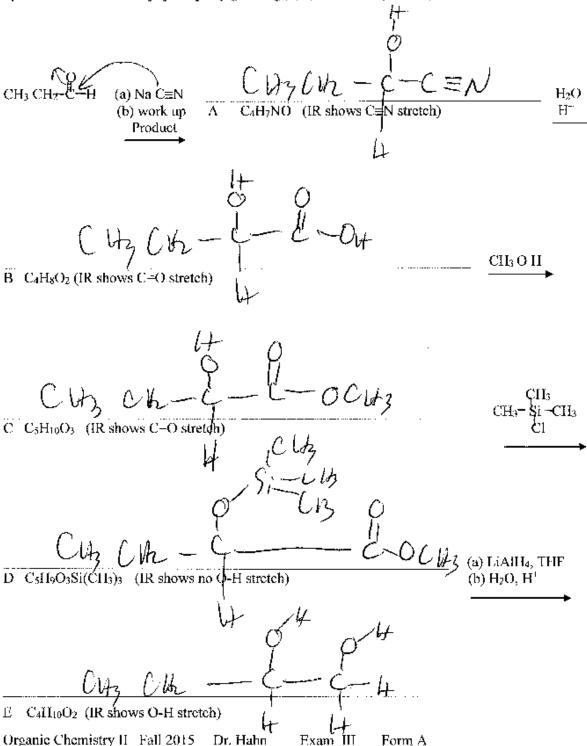
(B) Keeping in mind the general reaction mechanism of the addition of a nucleophile to carboxylic acid derivative, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (8 pts part



(C) Why do you get a different type of reaction mechanism for (A) ketone/aldehydes vs. (B) carboxylic acid derivatives? Explain in a few sentences. (6 pts part C)



2. 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.) (2 pts each, 10 pts total)



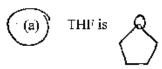
Exam III Organic Chemistry II (CHBM 442) Fall 15 12/2/15 Dr. Hahn MWF12pm Form B Exam#_____ Sign Name Print Name Print Name (1 pt name above print & sign, 1 pts scantron name) (100 pts, 12 pages + scantron sheet)

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 250 students told me what to grade on what page.)

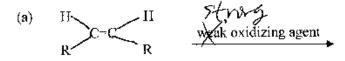
Circle answer on this form for backup to the scantron. There is no partial credit for showing work in the multiple choice.

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

- Multiple Choice (2 pts each, 24 pts) Choose the one best statement in each question. 1.
- Circle the best statement about common (non IUPAC) names: 1.



- Formaldehyde is CH₃-C-D(CH₃) (b)
- (c)
- None of the above are correct. **(d)**
 - 2. Which of the following are ways to get a carboxylic acid? Choose the best statement. (R not equal II)



- H_2O, H^4 **(b)**
- LiAIII4 (c)
- (b) and (c) will produce carboxylic acid. (d)
- All of the above results in a carboxylic acid. (c)

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

(b)
$$R$$
 $C=C$ R $O_3 \text{ or } O_8O_4$ R $C=O$ $O=C$ R

$$(d) \qquad CH_3 \cdot \stackrel{II}{\overset{\cdot}{C}} -O-H \qquad \underbrace{K_2Cr_2O_7, H^1}_{\overset{\cdot}{C}H_3} \qquad CH_3-C=O \\ CH_3 \qquad \qquad CH_3$$

((e)) All are correct

4. Which of the following is an incorrect reactions or which is the best statement?

(a)
$$R \longrightarrow R' + OH \rightarrow R \longrightarrow R'$$

(b)
$$R - R' + O - R'' - A'' + O - R'' - A''$$

(c)
$$R-C-R'+R''MgX \rightarrow R-C-R''$$

$$R''$$

(d) All above reactions are correct.

5. Choose the one best statement:

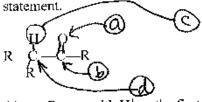
Epoxide is a 3 ring other which is especially reactive because the oxygen in epoxides are sp³ hybridized and have ring strain because of the 60° structure around the sp³ hybridized oxygen.

(b) Epoxides react with acidic and basic water to form alcohols (b)

(c) Epoxides react with Grignards and organolithium to form dials and organolithium to form dials

(d) All above statements are true.

6. In the following generalized drawing of ketone, which of the following are incorrect or is the best



(a) Reacts with H as the first step of reaction mechanisms.

(b) Reacts with nucleophile.

(c) Is an acidic hydrogen.

(d) Carbon after removal of acidic hydrogen, acts as a nucleophile.

(e) All statements above are true.

7. Which of the following are <u>not</u> exceptions to most carboxylic acid and carboxylic acid derivatives reactions (and do not do the standard reactions of carboxylic acid derivatives)? Or choose the best statement.

(b)
$$R = \stackrel{O}{\longleftarrow} NH_2 + R = O = II \rightarrow \mathcal{N}$$

(c)
$$R = C - O - H + R^n Mg X \rightarrow p - H$$

All of the above are exceptions to the standard reactions of carboxylic acid and carboxylic acid derivatives.

- 8. For nomenclature choose the one best statement.
- (a) Aldehyde has a suffix "al" but has a prefix "oxo"
- (b) Ketone has a suffix "one" but has a prefix "formy!"
- (c) Alcohol has a suffix "of" but has a prefix "hydroxy"
- (d) (a) and (b) are true.
- ((c)) All statements above are correct.
- Choose the one best statement.
- (a) Ethers are very stable to a lot of reactions.
- (b) Ethers react with acidic water to form alcohol.
- (c) Ethers form peroxides when left under air for an extended time. Ether peroxides explode.
- (d) All statements above are true.
 - (e) Only (a) and (b) are true.
 - Choose the one incorrect statement or choose the best statement.

- (b) R-C'-O-R' is an acctal
- (c) R—C—O-R' is a hemiacetal
- O-H

 (d) R--C-O-R' is a hemiketal

 R"
- (e) All above statements are correct.

11. Which of the following is correct?

- (b) CH₃-C-O-CH₂CH₃ is ethyl acetate
- (c) CH3-C±N is acctonitrile
- (d) (b) & (c) are correct
- (e) All are correct.

12. 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)
$$R = C = [-] + R' OH \rightarrow R = C = OR'$$
 is alcoholysis

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

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

II.	Short Answers (44 pts)
A.	Nomenclature: (2 pts each, 3 pts)
1.	Given the structural formula shown below, give the IUPAC name of the molecule.
a.	name butano: (nexandi anhydride
СӉ₃-€	O CH2-CH2-CH2-CH2-CH2-CH3
	butanoic hexanoic
b.	name
СНз-	8-o-cil-ch-ch propyl ethandate

- 2. Given the following 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.)
- a. ethyl methyl ether

Chy CHEO-CU3

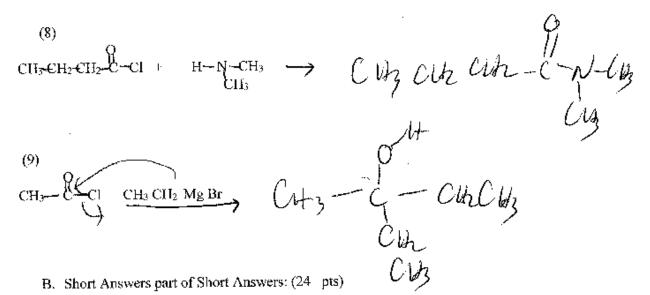
b. 2,3-epoxy pentane

4, C-C-C-C42 C47

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 is **not** acceptable.) DO **NOT** SHOW MECHANISMS. (2 pts each, 12 pts)

Circle the number of the 6 reaction which you want counted. If you do not choose, I will just grade the first 6 reactions. I will not grade all the reactions and give you points on only your best 6 reactions.

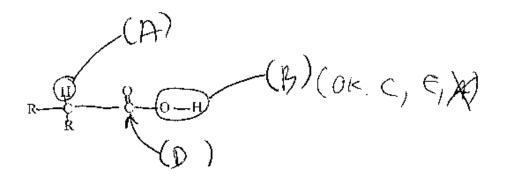
Clark (1) CH₂-O-CH₂-CH₃+ II Cl (large excess) → **MCPBA** (4) CH_2 - CH_2 - CH_2 -O-HCH₃-C≡C-11 HgSO₄, H³ H₂O (5)(6)



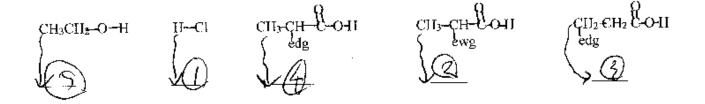
- 1. To make the ether CH₂O-CH₂CH₃ the following are two possible ways. (5 pts total)
 - (1) Which is the better reaction? [(a) or (b)] (circle one) (3 pts)

gives mixtures

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 (6 pts, 2 pts each)



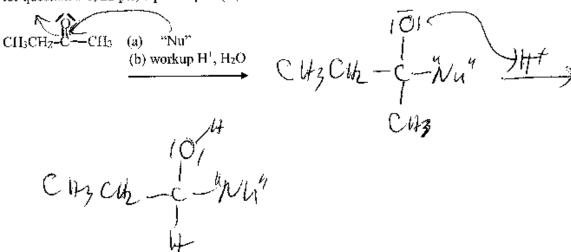
3. Put the following acids in order from <u>strongest acid (1)</u> to <u>weakest acid (5)</u> (edg – electron donating group, ewg – electron withdrawing group) (5 pts, 1 pt each)



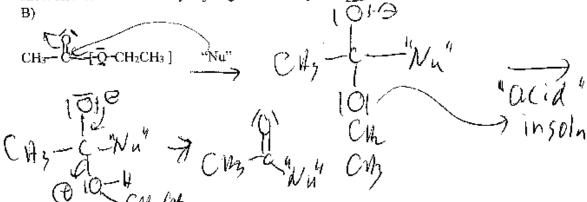
4. Put the following carboxylic acid derivative from the <u>most reactive (1)</u> to <u>least reactive (4)</u> carboxylic acid derivative. (8 pts, 2 pts each)

Part III. Long Answers (32 pts) Show work where applicable for partial and full credit.

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, 22 pts, 8 pts for part (A)



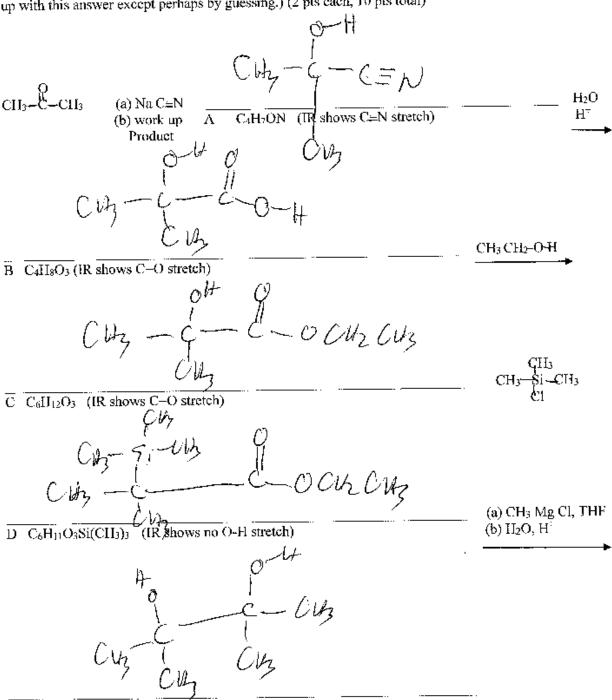
(B) Keeping in mind the general reaction mechanism of the addition of a nucleophile to carboxylic acid derivative, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (8 pts part



(C) Why do you get a different type of reaction mechanism for (A) ketone/aldehydes vs. (B) carboxylic acid derivatives? Explain in a few sentences. (6 pts part C)

CHzisabad "L" but OCRCBG
is much better "L"

2. 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.) (2 pts each, 10 pts total)



E C₆H₁₄O₂ (IR shows O-H stretch)

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 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, 24 pts) Choose the one best statement in each question.
- 1. Which of the following arc <u>not</u> exceptions to most carboxylic acid and carboxylic acid derivatives reactions (and do not do the standard reactions of carboxylic acid derivatives)? Or choose the best statement.

(a)
$$R = C = O = II \oplus NH_3 \Rightarrow$$

(b)
$$R \leftarrow C \rightarrow NH_2 + R \rightarrow O \rightarrow II \rightarrow$$

(c)
$$Q$$

 $R = C \rightarrow O \rightarrow H + R'' Mg X \rightarrow$

(d) All of the above are exceptions to the standard reactions of carboxylic acid and carboxylic acid derivatives.

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

(b)
$$CH_{3}-\begin{picture}(60,0) \put(0,0){\line(1,0){15}} \put(0,0){\line(1,0){$$

(d)
$$\stackrel{H}{\underset{R}{\longrightarrow}} C = C \stackrel{R}{\underset{R}{\longrightarrow}} O_3 \text{ or } OsO_4 \qquad \stackrel{R}{\underset{R}{\longrightarrow}} C = O \qquad O = C \stackrel{H}{\underset{R}{\longrightarrow}} O$$

- (e) All are correct
- 3. Which of the following is an incorrect reactions or which is the best statement?

$$(a) \qquad R - \overset{()}{C} - R' \div O - R'' + \overset{()}{R'} - R'' \overset{()}{R''} - O - R''' \overset{()}{R'} - O - R''' \overset{()}{R'} - O - R''' \overset{()}{R''} \overset{()}{R'} - O - R''' \overset{()}{R'} - O - R''' \overset{()}{R'} \overset{()}{R'} - O - R''' \overset{()}{R'} \overset{()}{R'} - O - R''' \overset{()}{R''} \overset{()}{R''} - O - R''' \overset{()}{R''} - O - R'' - O -$$

(p)
$$R \rightarrow C \rightarrow R$$
, + $OHL \rightarrow R \rightarrow C \rightarrow OH$

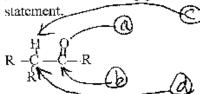
(c)
$$R \xrightarrow{Q} C - R^* \quad R^* \text{ Mg } X \rightarrow R \xrightarrow{Q+1} R^*$$

(d) All above reactions are correct.

- Choose the one incorrect statement or choose the best statement.
- (a) $R = \begin{array}{c} Q = H \\ C = O \cdot R' \text{ is a Ketal} \\ R \end{array}$
- (b) R C O'R' is an acctal
 - Q-H (c) R- C-O-R' is a hemiacotal
- (d) R————O-R' is a hemiketal
- (e) All above statements are correct.
- 5. Which of the following are ways to get a carboxylic acid? Choose the best statement. (R not equal H)
- (a) LiAIH_4 $\underline{\text{CO}_2}$
- (b) II H weak oxidizing agent
- (c) R-C \equiv N $\underline{\text{H}_2\text{O}, \text{H}^1}$
- (d) (a) and (c) will produce carboxylic acid.
- (e) All of the above results in a carboxylic acid.

- 6. Which of the following is correct?
- (a) CII3—C—CH2—CH3 is the carboxylic acid derivative, acetic anhydride
- (b) CH→C→O-CH2CH3 is ethyl acetate
- (c) CH₃ C≡N is acetonitrile
- (d) (b) & (e) are correct
- (e) All are correct.
- 7. Choose the one best statement:
- (a) Epoxide is a 3 ring other which is especially reactive because the oxygen in epoxides are sp³ hybridized and have ring strain because of the 60° structure around the sp³ hybridized oxygen.
- (b) Epoxides react with acidic and basic water to form alcohols
- (c) Epoxides react with Grignards and organolithium to form diols
- (d) All above statements are true.
- 8. Choose the one best statement.
- (a) Ethers are very stable to a lot of reactions.
- (b) Ethers react with acidic water to form alcohol.
- (c) Ethers form peroxides when left under air for an extended time. Ether peroxides explode.
- (d) All statements above are true.
- (e) Only (a) and (b) are true.

9. In the following generalized drawing of ketone, which of the following are incorrect or is the best



- (a) Reacts with II⁺ as the first step of reaction mechanisms.
- (b) Reacts with nucleophile.
- (c) Is an acidic hydrogen.
- (d) Carbon after removal of acidic hydrogen, acts as a nucleophile.
- (e) All statements above are true.
- For nomenclature choose the one best statement.
- (a) Aldehyde has a suffix "al" but has a prefix "oxo"
- (b) Ketone has a suffix "one" but has a prefix "formyl"
- (e) Alcohol has a suffix "ol" but has a prefix "hydroxy"
- (d) (a) and (b) are true.
- (c) All statements above are correct.
- 11. Circle the best statement about common (non IUPAC) names:
- (a) THF is
- (b) Formaldehyde is CH₂-C-O-H
- (c) Acetone is CH₃—II
- (d) None of the above are correct.

- 12. 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) $R = C [] + R'OH \rightarrow R = C O-R'$ is alcoholysis
- (b) $R = \{ [] : HO \rightarrow I \rightarrow R = \{ O \rightarrow I \text{ is hydrolysis} \}$

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

- II. Short Answers (44 pts)
- A. Nomenclature: (2 pts each, 3 pts)
- 1. Given the structural formula shown below, give the IUPAC name of the molecule.

CH₃-CH₂-CH₂-CH₂-C-Br

O CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₃

- 2. Given the following 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.)
- a. ethyl propyl ether

b. 3-cthoxy hexane

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 is <u>not</u> acceptable.) DO <u>NOT</u> SHOW MECHANISMS. (2 pts each, 12 pts)

Circle the number of the 6 reaction which you want counted. If you do not choose, I will just grade the first 6 reactions. I will not grade all the reactions and give you points on only your best 6 reactions.

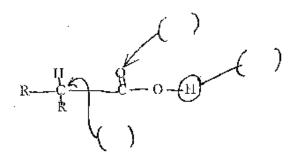
(8)
$$CH_3 CH_2 - C-O-II + CH_3-CH_2 O-II \rightarrow$$

- B. Short Answers part of Short Answers: (24 pts)
 - 1. To make the other CII3-Q-CH₂CH₃ the following are two possible ways. (5 pts total)
 - (1) Which is the better reaction? [(a) or (b)] (circle one) (3 pts)
 - a) CH₃ Cl + CH₃CH₂ O *

- S_N2 (Williamson Ether Synthesis)
- b) CII₃ O H + CH₃CH₂ OH II⁺/- II₂O
- S_N2 dehydration of alcohol .

(2) Explain briefly. (2 pts)

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 (6 pts, 2 pts each)



3. Put the following acids in order from <u>strongest acid (1)</u> to <u>weakest acid (5)</u> (edg = electron donating group, ewg = electron withdrawing group) (5 pts, 1 pt each)

CH3CH2-O-H H-CI CH3-CH-C-O-H CH3-CH-CO-H CH2-CH2-CO-H ewg edg

4. Put the following carboxylic acid derivative from the <u>most reactive (1)</u> to <u>least reactive (4)</u> carboxylic acid derivative. (8 pts)

RE-NHZ RE-O-ER RE-CE R-E-OR

Part III. Long Answers (32 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, 22 pts, 8 pts for part (A)

(B) 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.) (8 pts part B)

(C) Why do you get a different type of reaction mechanism for (A) ketone/aldehydes vs. (B) carboxylic acid derivatives? Explain in a few sentences. (6 pts part C)

2. 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.) (2 pts each, 10 pts total)

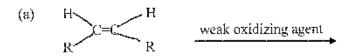
E C₄H₁₀O₂ (IR shows O-II stretch)

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 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.

- Multiple Choice (2 pts each, 24 pts) Choose the one best statement in each question. I.
- Circle the best statement about common (non IUPAC) names: l.
- (a)
- Formaldehyde is CH3—C-O-H (b)
- Acctone is CH₂ (c)
- None of the above are correct. (d)
 - 2. Which of the following are ways to get a carboxylic acid? Choose the best statement. (R not equal II)



- R-C±N (b)
- LiAlH₄ (c)
- (b) and (c) will produce carboxylic acid. (d)
- All of the above results in a carboxylic acid. (e)

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

$$(b) \qquad \begin{matrix} R \\ R \end{matrix} \qquad \begin{matrix} C-C \\ R \end{matrix} \qquad \begin{matrix} O_3 \text{ or } OsO_4 \end{matrix} \qquad \begin{matrix} R \\ R \end{matrix} \qquad \begin{matrix} C-O \end{matrix} \qquad O=C \begin{matrix} IJ \end{matrix}$$

(d)
$$CH_{3} \overset{H}{\overset{\cdot}{C}}$$
 $O-H$ $K_{2}Cr_{2}O_{7}, H^{+}$ $CH_{3}-C=O$ CH_{3}

(e) All are correct

4. Which of the following is an incorrect reactions or which is the best statement?

(a)
$$R \longrightarrow R' + OH \rightarrow R \longrightarrow R'$$

(b)
$$R \rightarrow C - R' + O \rightarrow R'' \rightarrow R \rightarrow R''$$
 R''

(c)
$$R - C - R' + R'' Mg X \rightarrow R - C - R''$$

$$\stackrel{O}{R} + \stackrel{C}{R} - R''$$

$$\stackrel{R}{R} + \stackrel{C}{R} - R''$$

(d) All above reactions are correct.

5. Choose the one best statement:

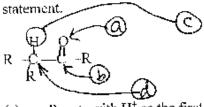
(a) Epoxide is a 3 ring ether which is especially reactive because the oxygen in epoxides are sp³ hybridized and have ring strain because of the 60° structure around the sp³ hybridized oxygen.

(b) Epoxides react with acidic and basic water to form alcohols

(c) Epoxides react with Grignards and organolithium to form diols

(d) All above statements are true.

6. In the following generalized drawing of ketone, which of the following are incorrect or is the best



(a) Reacts with II⁺ as the first step of reaction mechanisms.

(b) Reacts with nucleophile.

(c) Is an acidic hydrogen.

(d) Carbon after removal of acidic hydrogen, acts as a nucleophile.

(e) All statements above are true.

7. Which of the following are <u>not</u> exceptions to most carboxylic acid and carboxylic acid derivatives reactions (and do not do the standard reactions of carboxylic acid derivatives)? Or choose the best statement.

(a)
$$R = 0$$
 + $NH_3 \rightarrow$

(b)
$$R = \frac{O}{V} = NH_2 + R = O = H \Rightarrow$$

(d) All of the above are exceptions to the standard reactions of carboxylic acid and carboxylic acid derivatives.

8. For nomenclature choose the one best statement.

(a) Aldehyde has a suffix "al" but has a prefix "oxo"

(b) Ketone has a suffix "one" but has a prefix "formyl"

(e) Alcohol bas a suffix "of" but has a prefix "hydroxy"

(d) (a) and (b) are true.

(e) All statements above are correct.

9. Choose the one best statement.

(a) Ethers are very stable to a lot of reactions.

(b) Ethers react with acidic water to form alcohol.

(e) Ethers form peroxides when left under air for an extended time. Ether peroxides explode.

(d) All statements above are true.

(e) Only (a) and (b) are true.

Choose the one incorrect statement or choose the best statement.

(e) All above statements are correct.

11. Which of the following is correct?

- (a) CH_3 CH_3 CH_3 CH_3 is the carboxylic acid derivative, acetic anhydride
- (b) CH₃-C-O-CH₂CH₃ is ethyl acctate
- (c) CII-C=N is acetonitrile
- (d) (b) & (c) are correct
- (c) All are correct.
- 12. 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) $R = C [+ R'OH \rightarrow R = C OR' is alcoholysis]$
- (c) $R = C + 1 + R = N + H \Rightarrow R = C + N + R'$ is aminolysis R'
- (d) Q Q Q—H R—C—[] + Li Al II4 \rightarrow R—Q—H is reduction
- (e) All of the above reactions work for almost all carboxylic acid derivatives.

Form B

П.	Short Answers (44 pts)
A.	Nomenclature: (2 pts each, 3 pts)
1.	Given the structural formula shown below, give the IUPAC name of the molecule.
a.	name
CH₃-€	TH ₂ -CH ₂ -C-O-C-CH ₂ -CH ₂ -CH ₂ -CH ₃
b.	name
CH ₃	O C—O-CIICH ₂ -CH ₃
2. conde the hy	Given the following name, draw a structural formula of the molecule (skeletal formula acceptable, ensed structure, Lewis Dot structure acceptable, molecular formula not acceptable - don't forget to show drogens in your formula unless you are using the skeletal structure.)
a.	ethyl methyl ether
ь.	2,3-epoxy pentane

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 is <u>not</u> acceptable.) DO <u>NOT</u> SHOW MECHANISMS. (2 pts cach, 12 pts)

Circle the number of the 6 reaction which you want counted. If you do not choose, I will just grade the first 6 reactions. I will not grade all the reactions and give you points on only your best 6 reactions.

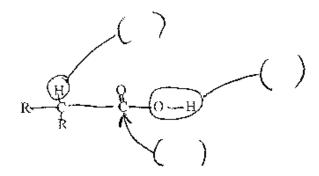
- (4) CII;-CH;-CH;-O-H Swem
- (5) CU₃-C=C-H HgSO₄, II⁺ II₂O

- B. Short Answers part of Short Answers: (24 pts)
- 1. To make the ether CII3-O-CH2CII3 the following are two possible ways. (5 pts total)

Form B

- (1) Which is the better reaction? [(a) or (b)] (circle one) (3 pts)
- a) $CH_3-O+H+CH_3CH_2+O+H+CH_3CH_3CH_2+O+H+CH_3CH_3CH_3+O+H+CH_3CH_3CH_3+O+H+CH_3+$
 - (2) Explain briefly. (2 pts)

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 (6 pts, 2 pts each)



3. Put the following acids in order from <u>strongest acid (1)</u> to <u>weakest acid (5)</u> (edg = electron donating group, ewg - electron withdrawing group) (5 pts, 1 pt each)

4. Put the following carboxylic acid derivative from the <u>most reactive (1)</u> to <u>least reactive (4)</u> carboxylic acid derivative. (8 pts, 2 pts each)

Part III. Long Answers (32 pts) Show work where applicable for partial and full credit.

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, 22 pts. 8 pts for part (A)

(B) 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.) (8 pts part B)

$$CH_3 - \overset{\circ}{C} - \overset{\circ}{+} \overset{\circ}{\overline{Q}} - CH_2CH_3] \xrightarrow{\text{"Nu"}}$$

(C) Why do you get a different type of reaction mechanism for (A) ketone/aldehydes vs. (B) carboxylic acid derivatives? Explain in a few sentences. (6 pts part C)

2. Complete the following synthesis by filling in the blank. I have provided some hims 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.) (2 pts each, 10 pts total)

B C₄H₈O₃ (IR shows C=O stretch)

 $\begin{array}{c} CH_3\\ CH_4-Si-CH_4\\ \hline C-C_6H_{12}O_3 \quad \text{(IR shows C+O stretch)} \end{array}$

D C₆H₁₁O₃Si(ClI₂)₃ (IR shows no O-H stretch)
(a) CFI₃ Mg Cl, THF
(b) H₂O, H⁺