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 + scantron 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. 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 are **not** 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.

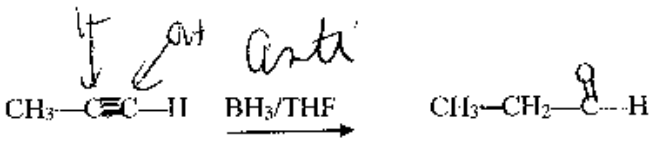
(a) $R-\overset{O}{\overset{\|}{C}}-O-H + NH_3 \rightarrow$ $R-\overset{O}{\overset{\|}{C}}-O\ NH_4$

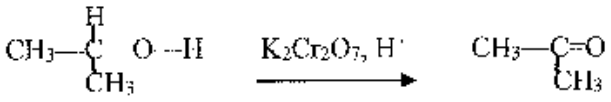
(b) $R-\overset{O}{\overset{\|}{C}}-NH_2 + R-O-H \rightarrow$ NR

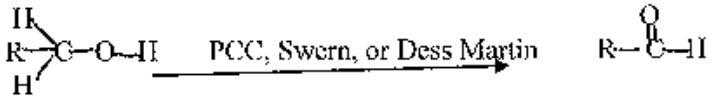
(c) $R-\overset{O}{\overset{\|}{C}}-O-H + R''MgX \rightarrow$ R-H

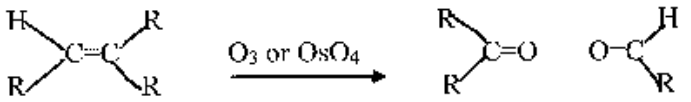
(d) All of the above are exceptions to the standard reactions of carboxylic acid and carboxylic acid derivatives.

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

(a) 

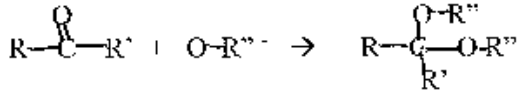
(b) 

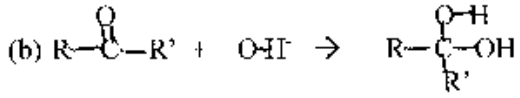
(c) 

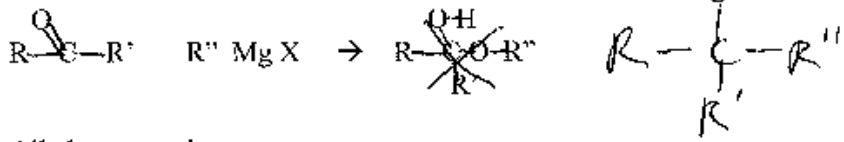
(d) 

(e) All are correct

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

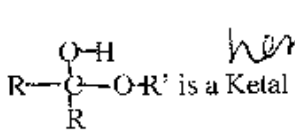
(a) 

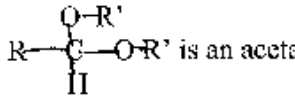
(b) 

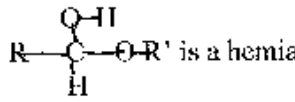
(c) 

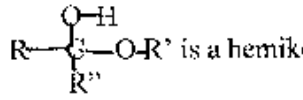
(d) All above reactions are correct.

4. Choose the one incorrect statement or choose the best statement.

(a)  hemiketal is a Ketal

(b)  is an acetal

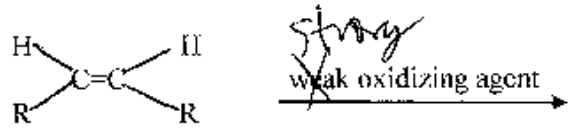
(c)  is a hemiacetal

(d)  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) $LiAlH_4$ $\xrightarrow{CO_2}$

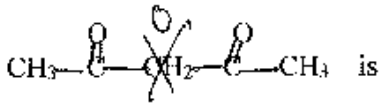
(b)  strong weak oxidizing agent

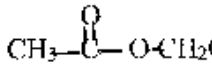
(c) R-C≡N $\xrightarrow{H_2O,\ H^+}$

(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)  is the carboxylic acid derivative, acetic anhydride

(b)  is ethyl acetate

(c) $CH_3C{\equiv}N$ is acetonitrile

(d) (b) & (c) are correct

(e) All are correct.

7. Choose the one best statement:

(a) Epoxide is a 3 ring ether which is especially reactive because the oxygen in epoxides are sp^3 hybridized and have ring strain because of the 60^0 structure around the sp^3 hybridized oxygen.

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

(c) Epoxides react with Grignards and organolithium to form ~~ol's~~ alcohol

(d) All above statements are true.

8. Choose the one best statement.

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

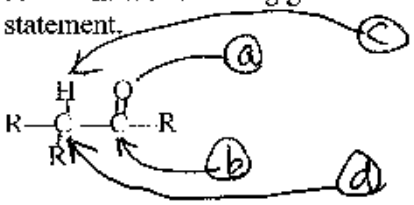
(b) Ethers react with acidic water to form alcohol.

(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 statement.



(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.

10. 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"

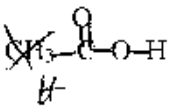
(c) Alcohol has a suffix "ol" but has a prefix "hydroxy"

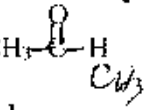
(d) (a) and (b) are true.

(e) All statements above are correct.

11. Circle the best statement about common (non IUPAC) names:

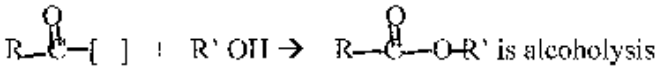
(a) THF is 

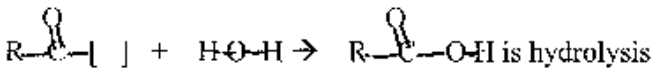
(b) Formaldehyde is 

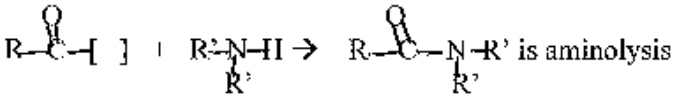
(c) Acetone is 

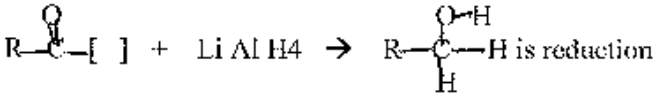
(d) None of the above are correct.

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)  is alcoholysis

(b)  is hydrolysis

(c)  is aminolysis

(d)  is reduction

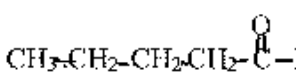
(e) All of the above reactions work for almost all carboxylic acid derivatives.

II. Short Answers (44 pts)

A. Nomenclature: (2 pts each, 3 pts)

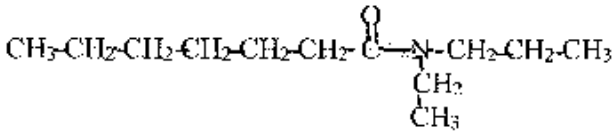
1. Given the structural formula shown below, give the IUPAC name of the molecule.

a. name pentanoyl bromide



pentanoyl bromide

b. name N-ethyl-N-propyl heptanamide



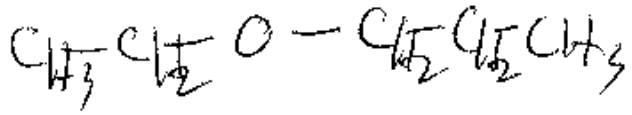
heptanoic acid

N-ethyl

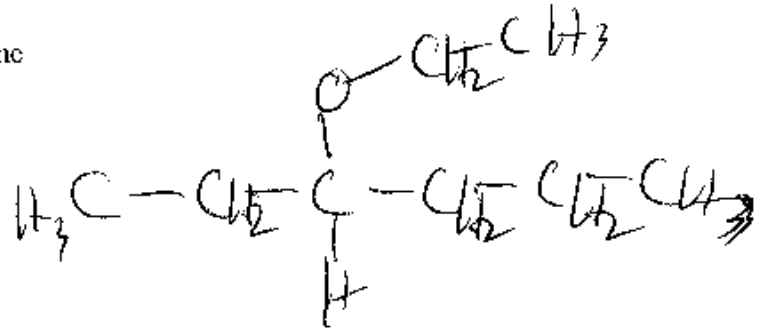
N-propyl

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



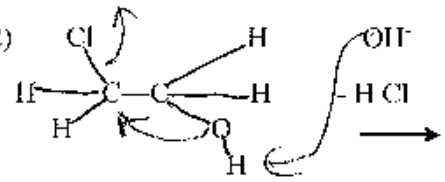
b. 3-ethoxy hexane



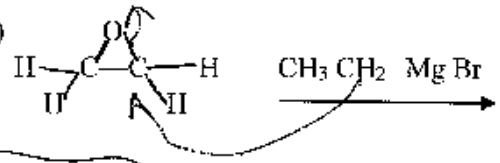
B. Reactions: Show the Organic Product for the following reactions by giving the structural formula of the product. (skeletal formula, condensed structure, Lewis Dot structure are all acceptable. Molecular Formula is **not** acceptable.) DO **NOT** SHOW MECHANISMS. (2 pts each, 12 pts)

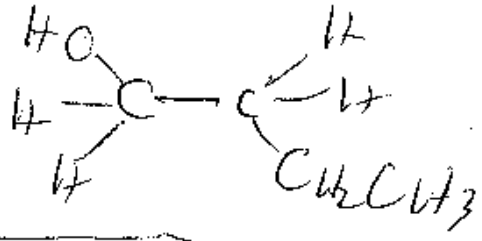
Circle the number of the 6 reaction which you want counted. If you do not choose, I will just grade the first 6 reactions. I **will not** grade all the reactions and give you points on only your best 6 reactions.

(1) $CH_3O\text{-}CH_2CH_2CH_3$ + H Br (large excess) →



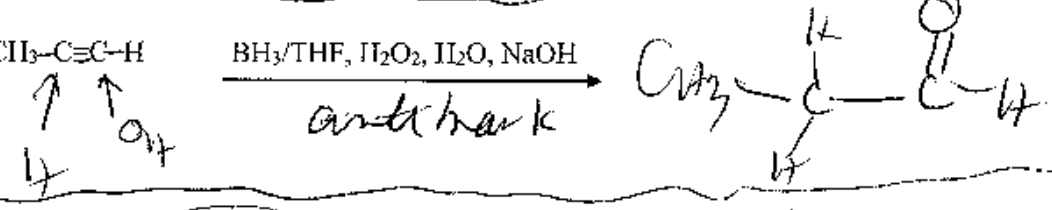
(3)



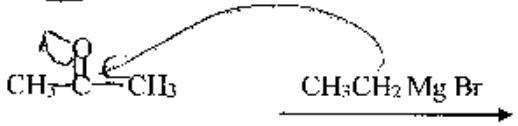


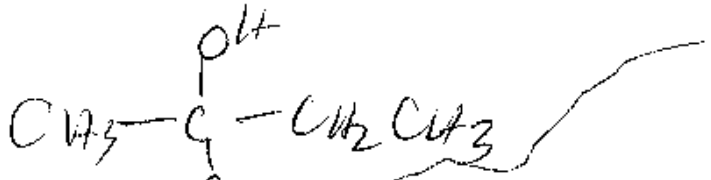
(4) $CH_3\text{-}CH_2\text{-}CH(CH_3)\text{-}OH$ $\xrightarrow{K_2Cr_2O_7 / H^+}$

(5) $CH_3\text{-}C\equiv C\text{-}H$ $\xrightarrow[\text{anti Markovnikov}]{BH_3/THF,\ H_2O_2,\ H_2O,\ NaOH}$

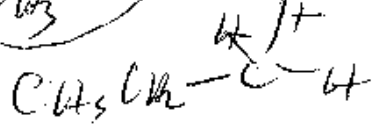


(6)

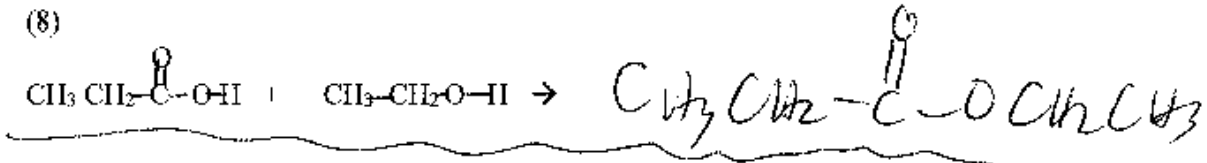




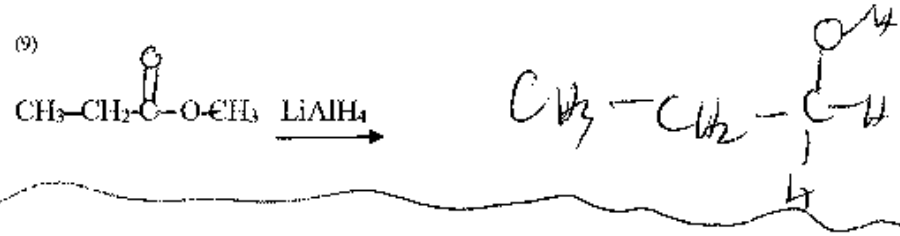
(7) $CH_3\text{-}CH_2\text{-}C(=O)\text{-}H$ $\xrightarrow{H_2NNH_2 / K\ O\ H}$



(8)



(9)



B. Short Answers part of Short Answers: (24 pts)

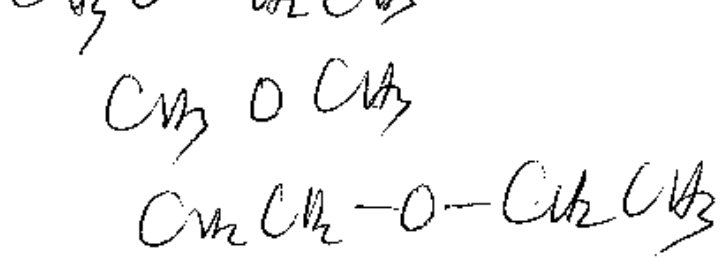
1. To make the ether $CH_3O-CH_2CH_3$ the following are two possible ways. (5 pts total)

(1) Which is the better reaction? [(a) or (b)] (circle one) (3 pts)

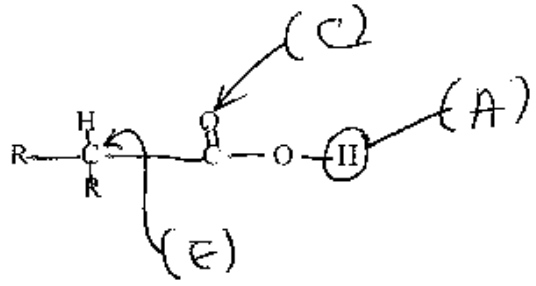
a) $CH_3Cl + CH_3CH_2O^-$ S_N2 (Williamson Ether Synthesis)
b) $CH_3OH + CH_3CH_2OH$ $H^+ / -H_2O$ S_N2 dehydration of alcohol

(2) Explain briefly. (2 pts)

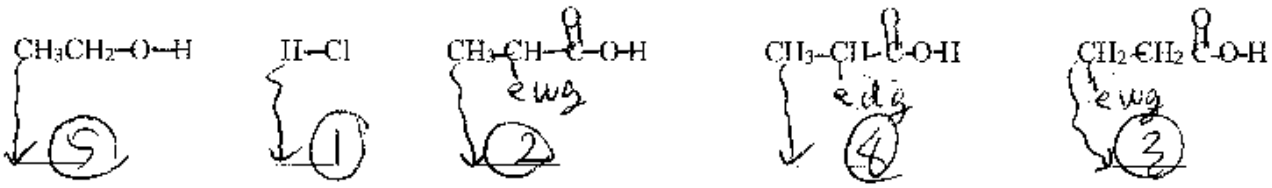
(b) gives a mixture of ethers



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)



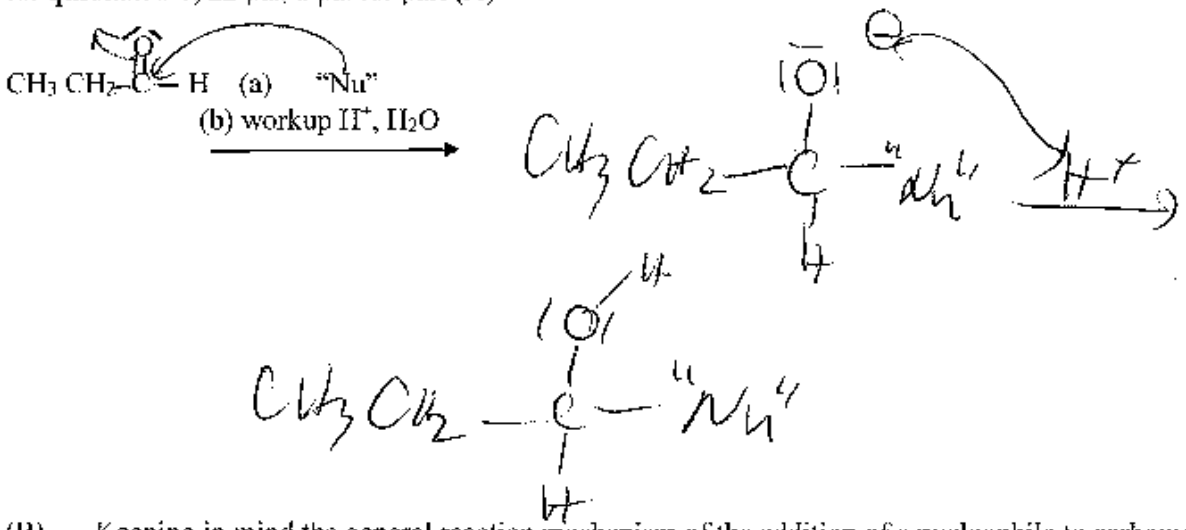
3. Put the following acids in order from **strongest acid (1)** to **weakest acid (5)** (edg = electron donating group, ewg = electron withdrawing group) (5 pts, 1 pt each)



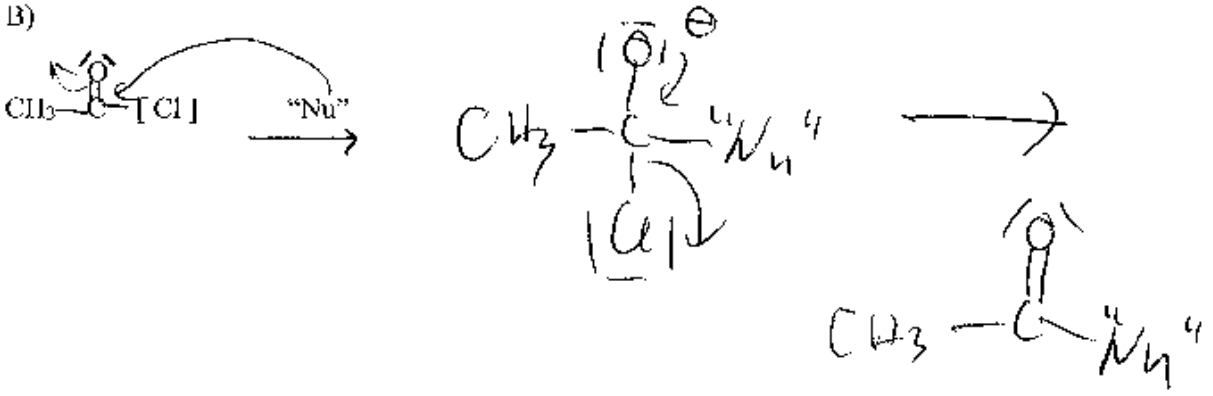
4. Put the following carboxylic acid derivative from the **most reactive (1)** to **least reactive (4)** carboxylic acid derivative. (8 pts)

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)



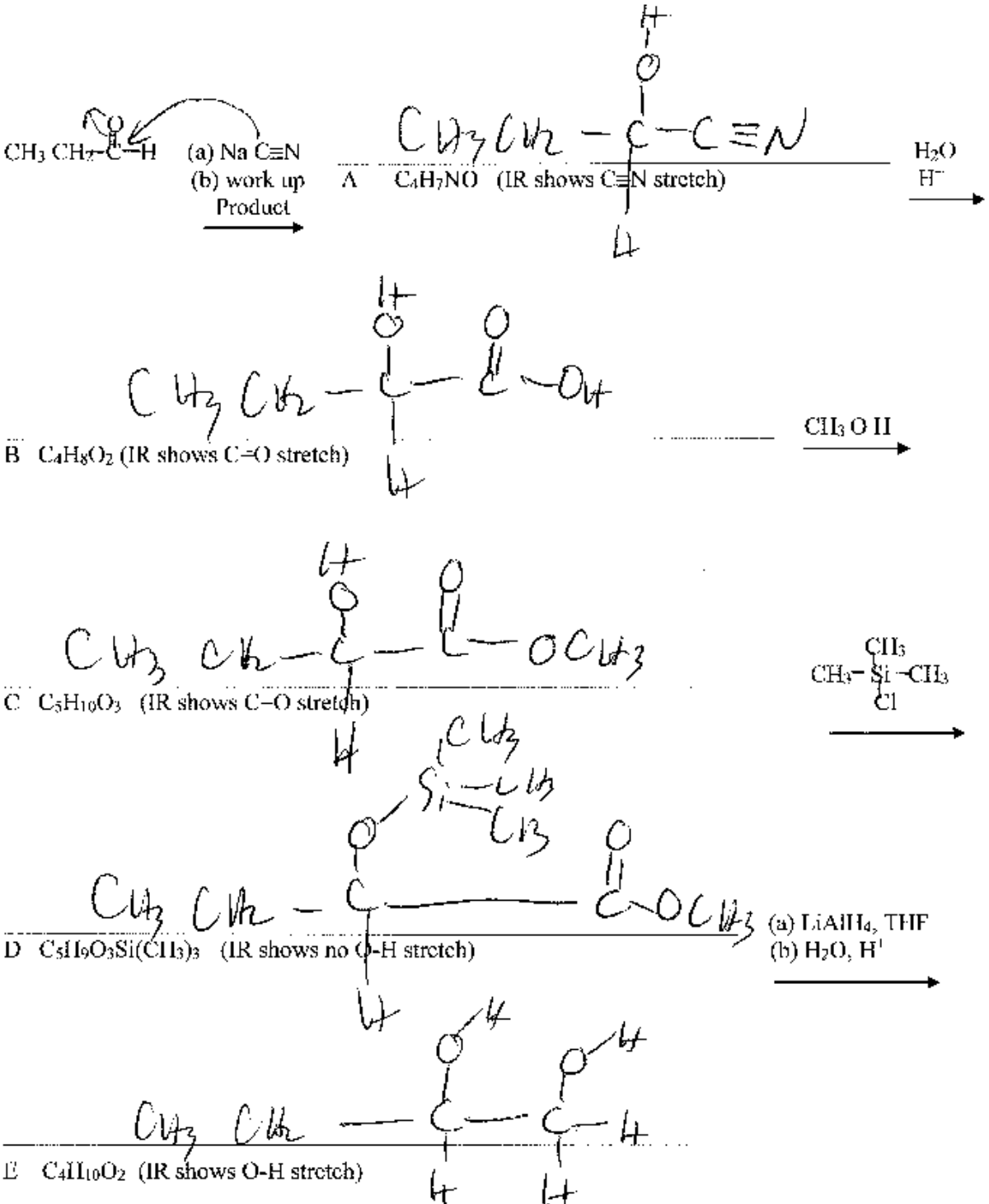
(B) Keeping in mind the general reaction mechanism of the addition of a nucleophile to carboxylic acid derivative, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (8 pts part B)



(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)

Carboxylic acid derivatives have good leaving groups. Aldehydes + Ketone have bad leaving groups

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 (CHEM 442) Fall 15 12/2/15 Dr. Hahn MWF12pm Form B Exam# ____

Sign Name Key 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.)

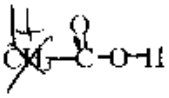
Circle answer on this form for backup to the scantron. There is no partial credit for showing work in the multiple choice.

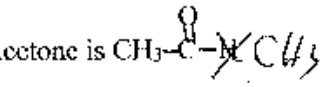
In all questions on all parts of this exam, R is not equal to hydrogen but is an alkyl.

I. 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:

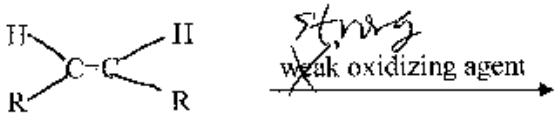
(a) THF is 

(b) Formaldehyde is 

(c) Acetone is 

(d) None of the above are correct.

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

(a) 

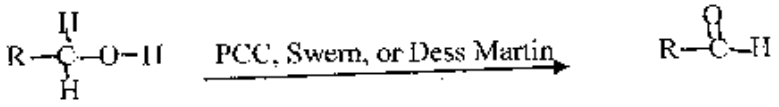
(b) R-C≡N $\xrightarrow{H_2O,\ H^+}$

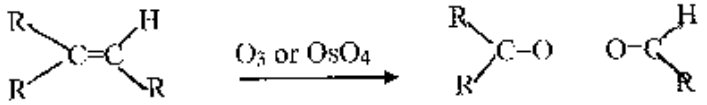
(c) $LiAlH_4$ $\xrightarrow{CO_2}$

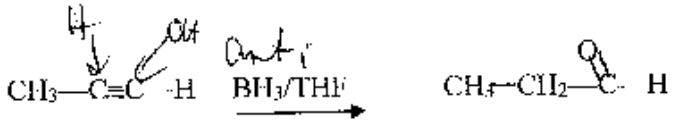
(d) (b) and (c) will produce carboxylic acid.

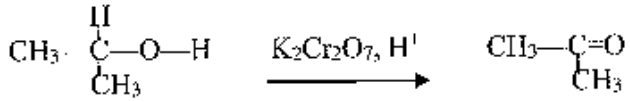
(e) All of the above results in a carboxylic acid.

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

(a) 

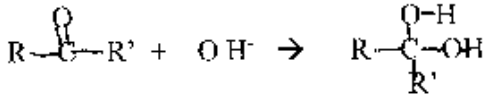
(b) 

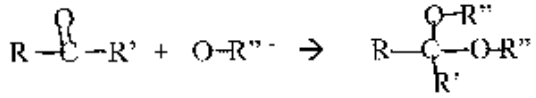
(c) 

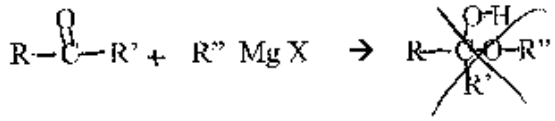
(d) 

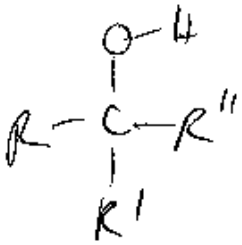
(e) All are correct

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

(a) 

(b) 

(e) 



(d) All above reactions are correct.

5. Choose the one best statement:

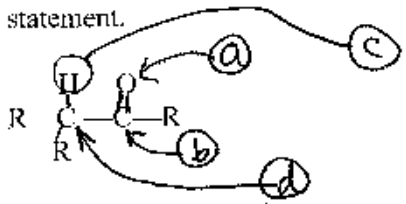
(a) Epoxide is a 3 ring ether which is especially reactive because the oxygen in epoxides are sp^3 hybridized and have ring strain because of the 60° structure around the sp^3 hybridized oxygen.

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

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

(d) All above statements are true.

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



(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 **not** 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) $R-C(=O)-O-H + NH_3 \rightarrow$ R-C(=O)-O NH_4

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

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

(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"

(c) Alcohol has a suffix "ol" 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.

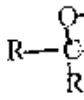
(b) Ethers react with acidic water to form alcohol.

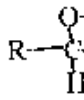
(c) Ethers form peroxides when left under air for an extended time. Ether peroxides explode.

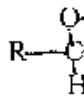
(d) All statements above are true.

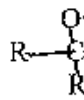
(e) Only (a) and (b) are true.

10. Choose the one incorrect statement or choose the best statement.

(a)  is a Ketal hemiketal

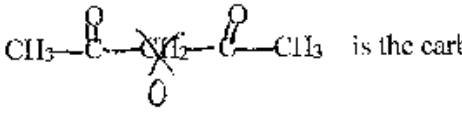
(b)  is an acetal

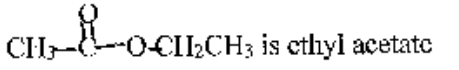
(c)  is a hemiacetal

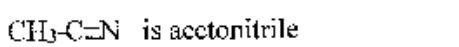
(d)  is a hemiketal

(e) All above statements are correct.

11. Which of the following is correct?

(a)  is the carboxylic acid derivative, acetic anhydride

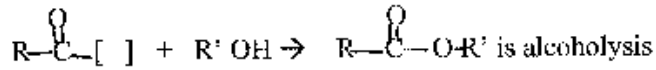
(b)  is ethyl acetate

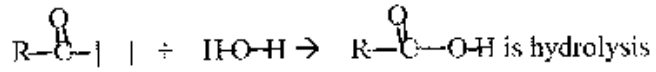
(c)  is acetonitrile

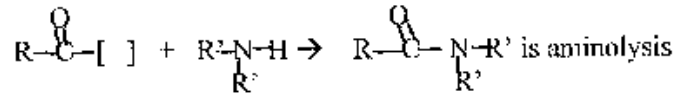
(d) (b) & (c) are correct

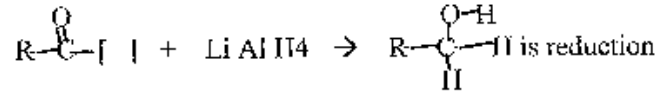
(e) All are correct.

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) 

(b) 

(c) 

(d) 

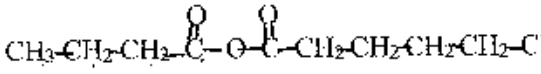
(e) All of the above reactions work for almost all carboxylic acid derivatives.

II. Short Answers (44 pts)

A. Nomenclature: (2 pts each, 3 pts)

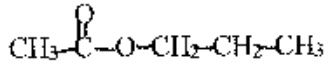
1. Given the structural formula shown below, give the IUPAC name of the molecule.

a. name butanoic hexanoic anhydride



butanoic hexanoic

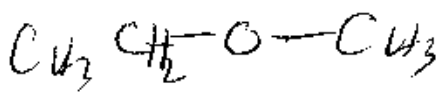
b. name _____



propyl ethanoate

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

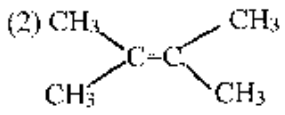
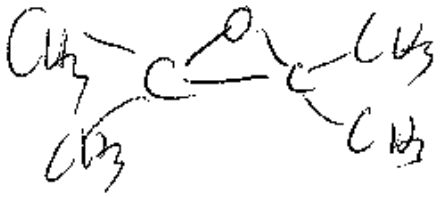


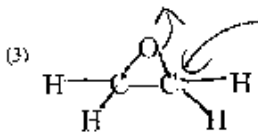
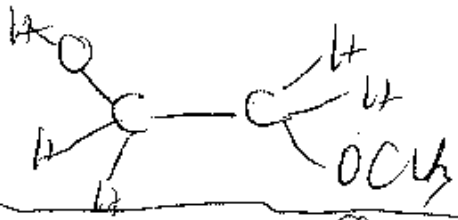
b. 2,3-epoxy pentane

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

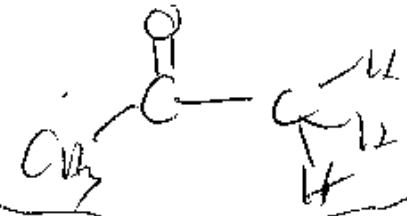
Circle the number of the 6 reaction which you want counted. If you do not choose, I will just grade the first 6 reactions. I **will not** grade all the reactions and give you points on only your best 6 reactions.

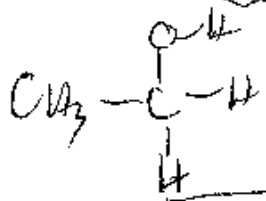
(1) $CH_3-O-CH_2-CH_3$ + II Cl (large excess) ⟶ CH_3Cl $ClCH_2CH_3$

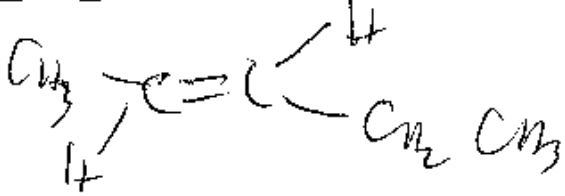
(2)  MCPBA ⟶ 

(3)  $O-CH_3^-$ ⟶ 

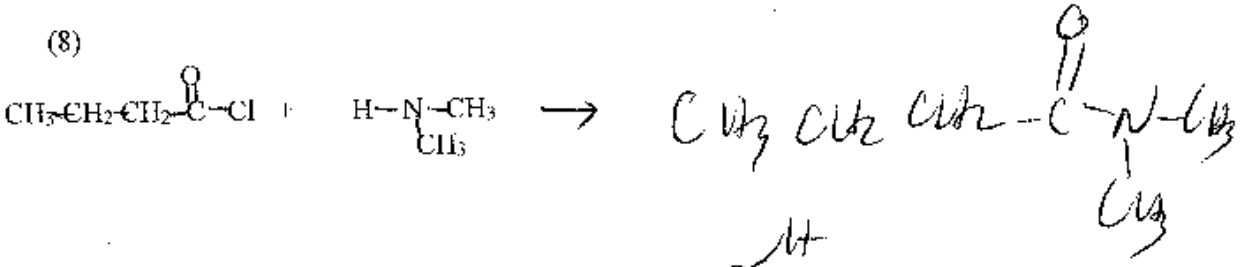
(4) $CH_3-CH_2-CH_2-O-H$ Swern ⟶ $CH_3CH_2-C(=O)-H$

(5) $CH_3-C\equiv C-H$ $HgSO_4, H^+ \cdot H_2O$ ⟶ mark 

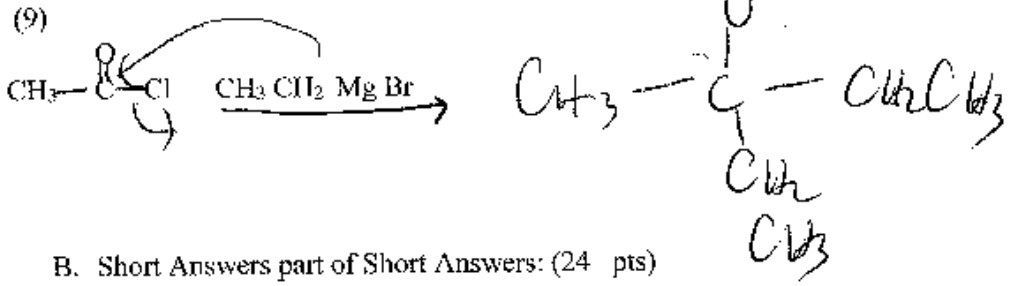
(6) $CH_3-C(=O)-H$ $LiAlH_4$ ⟶ 

(7) $CH_3-C(=O)-H$ + $CH_3CH_2-\overset{H}{C}(\ominus)-P^{\oplus}Ph_3$ ⟶ 

(8)



(9)



B. Short Answers part of Short Answers: (24 pts)

1. To make the ether $CH_3-O-CH_2CH_3$ the following are two possible ways. (5 pts total)

(1) Which is the better reaction? [(a) or (b)] (circle one) (3 pts)

a) $CH_3-OH + CH_3CH_2-OH \xrightarrow{H^+ / -H_2O}$ S_N2 dehydration of alcohol

b) $CH_3Cl + CH_3CH_2O^- \longrightarrow$ S_N2 (Williamson Ether Synthesis)

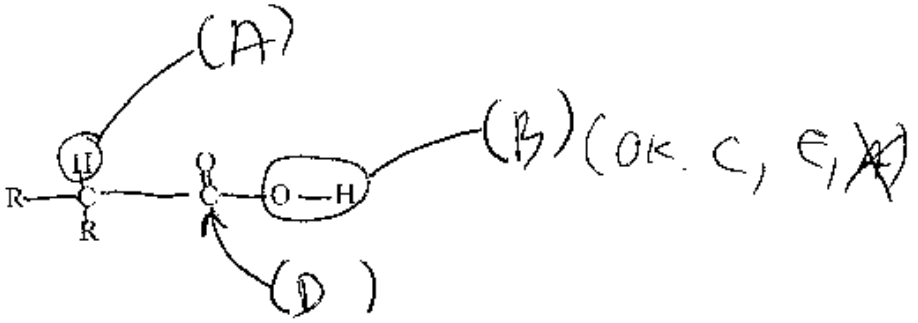
(2) Explain briefly. (2 pts)

gives mixtures

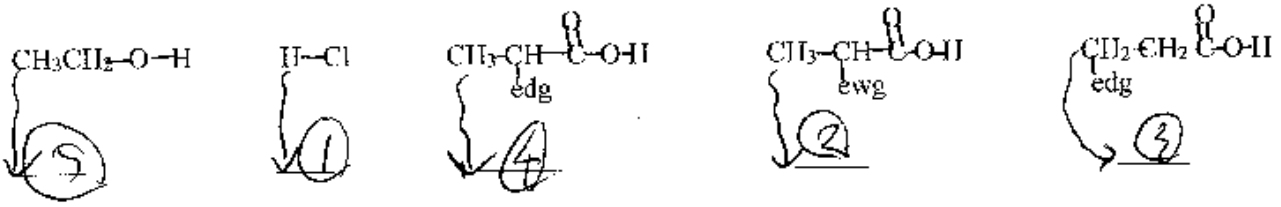
CH_3-O-CH_3 , $CH_3CH_2O-CH_2CH_3$

$CH_3-O-CH_2CH_3$

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 **strongest acid (1)** to **weakest acid (5)** (edg = electron donating group, ewg = electron withdrawing group) (5 pts, 1 pt each)

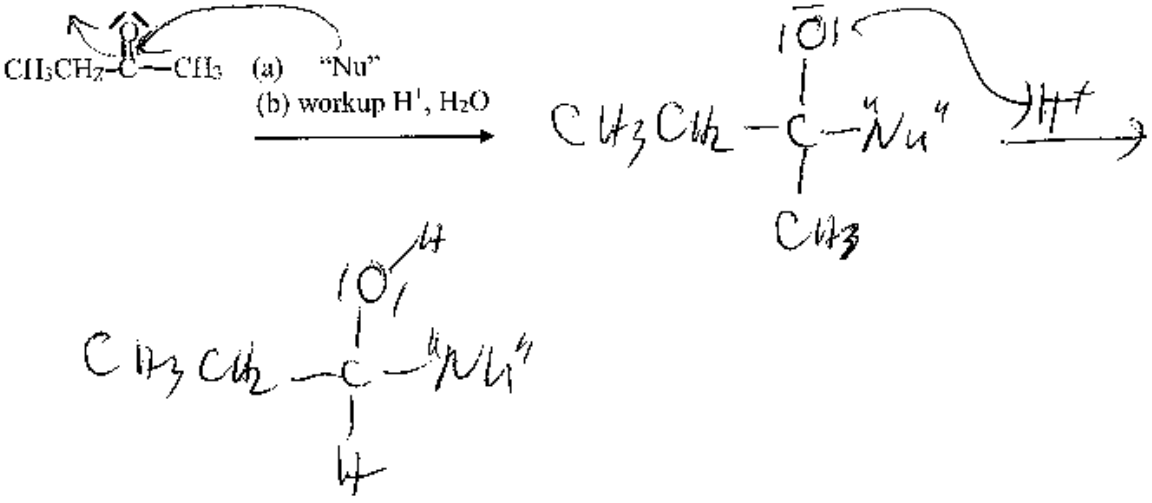


4. Put the following carboxylic acid derivative from the **most reactive (1)** to **least reactive (4)** carboxylic acid derivative. (8 pts, 2 pts each)

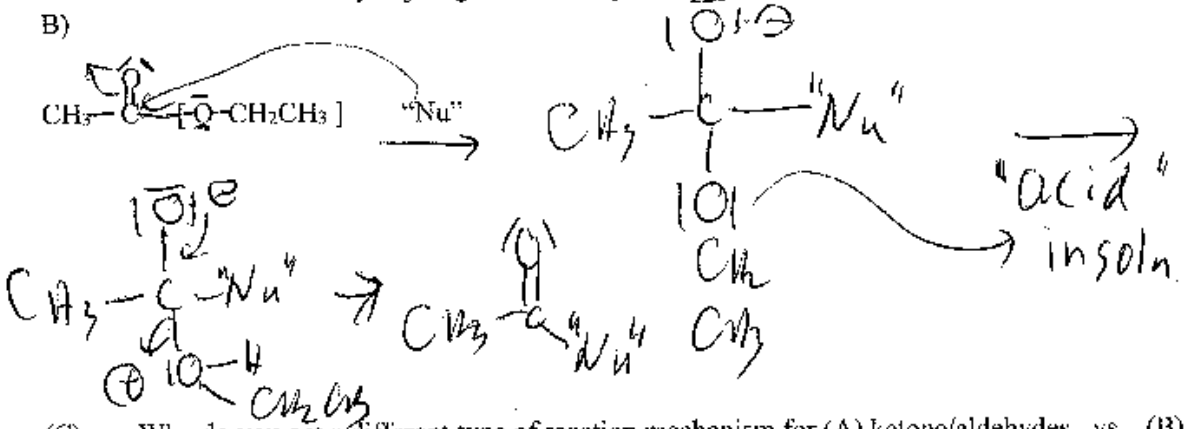
3 2 4 1

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)



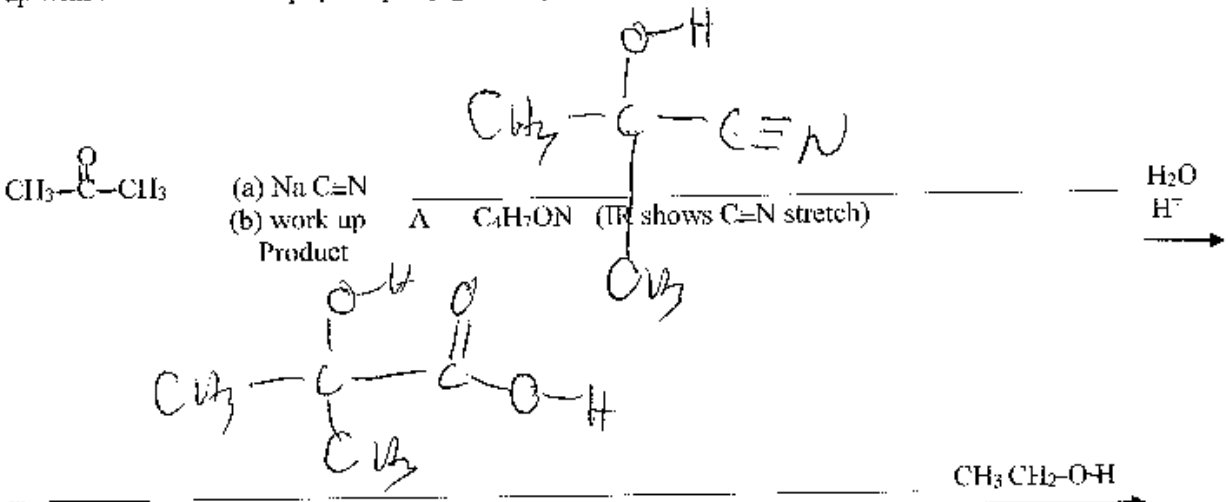
(B) Keeping in mind the general reaction mechanism of the addition of a nucleophile to carboxylic acid derivative, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (8 pts part B)



(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)

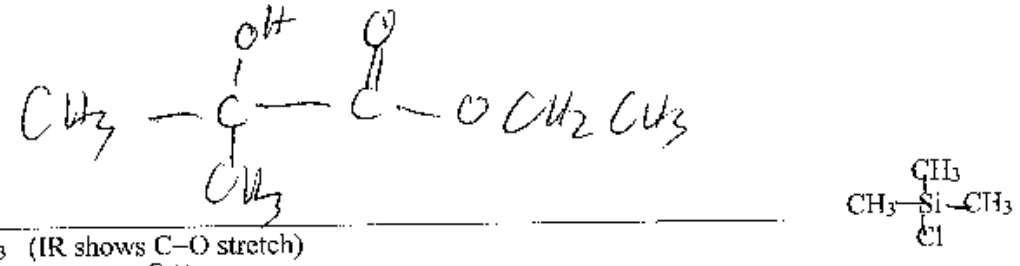
CH_3 is a bad "L" but $OCH_2CH_3^{\ominus}$ is much better "L"

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)

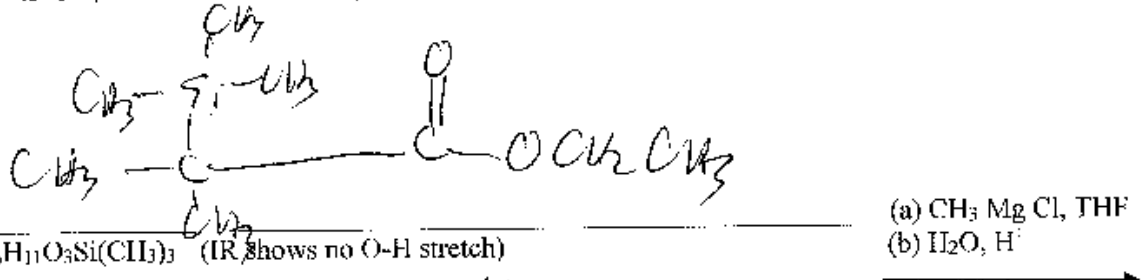


A C_4H_7ON (IR shows C≡N stretch)

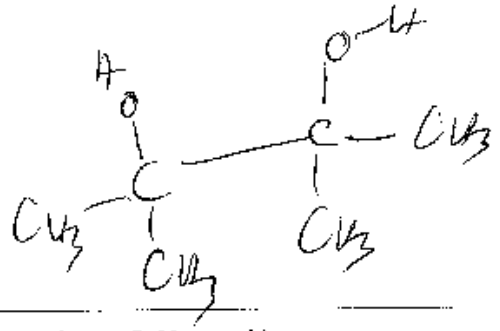
B $C_4H_8O_3$ (IR shows C–O stretch)



C $C_6H_{12}O_3$ (IR shows C–O stretch)



D $C_6H_{11}O_3Si(CH_3)_3$ (IR shows no O-H stretch)



E $C_6H_{14}O_2$ (IR shows O-H stretch)

Exam III Organic Chemistry II (CHEM 442) Fall 15 12/2/15 Dr. Hahn MWF12pm Form A Exam# _____

Sign Name _____ Print Name _____
(1 pt name above print & sign, 1 pts scantron name) (100 pts, 13 pages + scantron sheet) Color

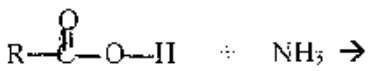
Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper – If you want me to grade something not in the space for the answer, clearly specify in writing. 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.)

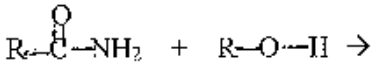
Circle answer on this form for backup to the scantron. There is no partial credit for showing work in the multiple choice.

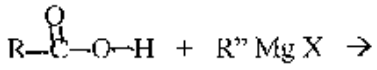
In all questions on all parts of this exam, R is not equal to hydrogen but is an alkyl.

I. Multiple Choice (2 pts each, 24 pts) Choose the **one** best statement in each question.

1. Which of the following are **not** 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) 

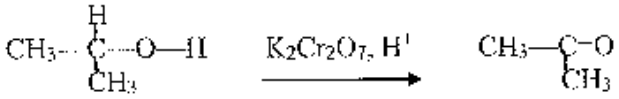
(b) 

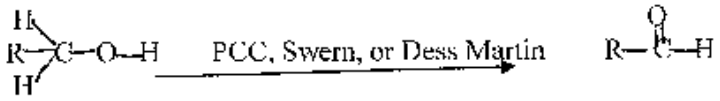
(c) 

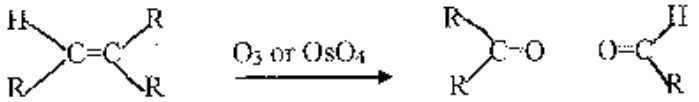
(d) All of the above are exceptions to the standard reactions of carboxylic acid and carboxylic acid derivatives.

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

(a) 

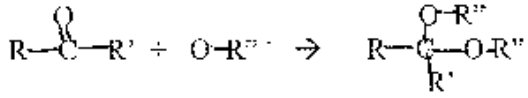
(b) 

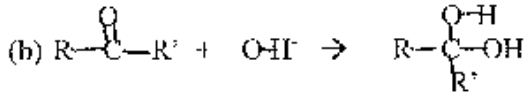
(c) 

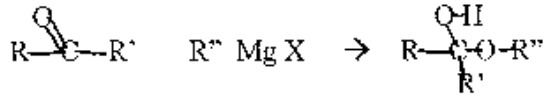
(d) 

(e) All are correct

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

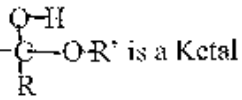
(a) 

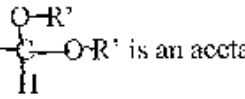
(b) 

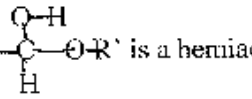
(c) 

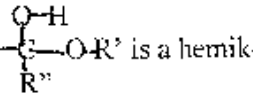
(d) All above reactions are correct.

4. Choose the one incorrect statement or choose the best statement.

(a)  is a Ketal

(b)  is an acetal

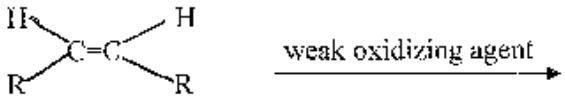
(c)  is a hemiacetal

(d)  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) $LiAlH_4$ $\xrightarrow{CO_2}$

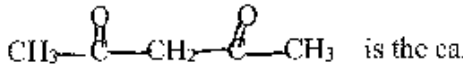
(b) 

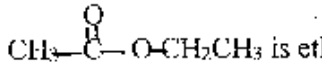
(c) R-C≡N $\xrightarrow{H_2O,\ H^+}$

(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)  is the carboxylic acid derivative, acetic anhydride

(b)  is ethyl acetate

(c) $CH_3\ C{\equiv}N$ is acetonitrile

(d) (b) & (c) are correct

(e) All are correct.

7. Choose the one best statement:

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

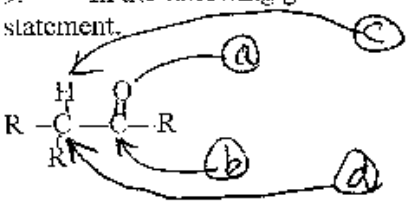
(b) Ethers react with acidic water to form alcohol.

(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 statement.



(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.

10. 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"

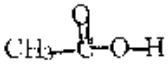
(c) Alcohol has a suffix "ol" but has a prefix "hydroxy"

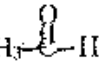
(d) (a) and (b) are true.

(e) All statements above are correct.

11. Circle the best statement about common (non IUPAC) names:

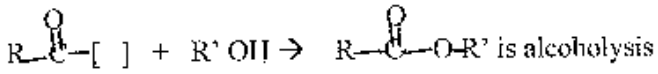
(a) THF is 

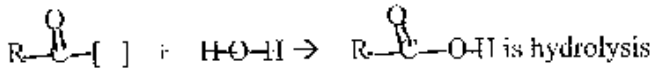
(b) Formaldehyde is 

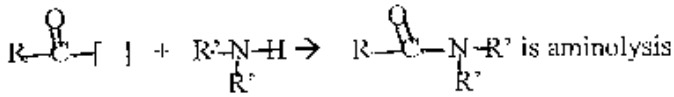
(c) Acetone is 

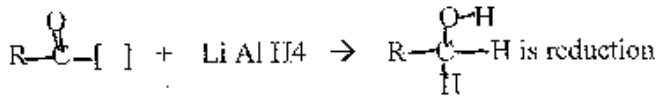
(d) None of the above are correct.

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)  is alcoholysis

(b)  is hydrolysis

(c)  is aminolysis

(d)  is reduction

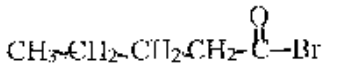
(e) All of the above reactions work for almost all carboxylic acid derivatives.

II. Short Answers (44 pts)

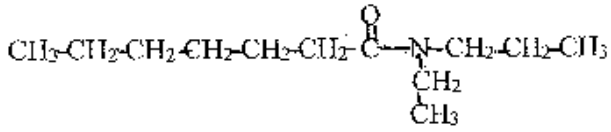
A. Nomenclature: (2 pts each, 3 pts)

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

a. name _____



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 not acceptable - don't forget to show the hydrogens in your formula unless you are using the skeletal structure.)

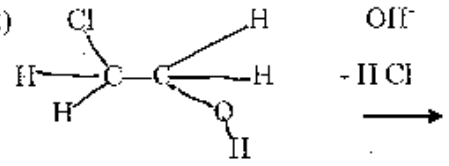
a. ethyl propyl ether

b. 3-ethoxy 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 **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.

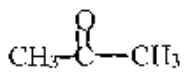
(1) $CH_3\text{-}O\text{-}CH_2CH_2CH_3$ + H Br (large excess) $\rightarrow$

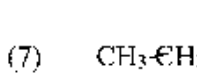
(2) 

(3) 

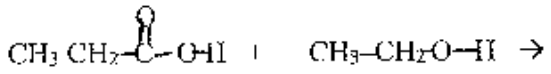
(4) $CH_3\text{-}CH_2\text{-}CH(CH_3)\text{-}O\text{-}H$ $\xrightarrow{K_2Cr_2O_7 / H^+}$

(5) $CH_3\text{-}C\equiv C\text{-}H$ $\xrightarrow{BH_3/THF,\ H_2O_2,\ H_2O,\ NaOH}$

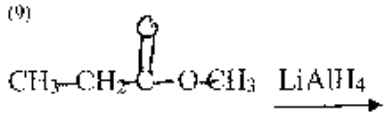
(6) 

(7) 

(8)



(9)



B. Short Answers part of Short Answers: (24 pts)

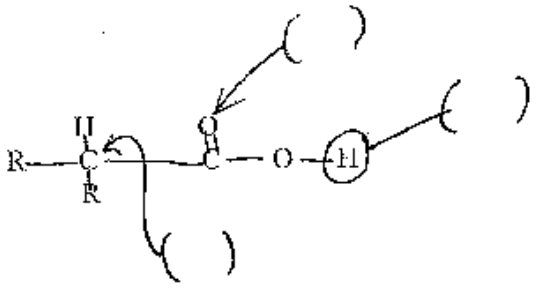
1. To make the ether $CH_3O\text{-}CH_2CH_3$ the following are two possible ways. (5 pts total)

(1) Which is the better reaction? [(a) or (b)] (circle one) (3 pts)

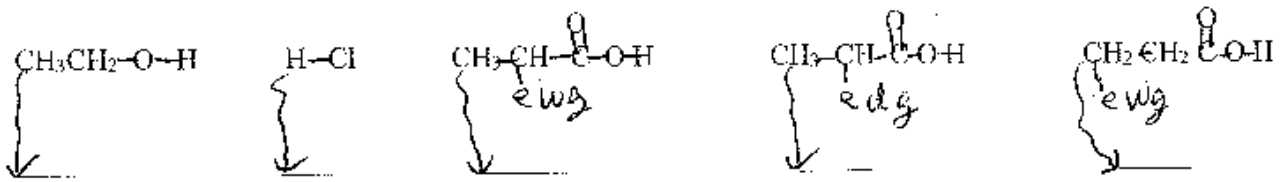
a) $CH_3Cl + CH_3CH_2O^-$ S_N2 (Williamson Ether Synthesis)
b) $CH_3OH + CH_3CH_2OH$ $H^+ / -H_2O$ S_N2 dehydration of alcohol

(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)



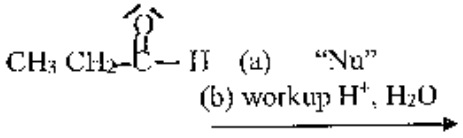
3. Put the following acids in order from **strongest acid (1)** to **weakest acid (5)** (edg = electron donating group, ewg = electron withdrawing group) (5 pts, 1 pt each)



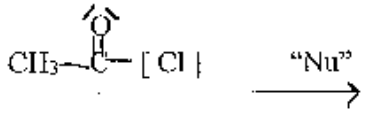
4. Put the following carboxylic acid derivative from the **most reactive (1)** to **least reactive (4)** carboxylic acid derivative. (8 pts)

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)

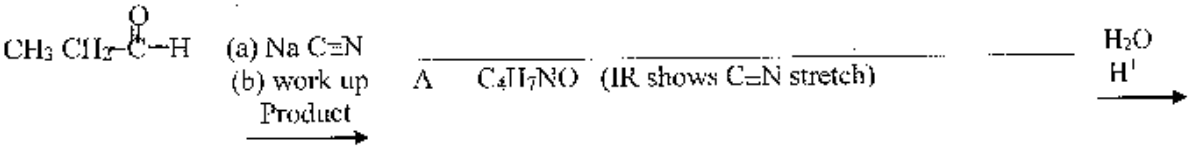


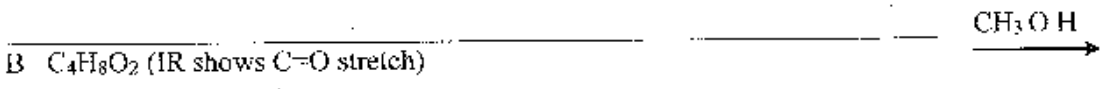
(B) Keeping in mind the general reaction mechanism of the addition of a nucleophile to carboxylic acid derivative, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (8 pts part B)



(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)

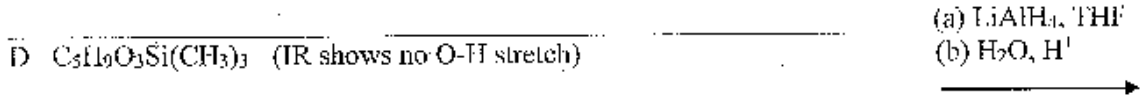
2. Complete the following synthesis by filling in the blank. I have provided some hints to help you come up with the answers. NOTE: The way I grade this is for you to fill in reasonable molecules based on the immediate prior molecule. i.e. If you fill in part A with the wrong molecule and then do the 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)





B $C_4H_8O_2$ (IR shows C=O stretch)

C $C_5H_{10}O_3$ (IR shows C=O stretch)



D $C_5H_9O_3Si(CH_3)_3$ (IR shows no O-H stretch)

E $C_4H_{10}O_2$ (IR shows O-H stretch)

Exam III Organic Chemistry II (CHEM 442) Fall 15 12/2/15 Dr. Hahn MWF12pm Form B Exam# X-2

Sign 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.)

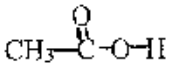
Circle answer on this form for backup to the scantron. There is no partial credit for showing work in the multiple choice.

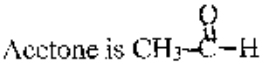
In all questions on all parts of this exam, R is not equal to hydrogen but is an alkyl.

I. 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:

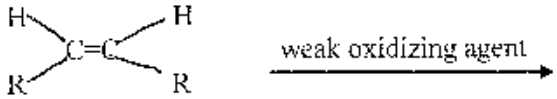
(a) THF is 

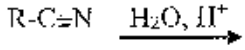
(b) Formaldehyde is 

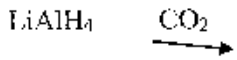
(c) Acetone is 

(d) None of the above are correct.

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

(a) 

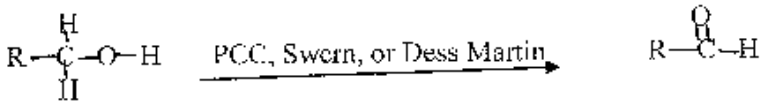
(b) 

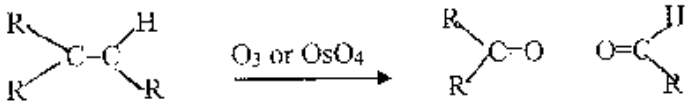
(c) 

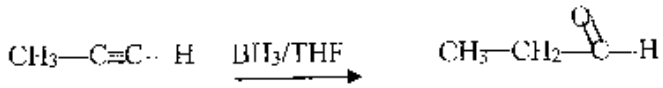
(d) (b) and (c) will produce carboxylic acid.

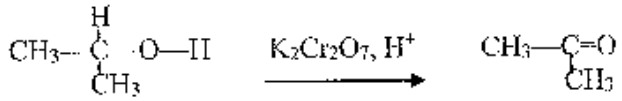
(e) All of the above results in a carboxylic acid.

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

(a) 

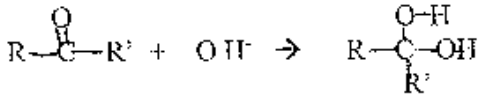
(b) 

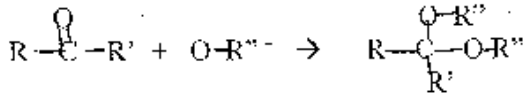
(c) 

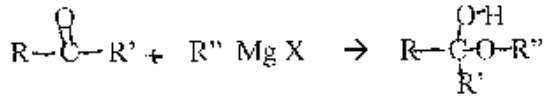
(d) 

(e) All are correct

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

(a) 

(b) 

(c) 

(d) All above reactions are correct.

5. Choose the one best statement:

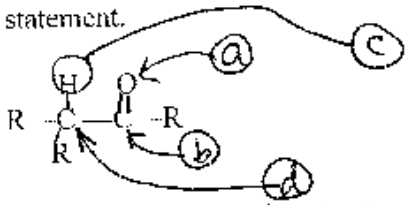
(a) Epoxide is a 3 ring ether which is especially reactive because the oxygen in epoxides are sp^3 hybridized and have ring strain because of the 60° structure around the sp^3 hybridized oxygen.

(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 statement.



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

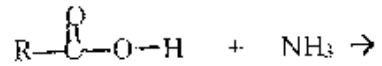
(b) Reacts with nucleophile.

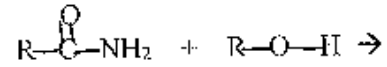
(c) Is an acidic hydrogen.

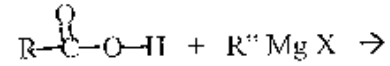
(d) Carbon after removal of acidic hydrogen, acts as a nucleophile.

(e) All statements above are true.

7. Which of the following are **not** 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) 

(b) 

(c) 

(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"

(c) Alcohol has a suffix "ol" 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.

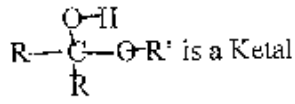
(b) Ethers react with acidic water to form alcohol.

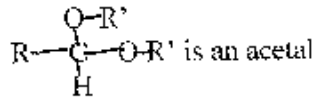
(c) Ethers form peroxides when left under air for an extended time. Ether peroxides explode.

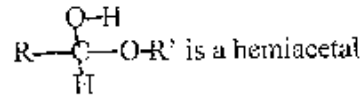
(d) All statements above are true.

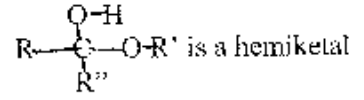
(e) Only (a) and (b) are true.

10. Choose the one incorrect statement or choose the best statement.

(a)  is a Ketal

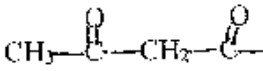
(b)  is an acetal

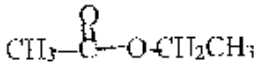
(c)  is a hemiacetal

(d)  is a hemiketal

(e) All above statements are correct.

11. Which of the following is correct?

(a)  is the carboxylic acid derivative, acetic anhydride

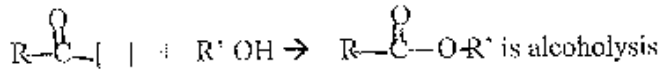
(b)  is ethyl acetate

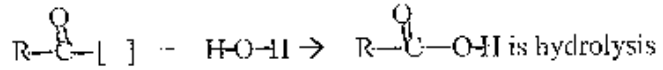
(c) $CH_3-C\equiv N$ is acetonitrile

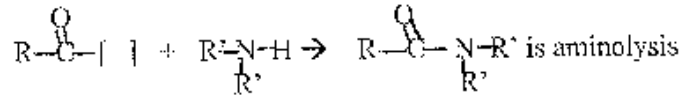
(d) (b) & (c) are correct

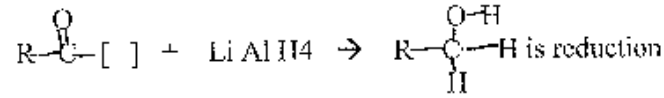
(e) All are correct.

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)  is alcoholysis

(b)  is hydrolysis

(c)  is aminolysis

(d) 

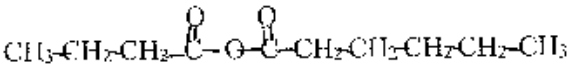
(e) All of the above reactions work for almost all carboxylic acid derivatives.

II. Short Answers (44 pts)

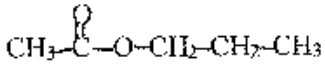
A. Nomenclature: (2 pts each, 3 pts)

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

a. name _____



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 not acceptable - don't forget to show the hydrogens in your formula unless you are using the skeletal structure.)

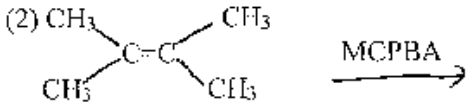
a. ethyl methyl ether

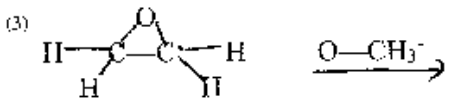
b. 2,3-epoxy pentane

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 **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.

(1) CH_3–O–CH_2–CH_3 + H Cl (large excess) ⟶

(2) 

(3) 

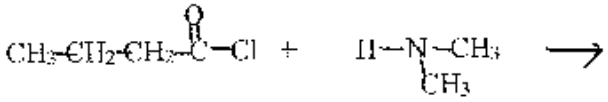
(4) CH_3–CH_2–CH_2–O–H Swern ⟶

(5) CH_3–C≡C–H $HgSO_4$, H^+ H_2O ⟶

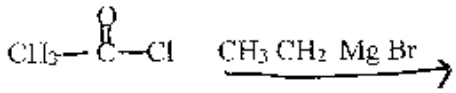
(6) CH_3–C(=O)–H $LiAlH_4$ ⟶

(7) CH_3–C(=O)–H + CH_3CH_2–C(H)(⊖)–P(⊕)–Ph_3 ⟶

(8)



(9)



B. Short Answers part of Short Answers: (24 pts)

1. To make the ether $CH_3-O-CH_2CH_3$ the following are two possible ways. (5 pts total)

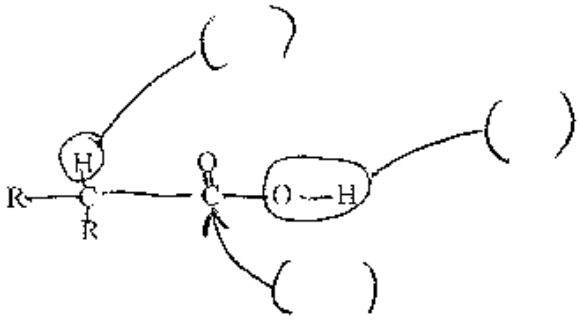
(1) Which is the better reaction? [(a) or (b)] (circle one) (3 pts)

a) $CH_3-OH + CH_3CH_2-OH \xrightarrow{H^+ / -H_2O}$ S_N2 dehydration of alcohol

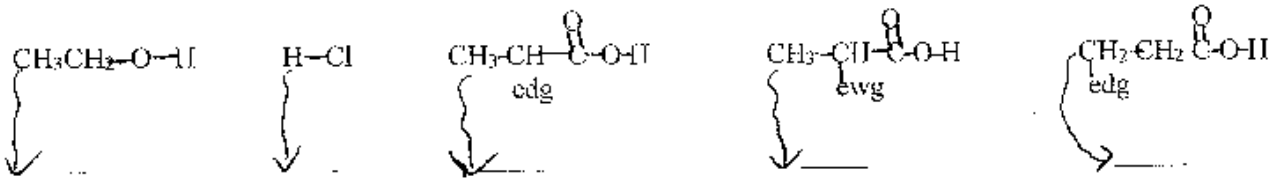
b) $CH_3Cl + CH_3CH_2O^- \longrightarrow$ S_N2 (Williamson Ether Synthesis)

(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)



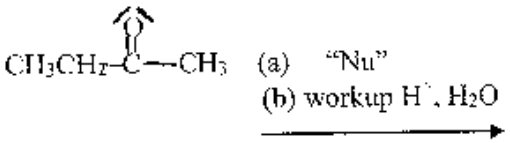
3. Put the following acids in order from **strongest acid (1)** to **weakest acid (5)** (edg = electron donating group, ewg = electron withdrawing group) (5 pts, 1 pt each)



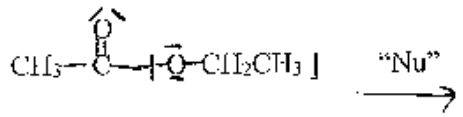
4. Put the following carboxylic acid derivative from the **most reactive (1)** to **least reactive (4)** carboxylic acid derivative. (8 pts, 2 pts each)

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)

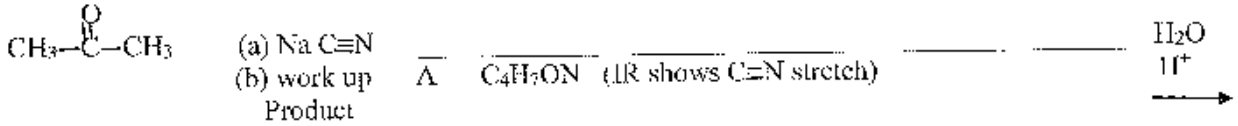


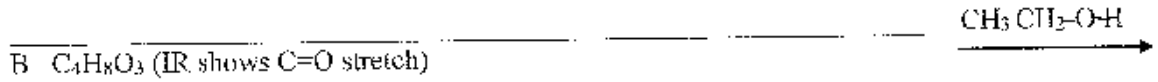
(B) Keeping in mind the general reaction mechanism of the addition of a nucleophile to carboxylic acid derivative, complete the following "GENERALIZED" reaction mechanism. (MECHANISM means you show all intermediates. If you just give reaction products, you will LOSE LOTS OF POINTS.) (8 pts part B)

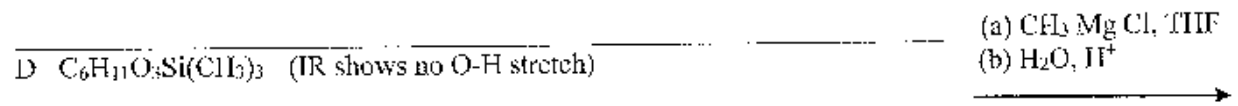


(C) Why do you get a different type of reaction mechanism for (A) ketone/aldehydes vs. (B) carboxylic acid derivatives ? Explain in a few sentences. (6 pts part C)

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 C6H14O2 (IR shows O-H stretch)