Chemistry 3B, Midterm 2

Tuesday, April 20, 2004

Student name: Answer Key

Student signature: ______

Write TA's full name (section number) or Lecture Only: ______

1. Please make sure that the exam has 9 pages including this one.
2. Please write your answers in the spaces provided.
3. Write clearly; illegible or ambiguous answers will be considered incorrect.
4. Only writing implements are allowed **(No Calculators)**.

GOOD LUCK!

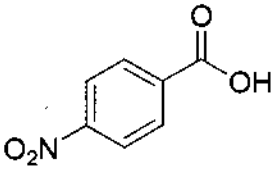
1.	30 points	______
2.	60 points	______
3.	20 points	______
4.	20 points	______
5.	20 points	______
6.	20 points	______
7.	10 points	______
Total	**180 points**	______

MINI-PERIODIC TABLE

I	II	III	IV	V	VI	VII	VIII
H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca	Ga	Ge	As	Se	Br	Kr

1. Answer the following questions. Every wrong answer cancels a correct answer (30 points).

(a). Number the carboxylic acids from most acidic to least acidic [1 = **most** acidic, 4 = **least** acidic] (6 points).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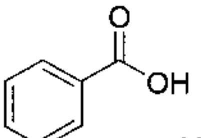
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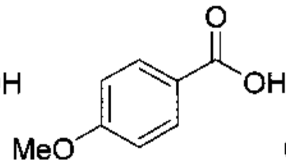
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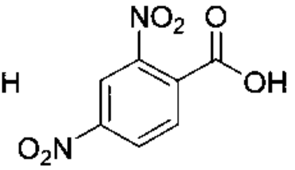
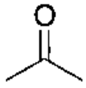
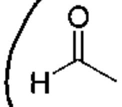
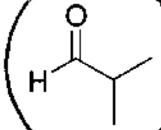
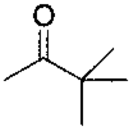

1

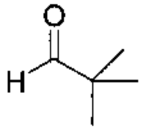
(b). Circle the compound(s) that would give the corresponding aldol **self-condensation** product under standard reaction conditions, e.g., HO^-, H_2O (6 points).



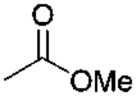
[✓ ]

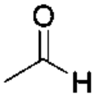
[✓ ]

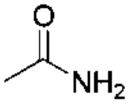


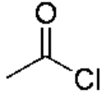


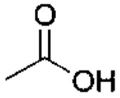
(c). Circle the compound(s) that are converted into a **new** compound upon treatment with LiAlH(O-*t*-Bu)$_3$ followed by aqueous workup (6 points).



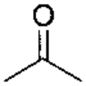




[✓ ]



(d). Rank the following compounds according to the number of deuteriums incorporated upon treatment with DO^-, D_2O [1 = **most** deuteriums, 5 = **fewest** deuteriums] (6 points).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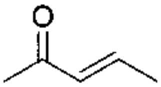
5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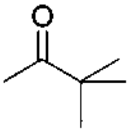
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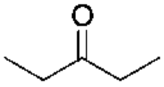
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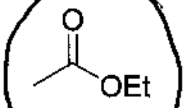
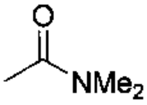
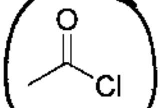
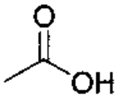
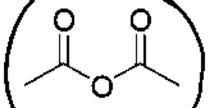
(e). Circle the carboxylic acid derivatives that upon heating with methoxide in methanol provide the methyl ester (6 points).

[✓ ]



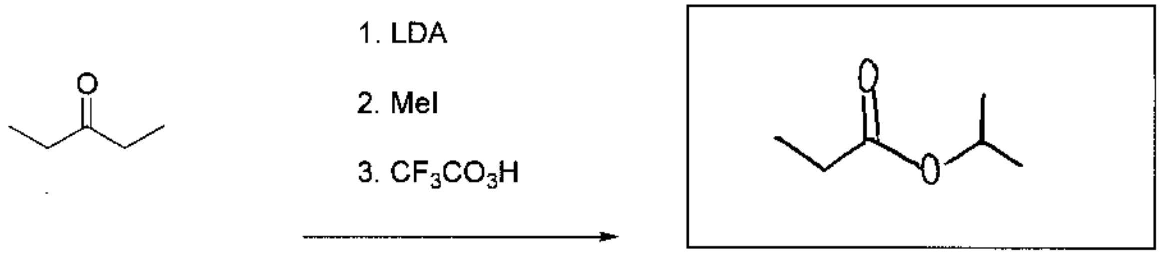
[✓ ]



[✓ ]

2. For each of the following reactions supply the missing reagents or major organic product in the space provided. If no reaction is expected indicate by N.R. (60 points total).

(a)

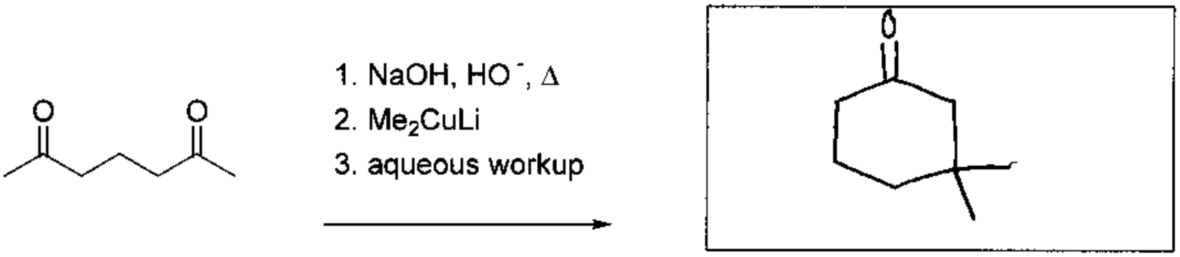


1. LDA

2. MeI

3. CF_3CO_3H

(b)

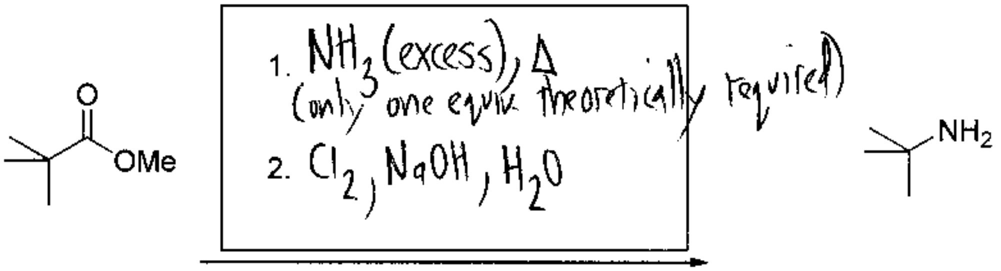


1. NaOH, HO^-, Δ

2. Me_2CuLi

3. aqueous workup

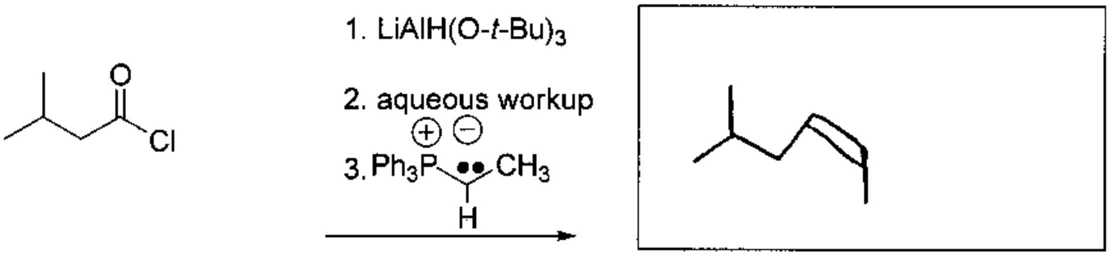
(c)



1. NH_3 (excess), Δ (only one equiv theoretically required)

2. Cl_2, NaOH, H_2O

(d)

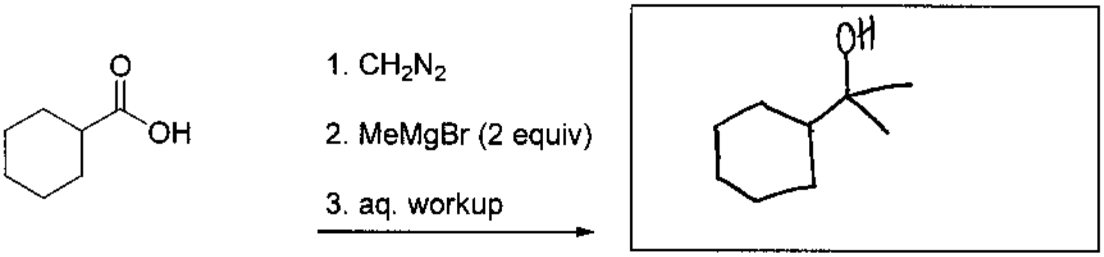


1. $LiAlH(O\text{-}t\text{-}Bu)_3$

2. aqueous workup

3. $Ph_3\overset{\oplus}{P}-\overset{\ominus}{\ddot{C}}H-CH_3$

(e)

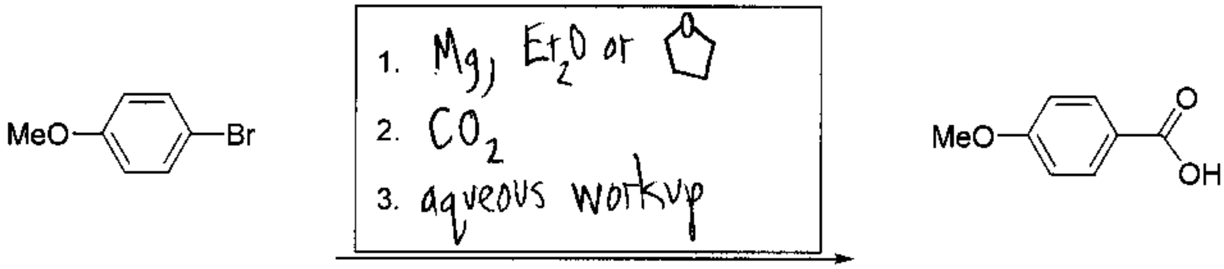


1. CH_2N_2

2. MeMgBr (2 equiv)

3. aq. workup

(f)

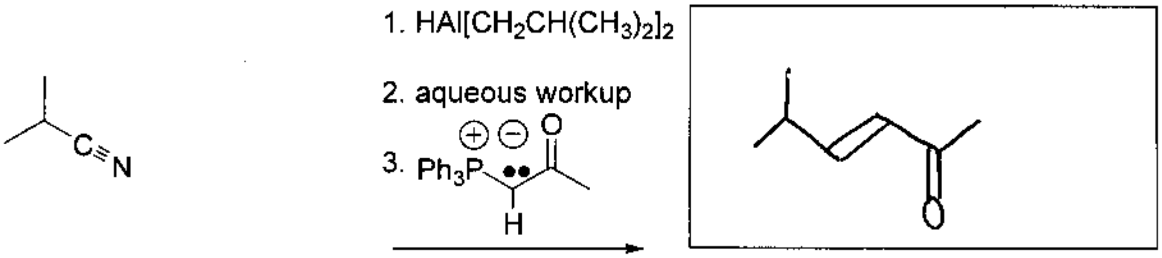


1. Mg, Et_2O or THF

2. CO_2

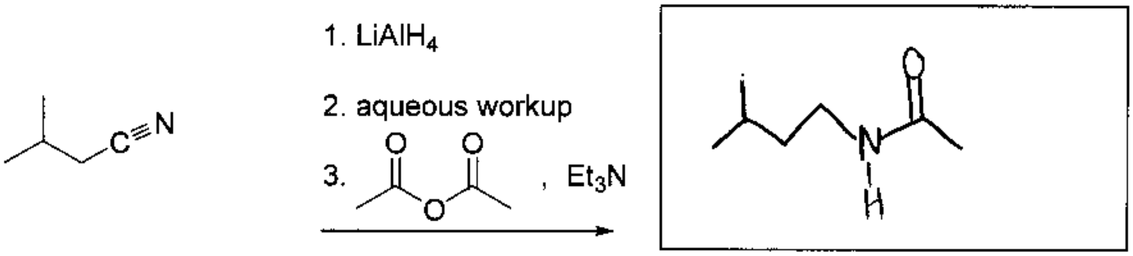
3. aqueous workup

(g)



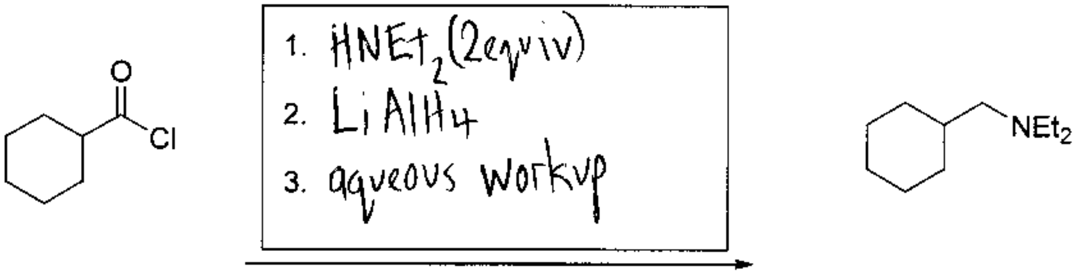
1. $HAl[CH_2CH(CH_3)_2]_2$
2. aqueous workup
3.

(h)



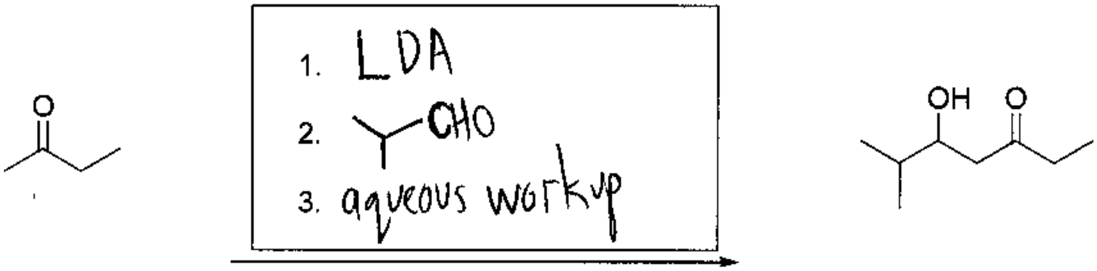
1. $LiAlH_4$
2. aqueous workup
3. , Et_3N

(i)



1. $HNEt_2$ (2equiv)
2. $LiAlH_4$
3. aqueous workup

(j)

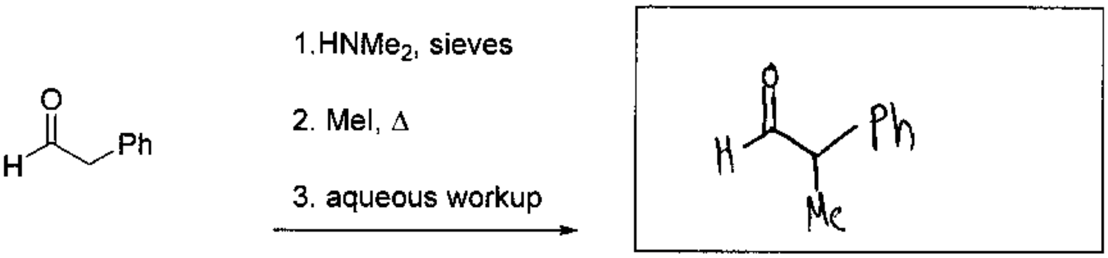


1. LDA
2. CHO
3. aqueous workup

(k)

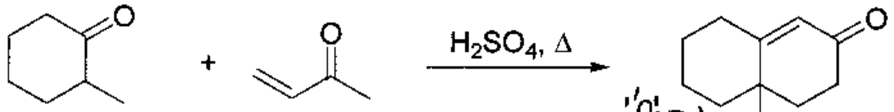
1. Cl_2, AcOH
2. PPh_3
3. HO^-

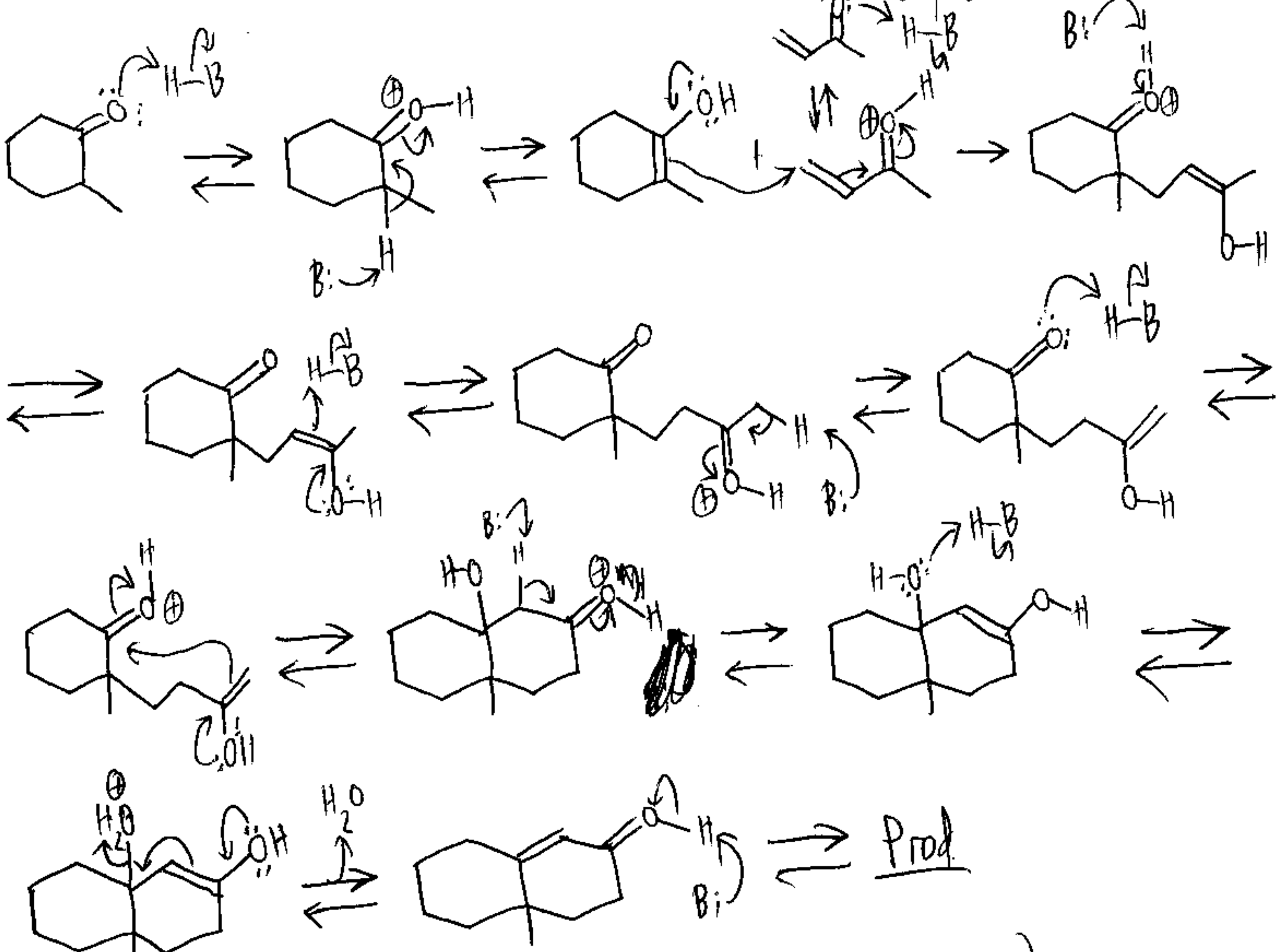
(l)



1. $HNMe_2$, sieves
2. MeI, Δ
3. aqueous workup

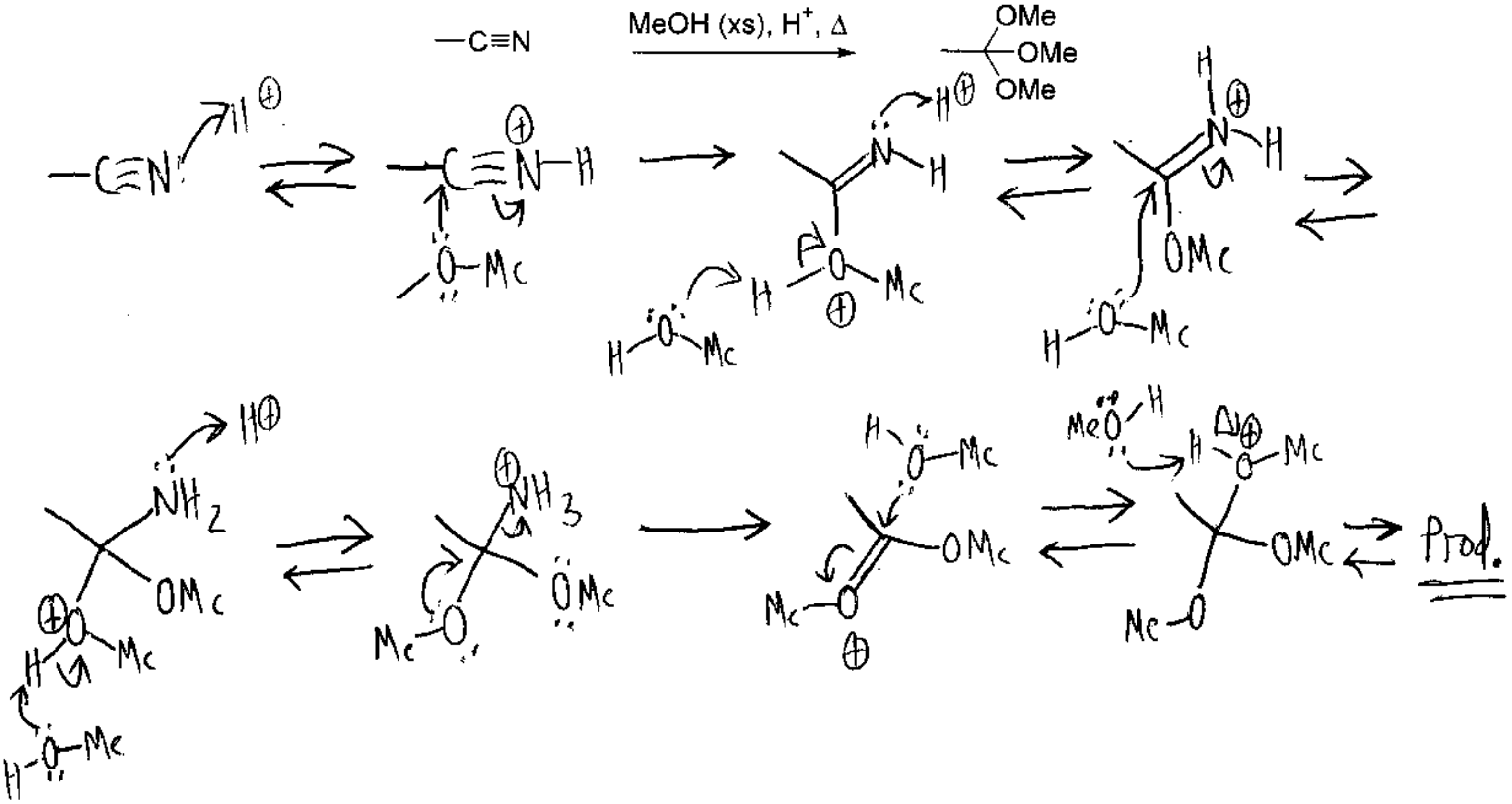
3. The Robinson annulation can also be performed under acidic conditions according to the "California acid procedure", which was co-developed by Clayton Heathcock in this department approximately 30 years ago. Provide a detailed mechanism for the acid-catalyzed Robinson annulation shown below (20 points).



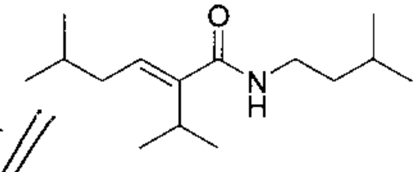


Note: B–H = H_2SO_4 or $H_3O^{\oplus}$ (H_2O released in dehydration step)
B: = $HSO_4^{\ominus}$ or H_2O

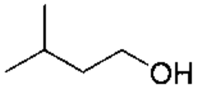
4. The product of the below transformation, which is called an orthoester, is often used to protect an ester from strong bases and nucleophiles. Draw a detailed mechanism by which the nitrile is converted to the orthoester (20 points).



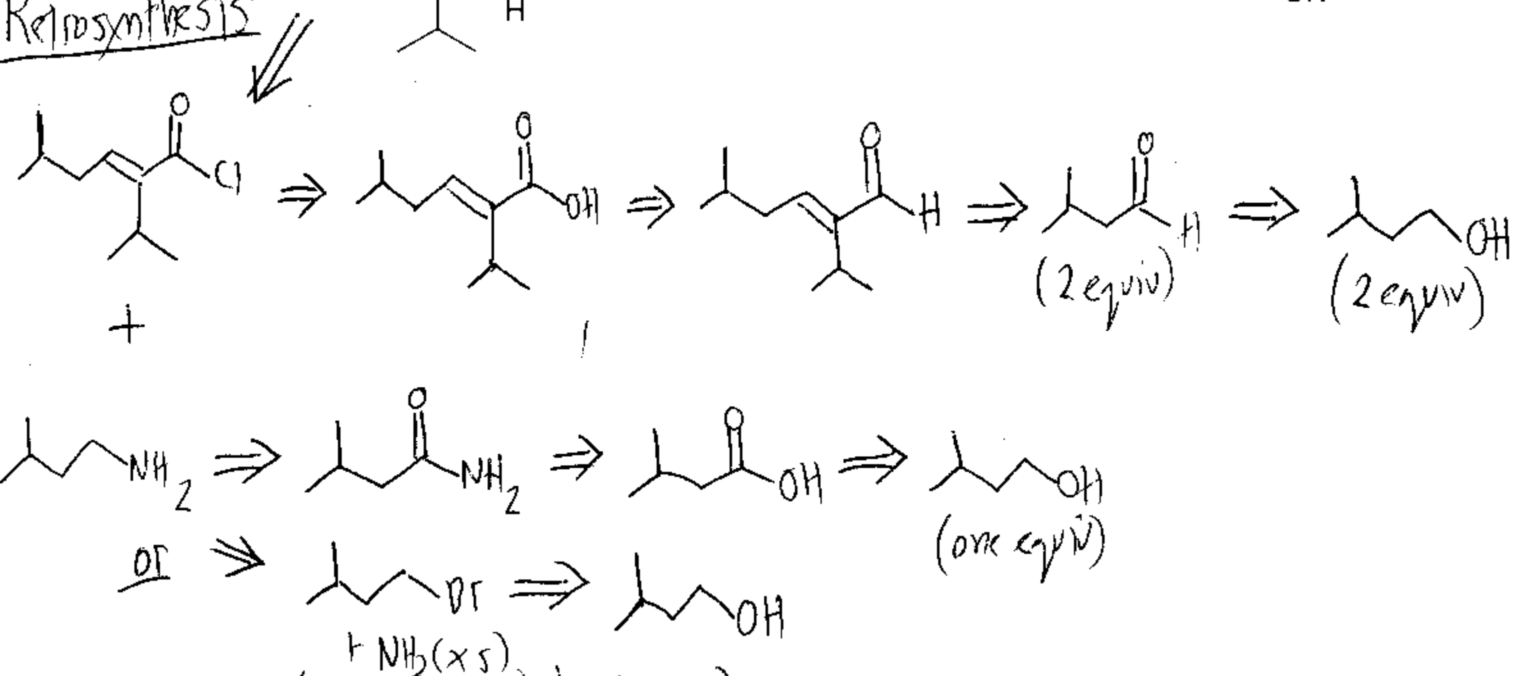
5. Provide the most efficient synthesis. You may employ any reagents of your choice. Points will be assigned according to steps listed in the forward synthesis direction (20 points).



from 3 equiv of

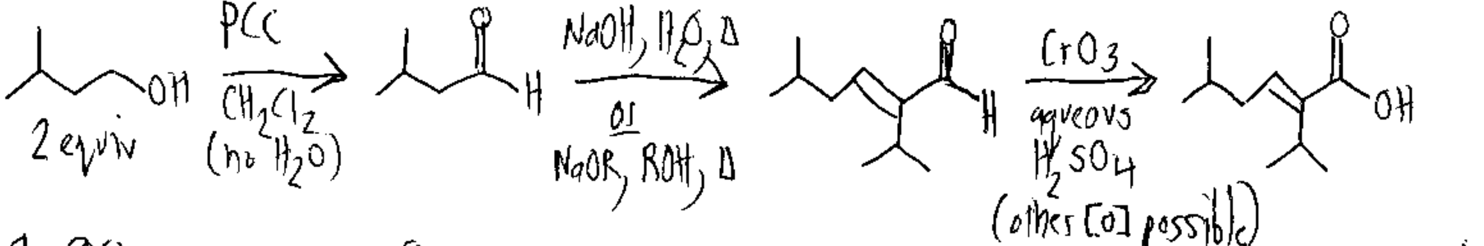


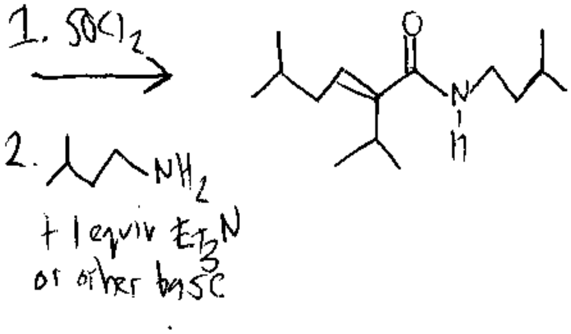
Retrosynthesis



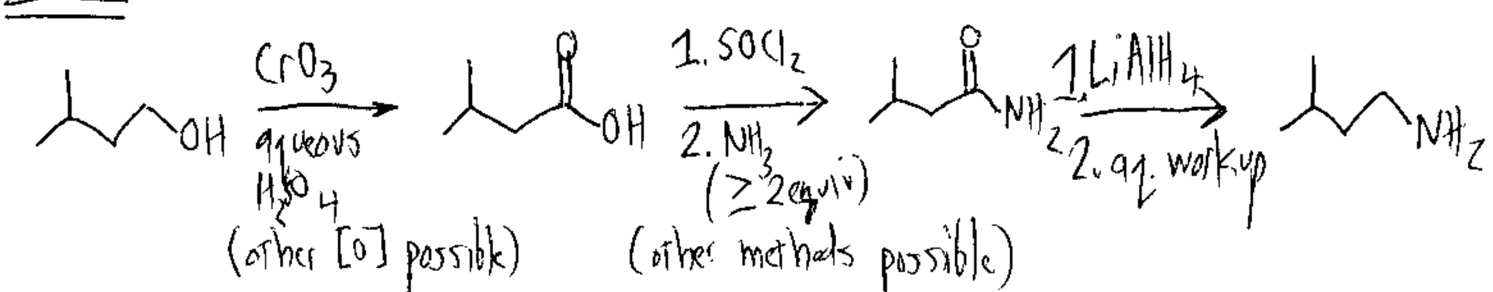
(other nucleophiles better) Will learn later.

Synthetic Direction.

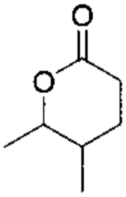




Note that amide could be formed from the corresponding ester, or even acid (Δ!), but these typically require excess amide due to slow rxn rate (full credit is given for these methods)



6. Provide the most efficient synthesis. You may employ any reagents of your choice. Points will be assigned according to steps listed in the forward synthesis direction (20 points).



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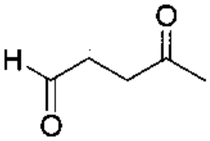
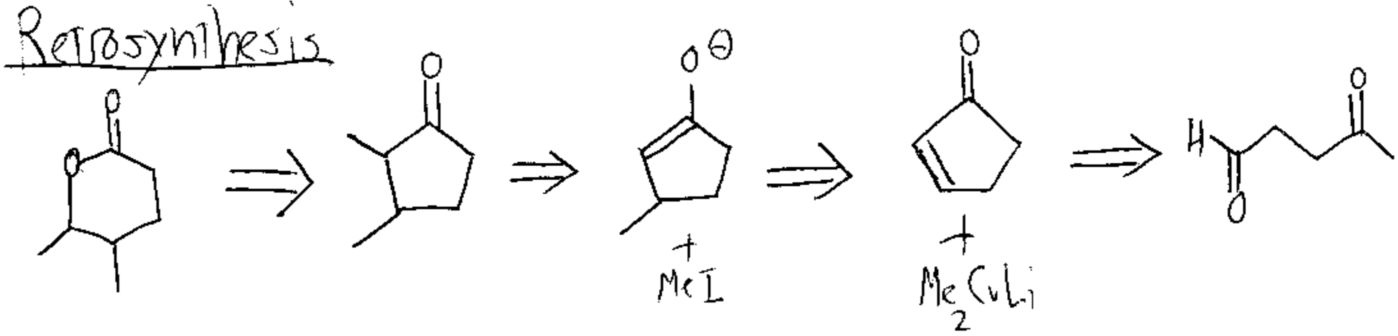
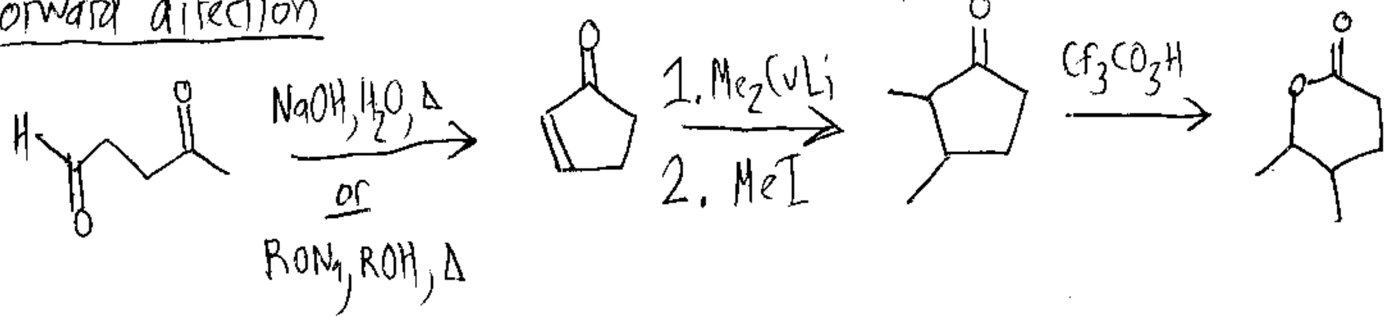


and any other reagents

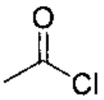
Retrosynthesis

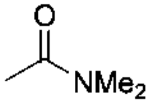


Forward direction

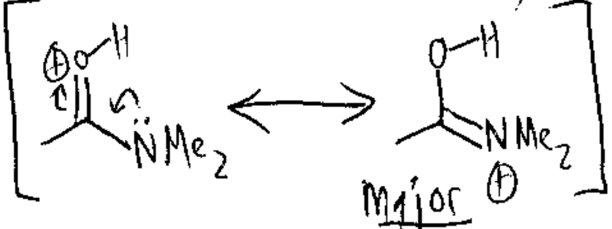


7a. Is the oxygen of acid chloride A or amide B more basic, i.e., easier to protonate? Briefly explain your answer (5 points).



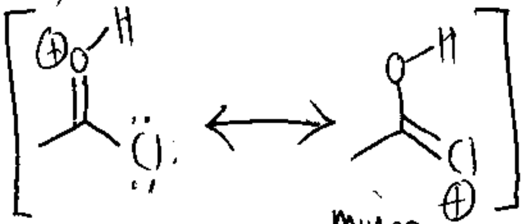


The amide is easier to protonate: This is because the protonated amide is ~~[illegible]~~ <u>much</u> more effectively stabilized by resonance



<u>major</u>

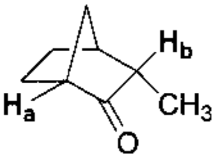
(N not as electronegative as O)



<u>minor</u>

(Cl as electronegative as O and 3rd row (Cl)/2nd row (O) orbital overlap is poor)

7b. Explain why the molecule drawn below incorporates only one deuterium when treated with DO$^-$, D$_2$O. Indicate which of the labeled hydrogens, H$_a$ or H$_b$, is exchanged. Briefly explain your answer (5 points).



Only H$_b$ is exchanged. For deprotonation to occur the C—H bond must overlap with the π-bond of the C=O for resonance ~~[illegible]~~ stabilization. Deprotonation at Ha would also generate a highly strained enolate.