NAME (Print): _____

EID _____

SIGNATURE: _____

Chemistry 320N
Final Exam
May 1, 2025

Please print the first three letters of your last name in the three boxes

Please Note: Please take your time. You have three hours to take this exam. Please do not rush, we want you to show us everything you have learned during your organic chemistry journey. Making careless mistakes is not good for anyone! If you find yourself getting anxious because of a problem, skip it and come back. Please do not second guess yourself! Keep track of the questions worth a lot of points. (This does not mean they are hard, it just means we think they cover important material.)

One last thing: I recommend you close your eyes for a moment, then take some nice deep breaths before you begin. YOU GOT THIS!

FINALLY, DUE TO SOME UNFORTUNATE RECENT INCIDENTS YOU ARE NOT ALLOWED TO INTERACT WITH YOUR CELL PHONE IN ANY WAY. IF YOU TOUCH YOUR CELL PHONE DURING THE EXAM YOU WILL GET A "0" NO MATTER WHAT YOU ARE DOING WITH THE PHONE. PUT IT AWAY AND LEAVE IT THERE!!!

Student Honor Code for the University of Texas at Austin

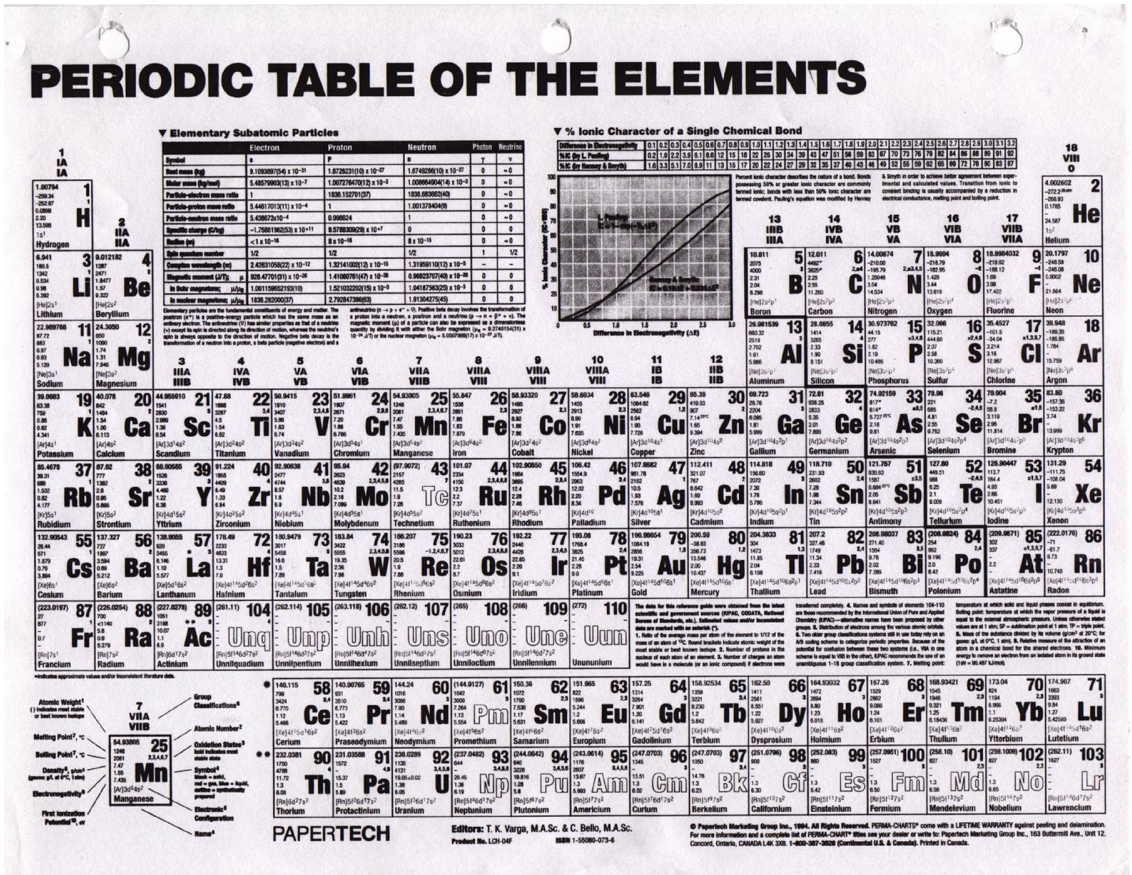
"I pledge, as a member of The University of Texas at Austin community, to do my work honestly, respectfully, and through the intentional pursuit of learning and scholarship."

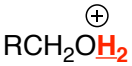
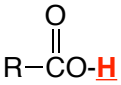
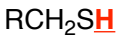
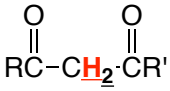
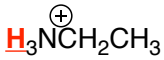
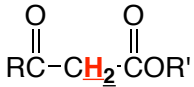
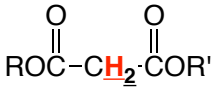
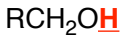
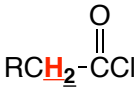
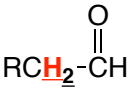
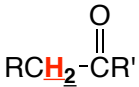
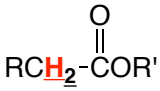
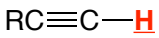
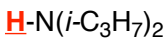
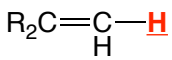
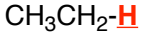
Elaboration

1. I pledge to be honest about what I create and to acknowledge what I use that belongs to others.
2. I pledge to value the process of learning in addition to the outcome, while celebrating and learning from mistakes.
3. This code encompasses all of the academic and scholarly endeavors of the university community.

_____

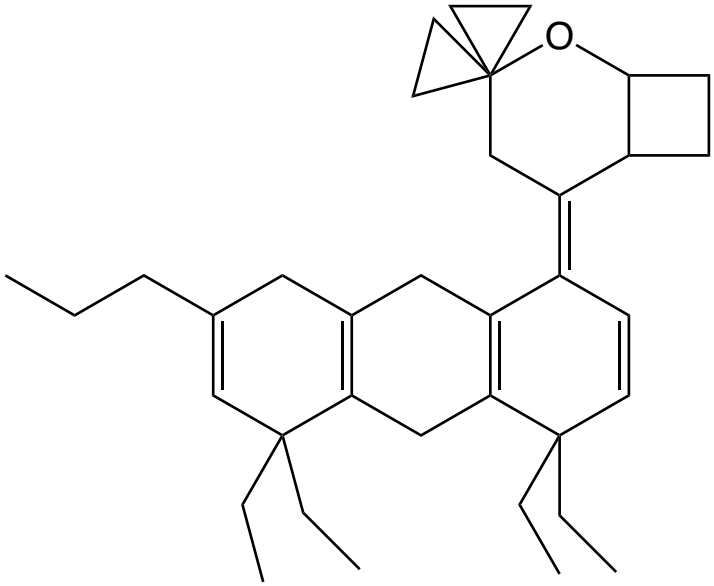
(Your signature)



Compound		pK_a
Hydrochloric acid		-7
Protonated alcohol		-2
Hydronium ion		-1.7
Carboxylic acids		3-5
Thiols		8-9
Ammonium ion		9.2
β-Dicarbonyls		10
Primary ammonium		10.5
β-Ketoesters		11
β-Diesters		13
Water		15.7
Alcohols		15-19
Acid chlorides		16
Aldehydes		18-20
Ketones		18-20
Esters		23-25
Terminal alkynes		25
LDA		40
Terminal alkenes		44
Alkanes		51

Golden Rules of Chemistry for your reference

A. Predicting Structure and Bonding 1. In most stable molecules, all the atoms will have filled valence shells. 2. Five- and six-membered rings are the most stable. 3. There are two possible arrangements of four different groups around a tetrahedral atom. **B. Predicting Stability and Properties** 4. The most important question in organic chemistry is "Where are the electrons?" 5. Delocalization of charge over a larger area is stabilizing. 6. Delocalization of unpaired electron density over a larger area is stabilizing. 7. Delocalization of pi electron density over a larger area is stabilizing. **C. Predicting Reactions** 8. Reactions will occur if the products are more stable than the reactants and the energy barrier is low enough. 9. Functional groups react the same in different molecules. 10. A reaction mechanism describes the sequence of steps occurring during a reaction. 11. Most bond-making steps in reaction mechanisms involve nucleophiles reacting with electrophiles.



Hello everyone, Poptart here! Best of luck in your final. You got this! If you were wondering, here is my official IUPAC name: (*E*)-5-(4,4,5,5-tetraethyl-7-propyl-5,8,9,10-tetrahydroanthracen-1(4*H*)-ylidene)-2-oxaspiro[bicyclo[4.2.0]octane-3,1'-cyclopropane]

We are here at the end of your OChem experience (for most of you). ***I have been honored to be on this journey of learning and discovery with you***. You started by learning about molecular structure and bonding in OChem 1 and now you can carry out sophisticated syntheses to make complex molecules from simpler ones. That technology, the ability to make and break specific chemical bonds, has created what we know as modern life. And now you understand how it works. But that is not all. You also have a solid foundation for understanding the structure and reactivity of the very molecules that are responsible for life on this planet.

And if you have gone through my previous finals you have seen this poem before, but I want you to read this on your own OChem II final exam. This is to each one of you, my sincere wish, taken from the words of one of the great poets of the 20th Century, Bob Dylan.

"May your wishes all come true
May you always do for others
And let others do for you
May you build a ladder to the stars
And climb on every rung
May you stay forever young

May you always know the truth
And see the light surrounding you
May you always be courageous
Stand upright and be strong
May you stay forever young

May your hands always be busy
May your feet always be swift
May you have a strong foundation
When the winds of changes shift
May your heart always be joyful
May your song always be sung
And may you stay forever young"

Here is my original final verse, written specifically for each of you:

"Every chance you get,
You should go out for a run,
That is the very best way
For you to stay forever young."

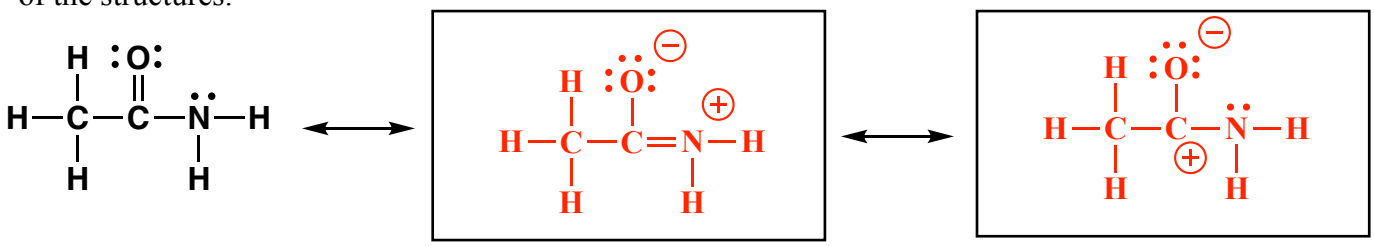
DON'T TEAR OUT THIS PAGE, *IT WILL MESS UP OUR SCANS!!!*

Use this for scratch paper

1. (5 pts) What is the most important question in organic chemistry?

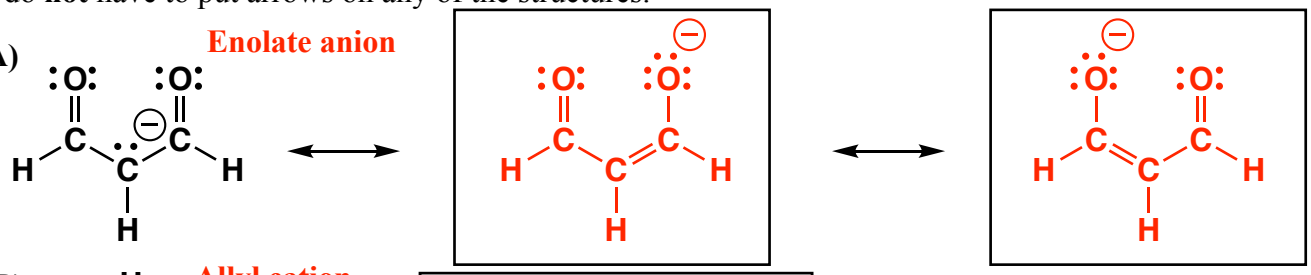
Where are the electrons?

2. (10 pts) Amides are best represented as the hybrid of three contributing structures. Draw the second and third important contributing structures in the spaces provided. You do **not** have to put arrows on any of the structures.

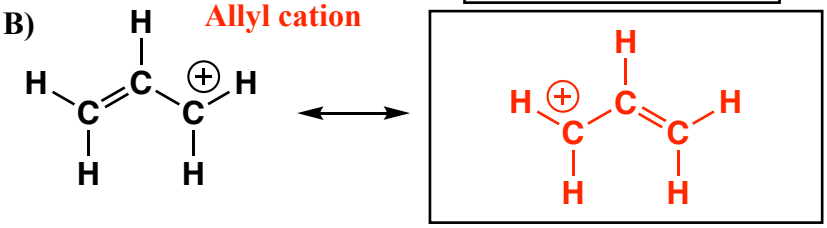


3. (18 pts) Many other molecules you have seen are best represented as the hybrid of contributing structures. Draw the most important contributing structures for each species in the spaces provided. You do **not** have to put arrows on any of the structures.

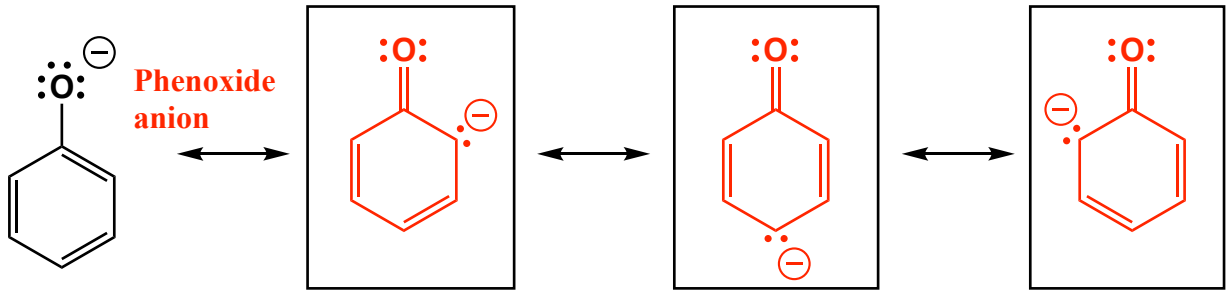
A) Enolate anion



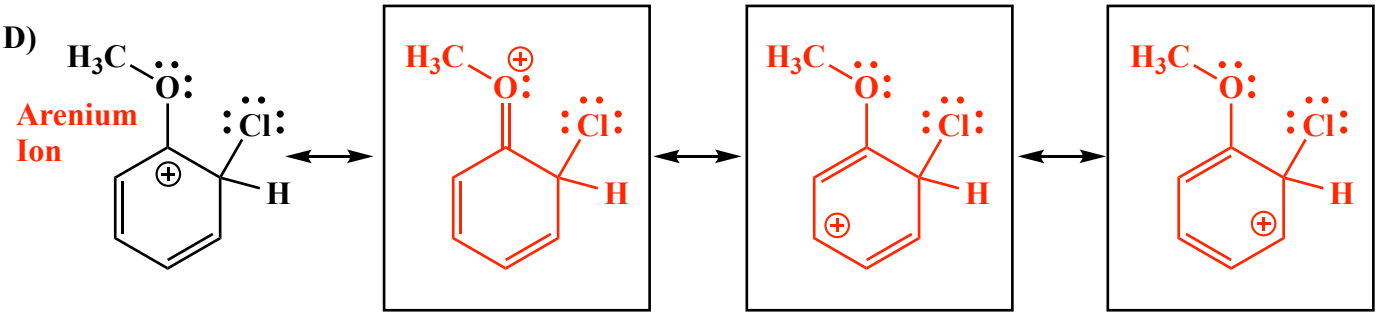
B) Allyl cation



C) Phenoxide anion



D) Arenium Ion



4. (2 pts each). Here is an OChem II Crossword puzzle! Fill in the word that is missing in each clue and write it in the appropriate boxes on Page 3. You will likely recognize these as Rules of the Day throughout the semester!

DOWN

1. According to Huckel's rules, for a molecule to be aromatic all ring atoms are sp^2 hybridized, the ring must be flat, _____ and it must have "4n + 2" pi electrons (2, 6, 10, 14, 18, 22 ....) where n = 0,1,2,3,4,5...).

2. Protonation of a carbonyl oxygen atom in acid makes the carbonyl carbon atom much more _____ (i.e. able to react with weaker nucleophiles).

4. The Z-alkenes and even _____ help the membrane bilayers become fluid enough to function.

5. Molecules appear to our eye to be a combination of the wavelengths _____ (not absorbed).

8. Carbohydrate monomers can be linked together via acetal bonds and this linkage can be alpha or beta (For glucose alpha is axial). This type of acetal bond is called a _____ bond.

12. An _____ is formed when a secondary amine reacts with a ketone or aldehyde.

13. A methyl _____ is the synthesis key recognition element (KRE) for synthesis by the acetoester synthesis.

16. _____ are biological molecules, such as triglycerides and steroids, that are not soluble in water.

ACROSS

3. _____ make up biological membranes and are composed of two fatty acid molecules linked to glycerol along with a negatively-charged phosphate connected to a group such as positively-charged choline.

6. Carbohydrates like glucose exist in the cyclic_____ form in solution.

7. The stronger the acid, the _____ the pK_a and the more stable the conjugate base.

9. The _____ ester synthesis is entirely analogous to the acetoester synthesis, except diethyl malonate is used and a substituted carboxylic acid derivative is the ultimate product following ester hydrolysis in acid (H_3O+) and heating (loss of CO_2).

10. High fructose corn syrup is derived from corn starch using _____ to convert the poly-D-Glucose polymer to individual D-glucose molecules, then converting some of the D-glucose to D-fructose in analogy to natural bee honey.

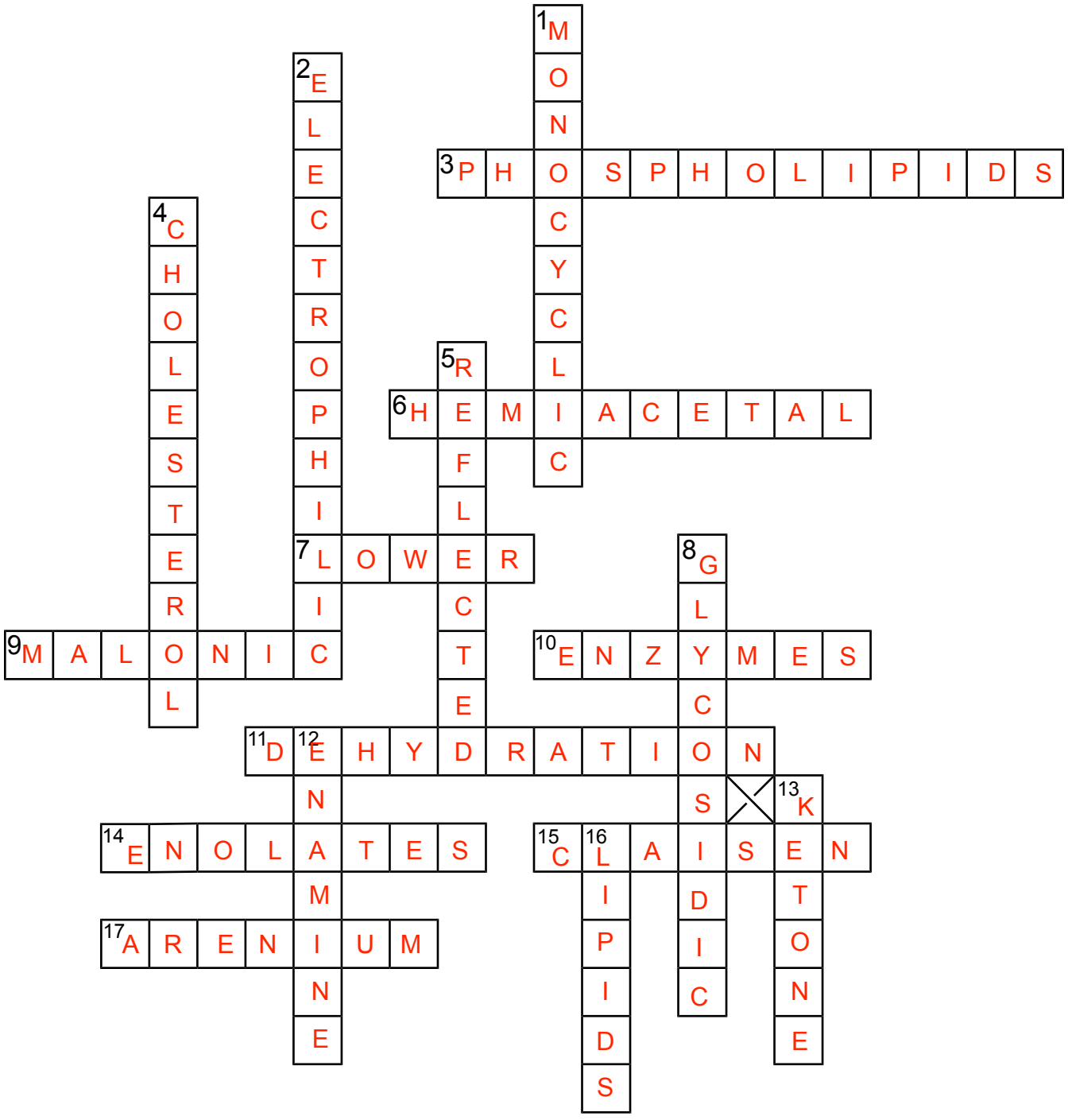
11. The Robinson annulation is a Michael reaction followed by an aldol reaction to make a six-membered ring, then the reaction ends with a _____.

14. The key to remember is that LDA quantitatively makes _____ from aldehydes, ketones and esters.

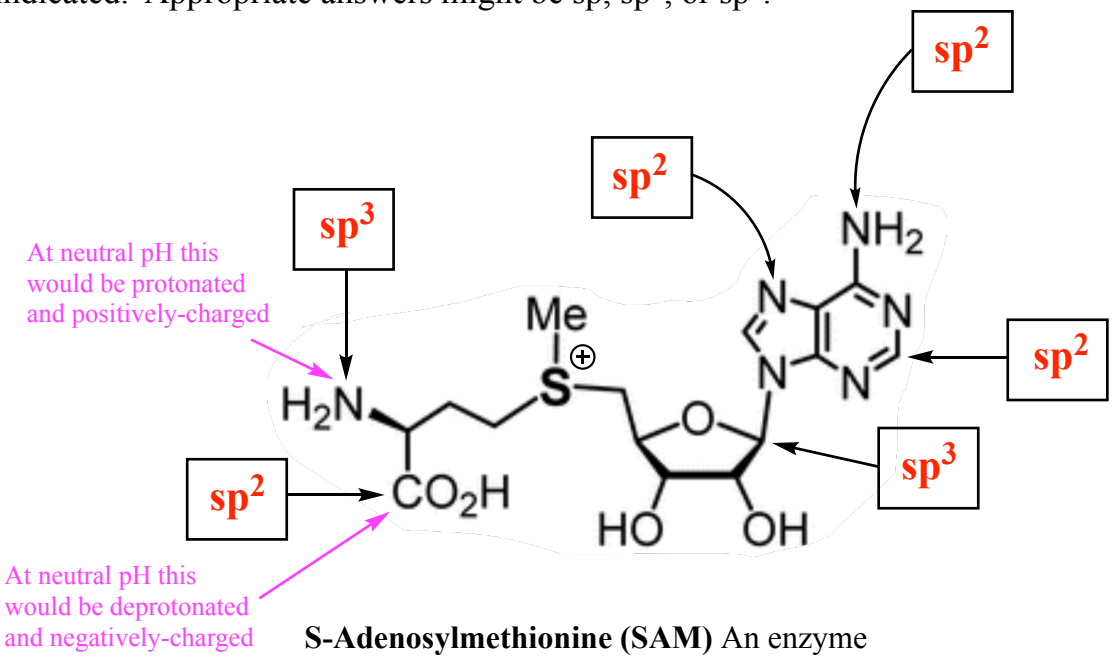
15. A Dieckmann reaction is a cyclic version of the _____ condensation in which a diester reacts to give a 5 or 6-membered ring.

17. Substituents already on the ring influence reactivity and orientation by interacting with the partial positive charges of the _____ ion intermediate.

4 (cont.). (2 pts each). Here is an OChem II Crossword puzzle! Fill in the words that are missing based on the clues on Page 2. You will likely recognize these as Rules of the Day throughout the semester!



5. (2 pts each) For each arrow, in the box provided write the hybridization state of the atom indicated. Appropriate answers might be sp, sp^2, or sp^3.

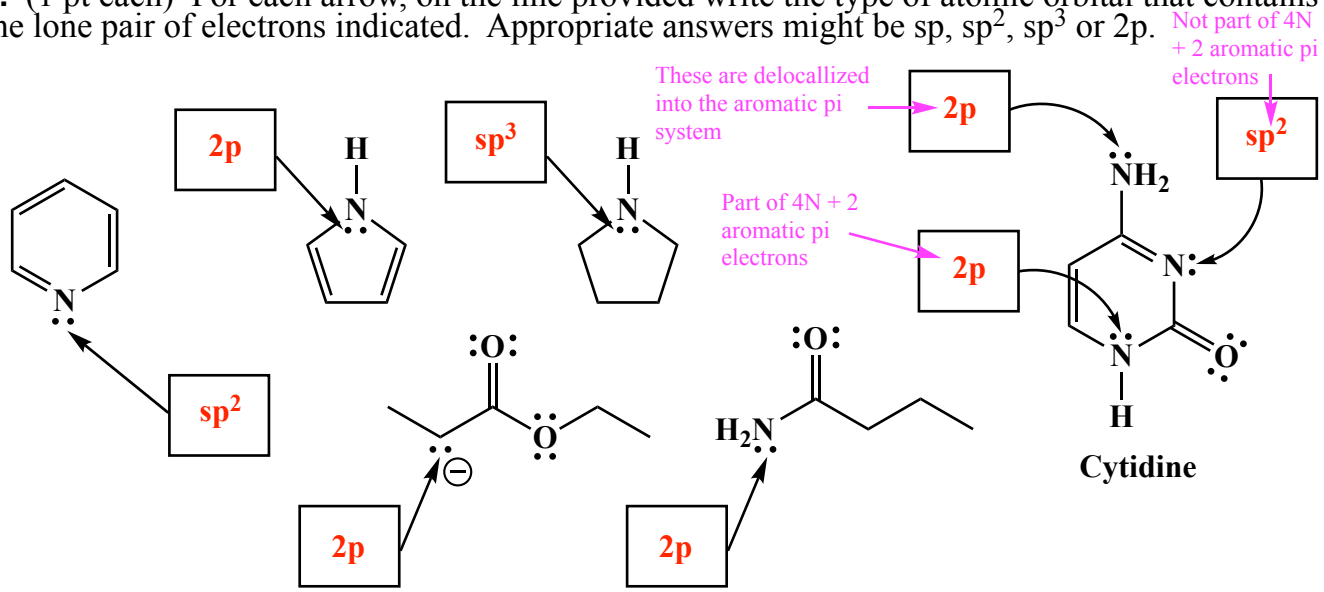


S-Adenosylmethionine (SAM) An enzyme cofactor used when a methyl group is transfered. (I copied this structure off of the internet)

(4 pts) The above structure was copied from the internet. In the box provided, briefly explain what is chemically incorrect about this structure.

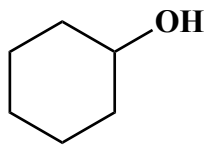
In the structure, the carboxylic acid is protonated and neutral while the adjacent amine group is neutral and not protonated. There is no pH at which this is possible! At neutral pH the carboxlyic acid would be deprotonated and negatively-charged, while the amine would be protonated and postiviely-charged.

6. (1 pt each) For each arrow, on the line provided write the type of atomic orbital that contains the lone pair of electrons indicated. Appropriate answers might be sp, sp^2, sp^3 or 2p.

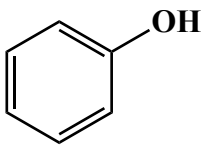


7. (2 pts each) For each pair of molecules, fill in the circle to indicate which one is the stronger acid (lower pK_a).

A.

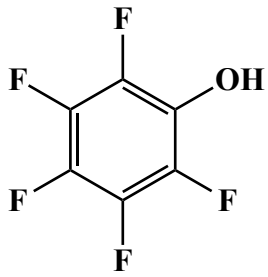


○ Stronger Acid

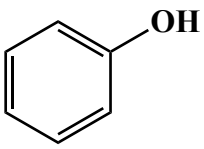


● Stronger Acid

B.

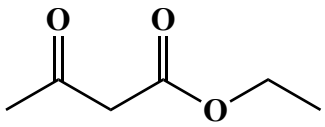


● Stronger Acid

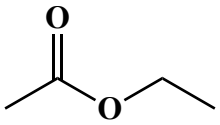


○ Stronger Acid

C.

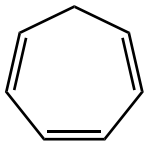


● Stronger Acid



○ Stronger Acid

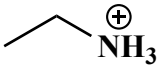
D.



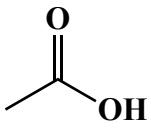
○ Stronger Acid

● Stronger Acid

E.

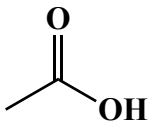


○ Stronger Acid

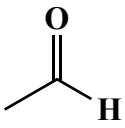


● Stronger Acid

F.



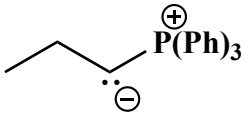
● Stronger Acid



○ Stronger Acid

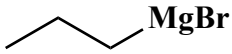
8. (2 pts each) For each of the following molecules we have seen in reaction mechanisms, fill in the circle to indicate whether the molecules acts as a nucelophile or electrophile. For this one, you can ignore acid or base considerations and just focus on the nuclophile/electrophile properties of the molecules.

A.



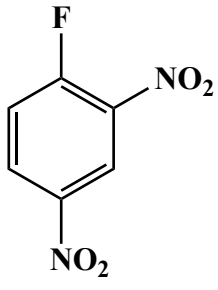
● Nucleophile
○ Electrophile

B.



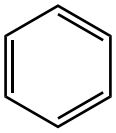
● Nucleophile
○ Electrophile

C.



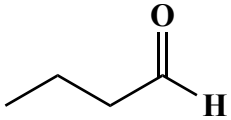
○ Nucleophile
● Electrophile

D.



● Nucleophile
○ Electrophile

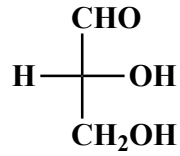
E.



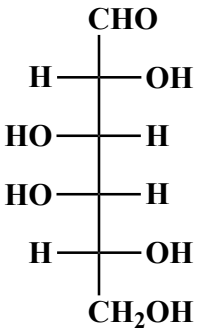
○ Nucleophile
● Electrophile

9. (2, 3 or 4 pts each) For each set of molecules, fill in the circles that correctly describe the situation.

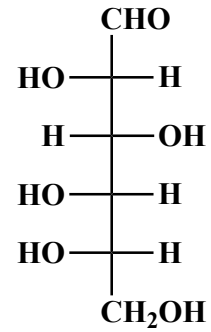
A)



D-Glyceraldehyde

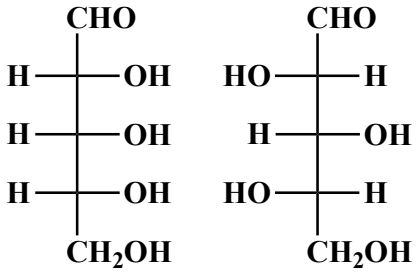


● D-Carbohydrate
○ Not a D-carbohydrate



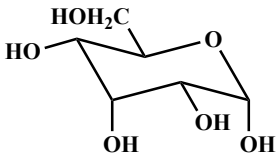
○ D-Carbohydrate
● Not a D-Carbohydrate

B)

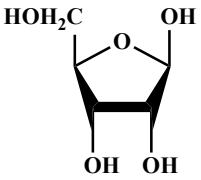


○ Enantiomers
● Diastereomers

C)

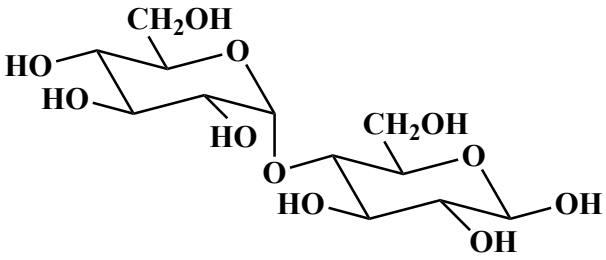


○ Furanose
● Pyranose



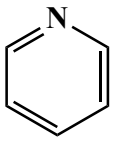
● Furanose
○ Pyranose

D)

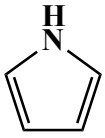


○ This molecule has an α(1,6) glycosidic bond
○ This molecule has a β(1,6) glycosidic bond
● This molecule has an α(1,4) glycosidic bond

E)



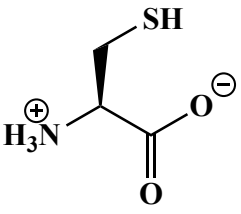
● Can be used as a base
○ Not a base



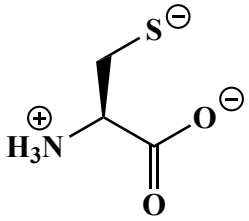
○ Can be used as a base
● Not a base

G)

The pK_a of R-$\overset{\oplus}{N}H_3$ is about 10
The pK_a of R-CO_2H is about 3.5
The pK_a of R-CH_2SH is about 8.3

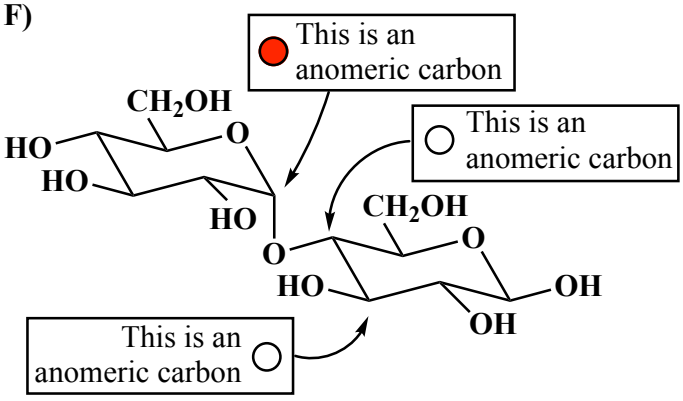


○ This is correct for pH 2.0
● This is correct for pH 7.0
○ This is correct for pH 9.0
○ This is never correct



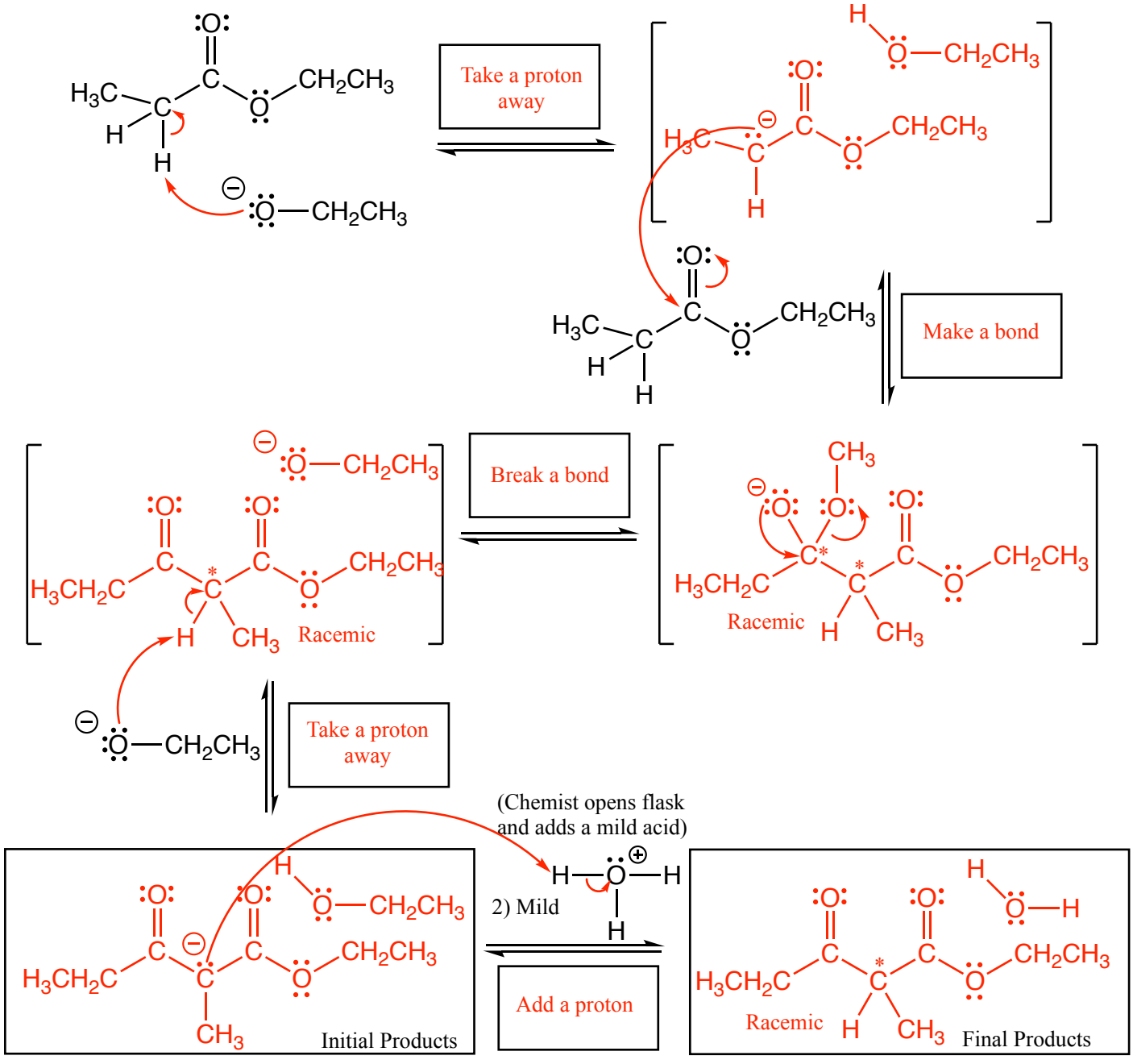
○ This is correct for pH 2.0
○ This is correct for pH 7.0
● This is correct for pH 9.0
○ This is never correct

F)

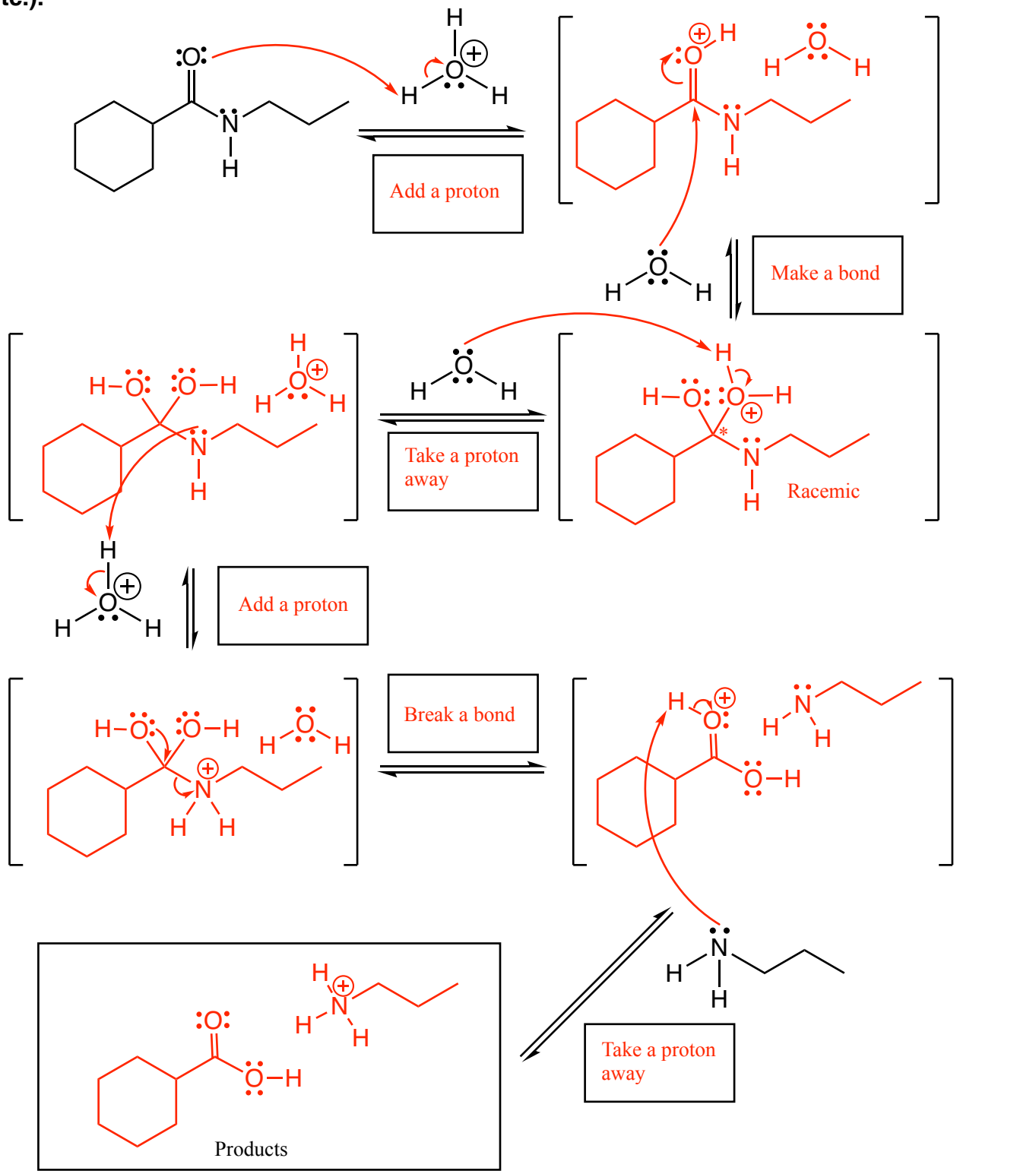


C.

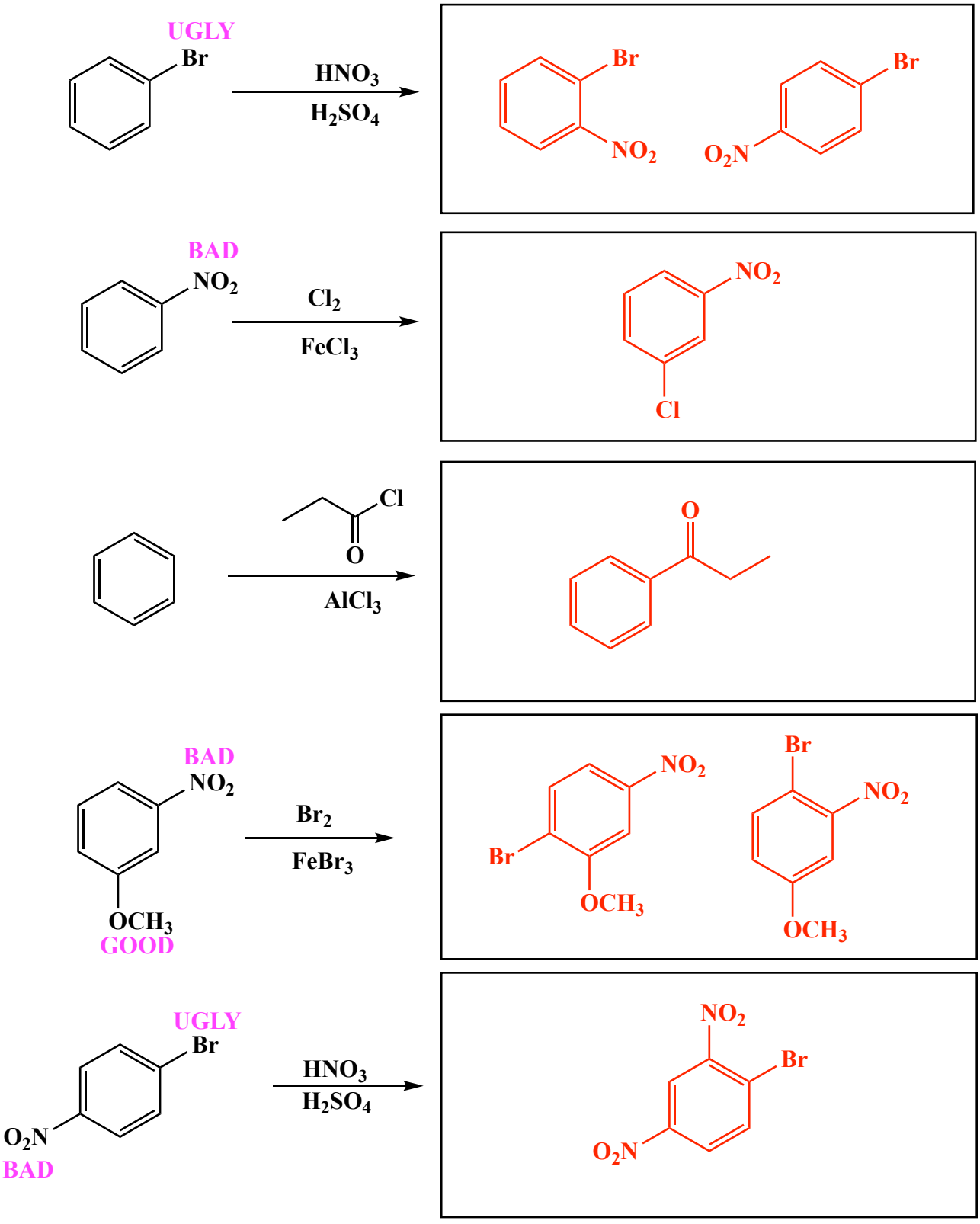
10. (30 pts) Complete the mechanism for the following Claisen reaction. **Be sure to show arrows to indicate movement of all electrons, write all lone pairs, all formal charges, and all the products for each step.** Remember, I said all the products for each step. **IF A NEW CHIRAL CENTER IS CREATED IN AN INTERMEDIATE OR PRODUCT, MARK IT WITH AN ASTERISK AND LABEL THE MOLECULE AS RACEMIC IF APPROPRIATE. In the boxes provided, write which of the 4 mechanistic elements describes each step (make a bond, break a bond, etc.).**



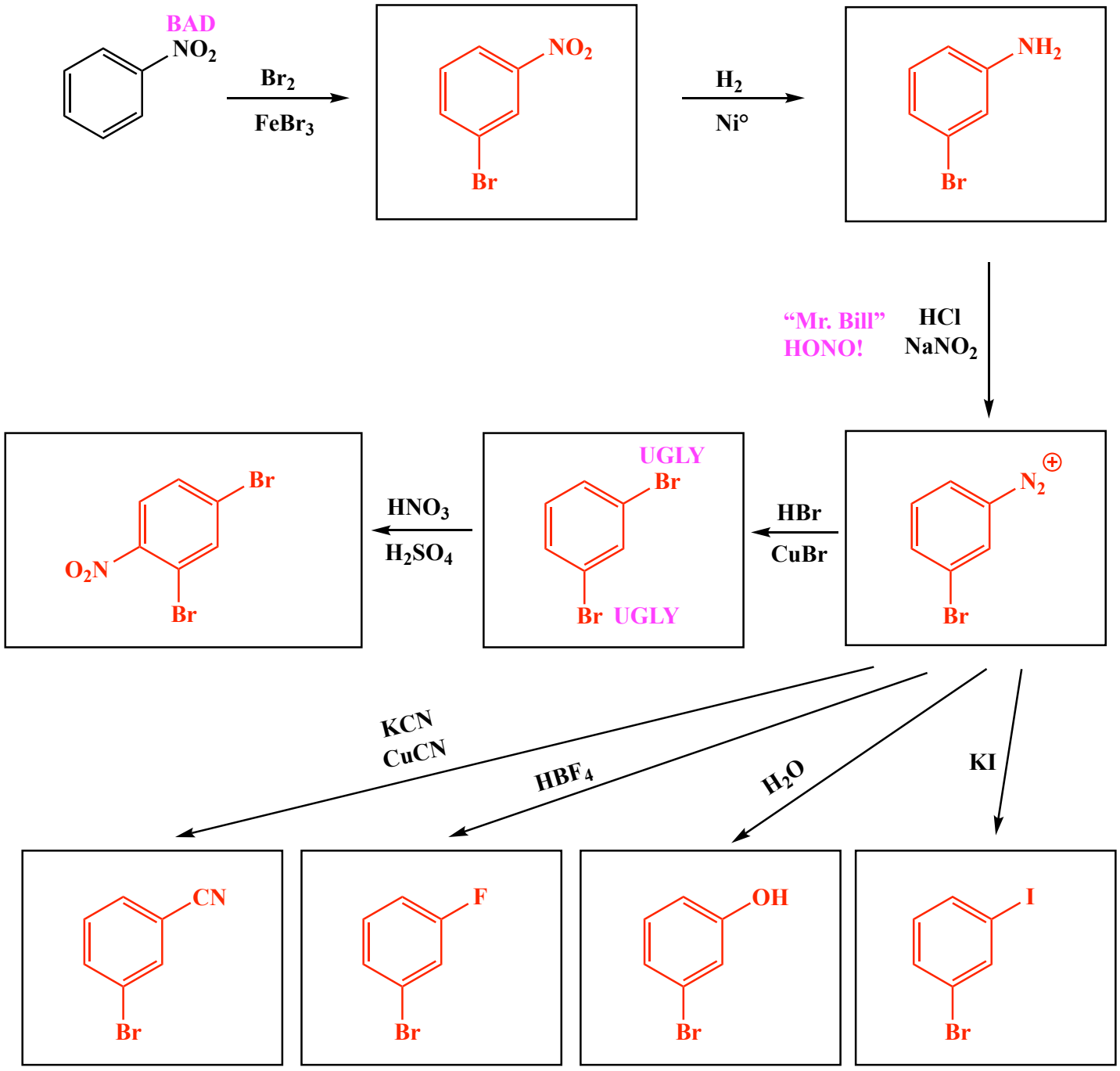
11. (34 pts) Complete the mechanism for the following amide hydrolysis. **Be sure to show arrows to indicate movement of <u>all</u> electrons, write <u>all</u> lone pairs, <u>all</u> formal charges, and <u>all</u> the products for each step.** Remember, I said <u>all</u> the products for each step. **IF A NEW CHIRAL CENTER IS CREATED IN AN INTERMEDIATE OR PRODUCT, MARK IT WITH AN ASTERISK AND LABEL THE MOLECULE AS RACEMIC IF APPROPRIATE. In the boxes provided, write which of the 4 mechanistic elements describes each step (make a bond, break a bond, etc.).**



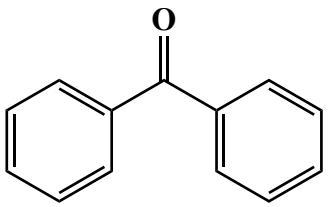
12. (3 or 5 pts.) Write the predominant product(s) that will occur for each transformation. If a new chiral center is created and a racemic mixture is formed, you must draw both enantiomers and write "racemic" under the structure. Use wedges (◀) and dashes (····|||) to indicate stereochemistry. For these, only write the principle organic products, do not include side products like ethanol, CO_2 or metal salts. **For all aldol reactions, we only want you to draw the dehydrated products.**



12 (cont.) (3 or 5 pts.) Write the predominant product(s) that will occur for each transformation. If a new chiral center is created and a racemic mixture is formed, you must draw both enantiomers and write "racemic" under the structure. Use wedges (◄) and dashes (·····) to indicate stereochemistry. For these, only write the principle organic products, do not include side products like ethanol, CO_2 or metal salts. **For all aldol reactions, we only want you to draw the dehydrated products.**



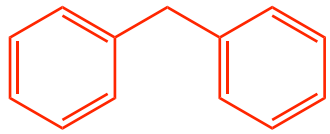
12 (cont.) (3 or 5 pts.) Write the predominant product(s) that will occur for each transformation. If a new chiral center is created and a racemic mixture is formed, you must draw both enantiomers and write "racemic" under the structure. Use wedges (◄) and dashes (·····) to indicate stereochemistry. For these, only write the principle organic products, do not include side products like ethanol, CO_2 or metal salts. **For all aldol reactions, we only want you to draw the dehydrated products.**

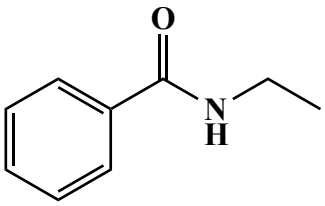


$H_2N\text{-}NH_2$

KOH

Wolff-Kischner

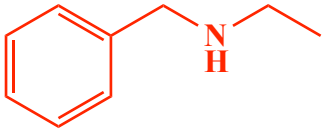


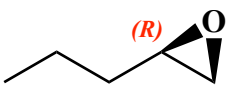


1) $LiAlH_4$

2) H_2O

Reduction





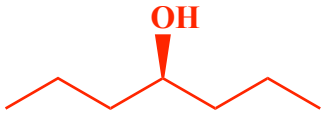
1) CH_3CH_2MgBr

ether

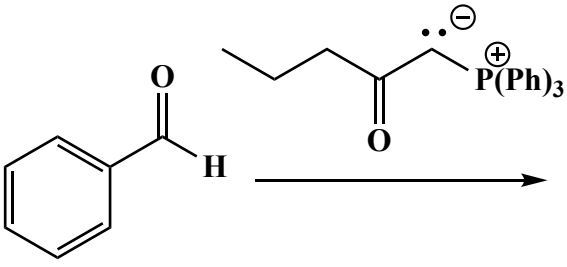
2) $H_3O^{\oplus}$

mild

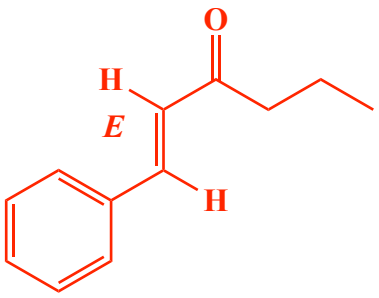
Grignard



(Not chiral!)

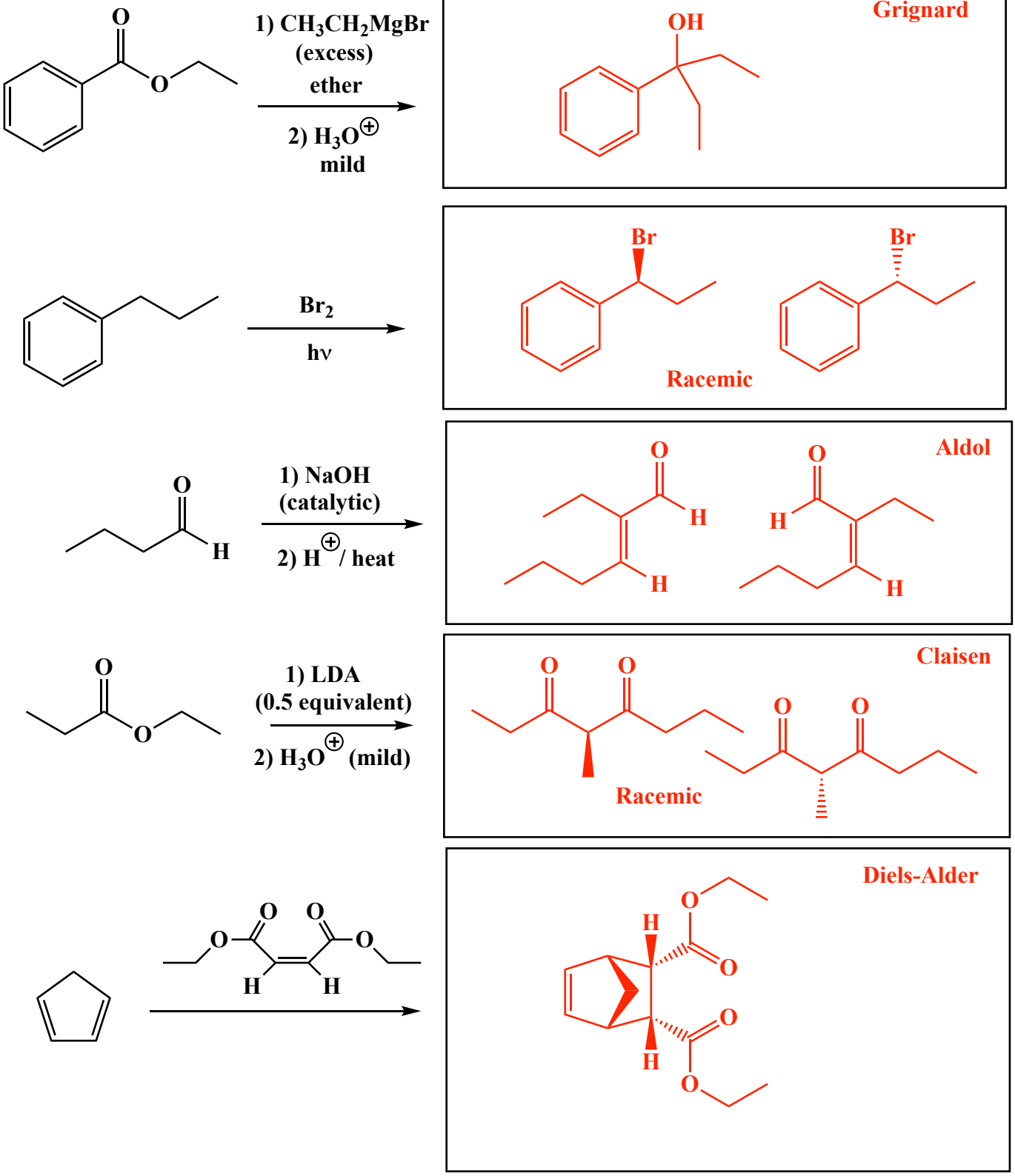


Wittig

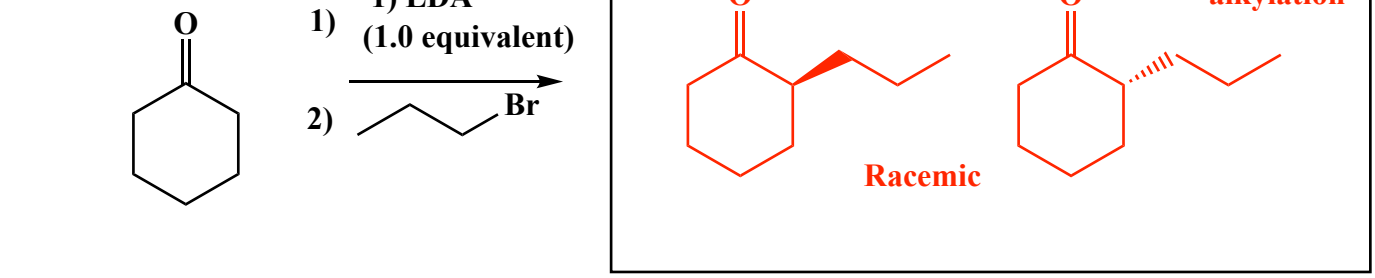


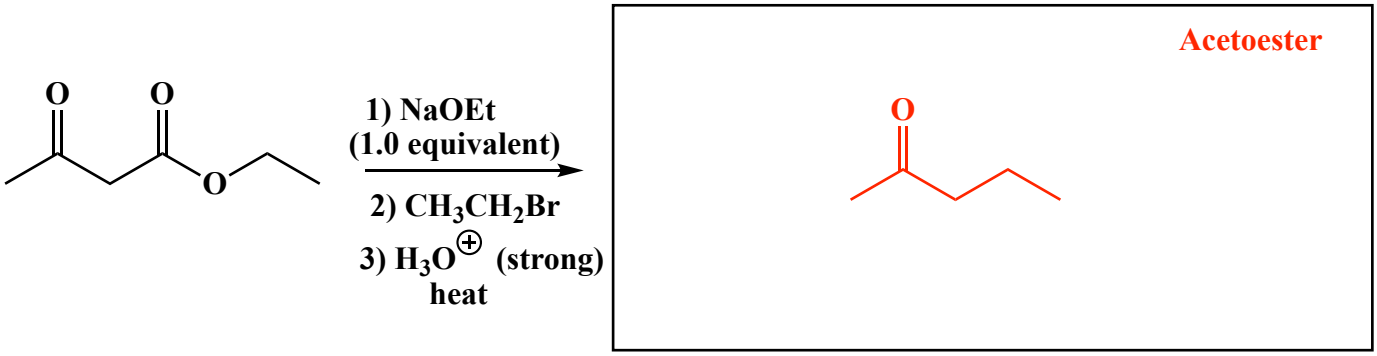
e

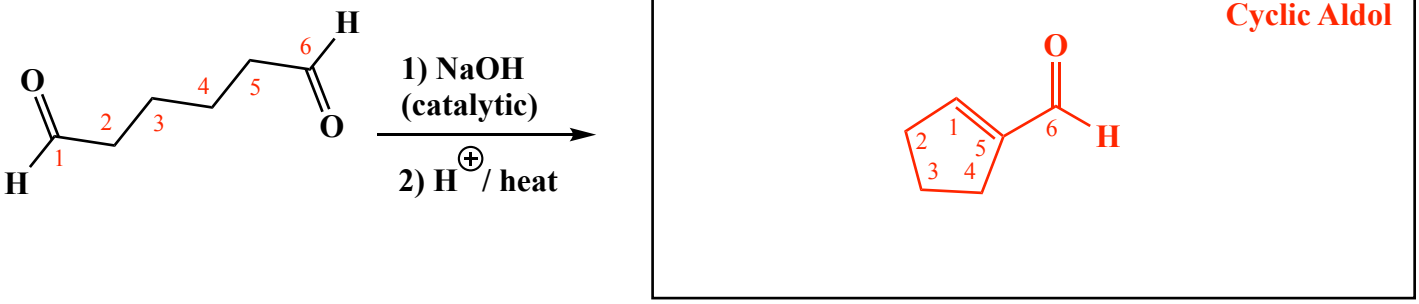
12 (cont.) (3 or 5 pts.) Write the predominant product(s) that will occur for each transformation. If a new chiral center is created and a racemic mixture is formed, you must draw both enantiomers and write "racemic" under the structure. Use wedges (◄) and dashes (····ıı) to indicate stereochemistry. For these, only write the principle organic products, do not include side products like ethanol, CO_2 or metal salts. **For all aldol reactions, we only want you to draw the dehydrated products.**

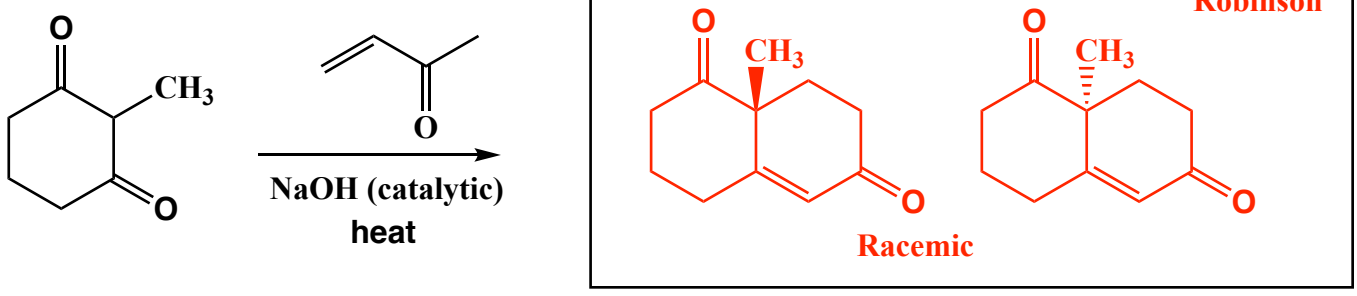


12 (cont.) (3 or 5 pts.) Write the predominant product(s) that will occur for each transformation. If a new chiral center is created and a racemic mixture is formed, you must draw both enantiomers and write "racemic" under the structure. Use wedges (◄) and dashes (·····) to indicate stereochemistry. For these, only write the principle organic products, do not include side products like ethanol, CO_2 or metal salts. **For all aldol reactions, we only want you to draw the dehydrated products.**



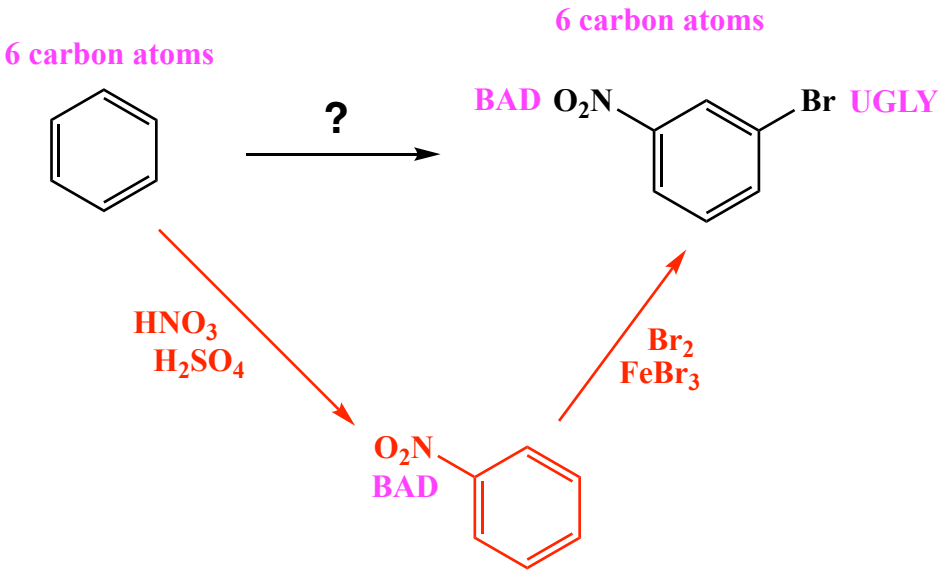






13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. You must draw all stereoisomers formed, and use wedges and dashes to indicate chirality at each chiral center. Write racemic when appropriate. **All the carbons of the product must come from carbons of the starting material.**

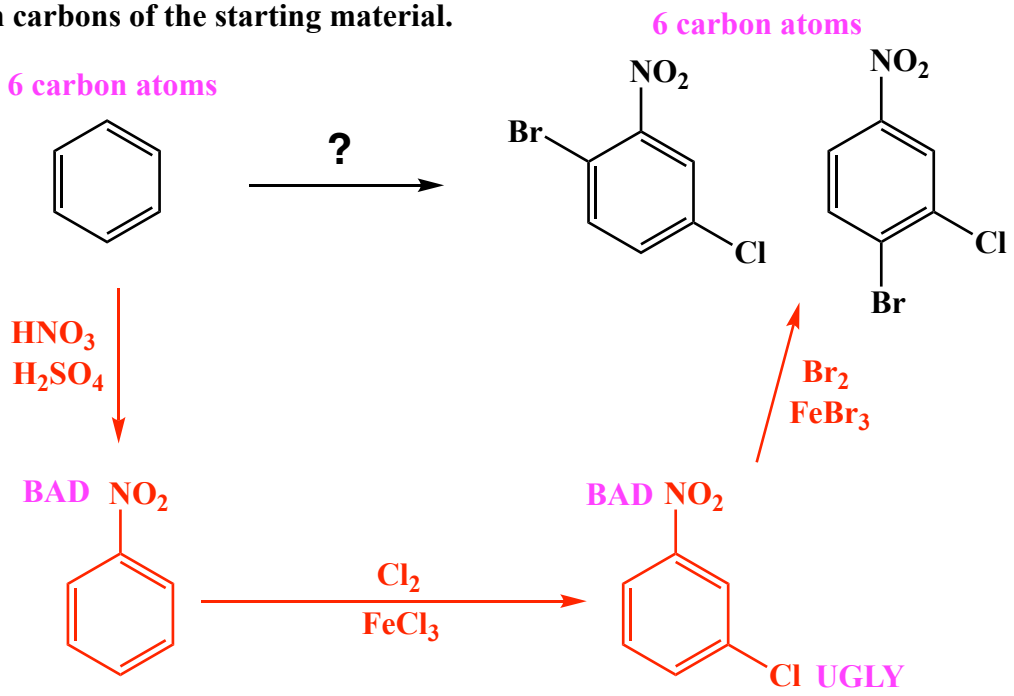
A) (4 pts)



Recognize that the product has both a nitro (BAD) and a bromo group (UGLY) that are meta to each other. Therefore, you will need to add the nitro group first, as only BAD groups like nitro will give predominantly meta products.

13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. You must draw all stereoisomers formed, and use wedges and dashes to indicate chirality at each chiral center. Write racemic when appropriate. **All the carbons of the product must come from carbons of the starting material.**

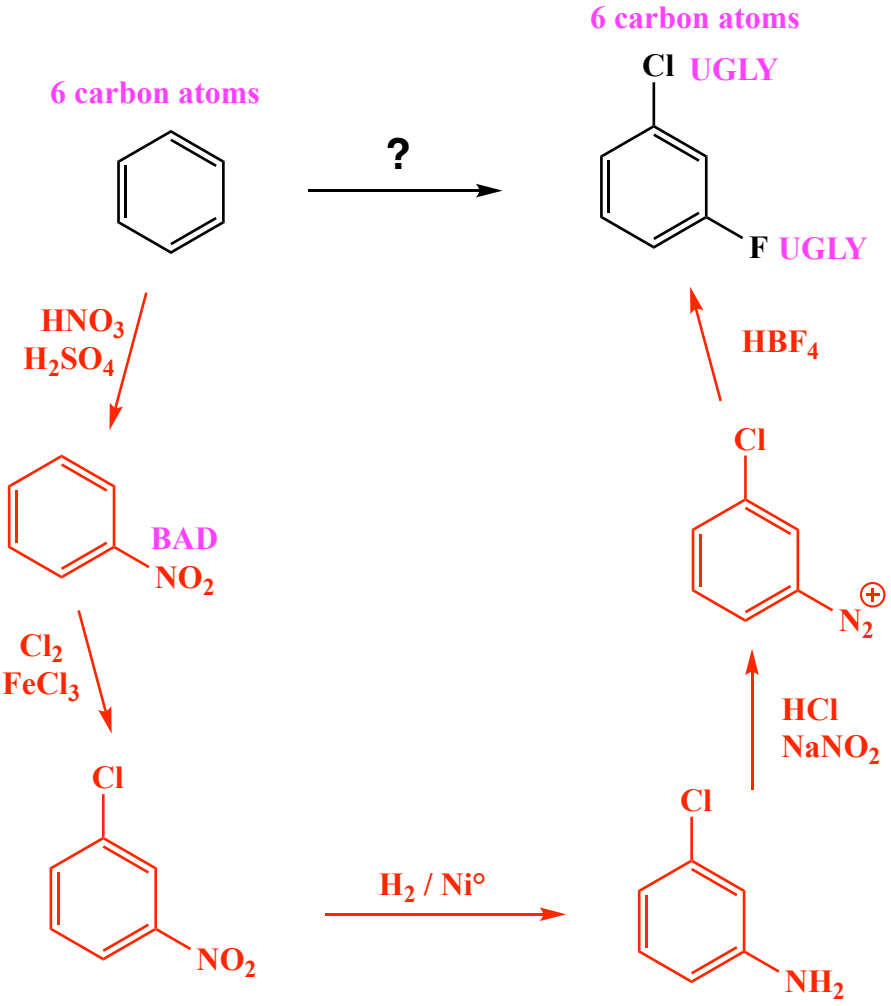
B) (7 pts)



Recognize that this is harder than it looks because only one sequence of reactions gives the desired two products. In particular, recognize that the nitro and chloro groups are meta to each other, so the BAD nitro group had to be added first using HNO_3 and H_2SO_4, followed by the chloro group using Cl_2 and $FeCl_3$. Only then can you add the bromo group using Br_2 and $FeBr_3$, as the UGLY chloro group will direct the Br ortho and para to itself as shown.

13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. You must draw all stereoisomers formed, and use wedges and dashes to indicate chirality at each chiral center. Write racemic when appropriate. **All the carbons of the product must come from carbons of the starting material.**

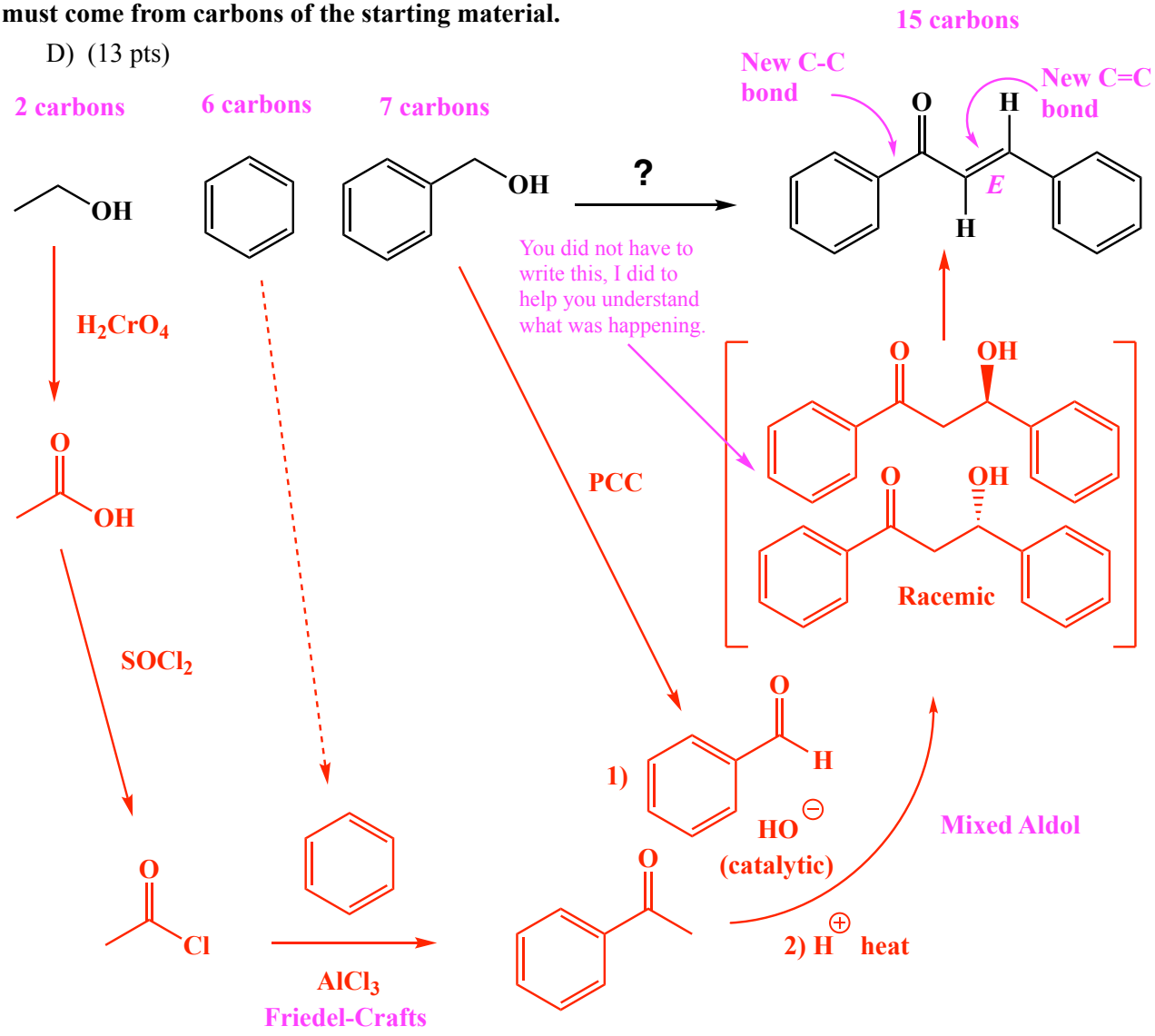
C) (13 pts)



Recognize the product has two UGLY groups that are meta to each other, so there is no way to make this product using electrophilic aromatic substitution reactions directly. Instead, assume you need to call "Mr. Bill" and use a diazonium reaction. In particular, **recognize** that you only know how to make F- derivatives of benzene using HBF_4 from a diazonium, so assume that is the last step of the synthesis. Assume the only way to get the required meta-substituted chloro diazonium derivative is to start with a nitration reaction using HNO_3 and H_2SO_4, putting the BAD nitro group on first followed by the Cl_2 $FeCl_3$ reaction to give meta substitution. H_2/Ni followed by "Mr. Bill, HONO!!!" (HCl, $NaNO_2$) gives the needed meta-substituted diazonium.

13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. You must draw all stereoisomers formed, and use wedges and dashes to indicate chirality at each chiral center. Write racemic when appropriate. **All the carbons of the product must come from carbons of the starting material.**

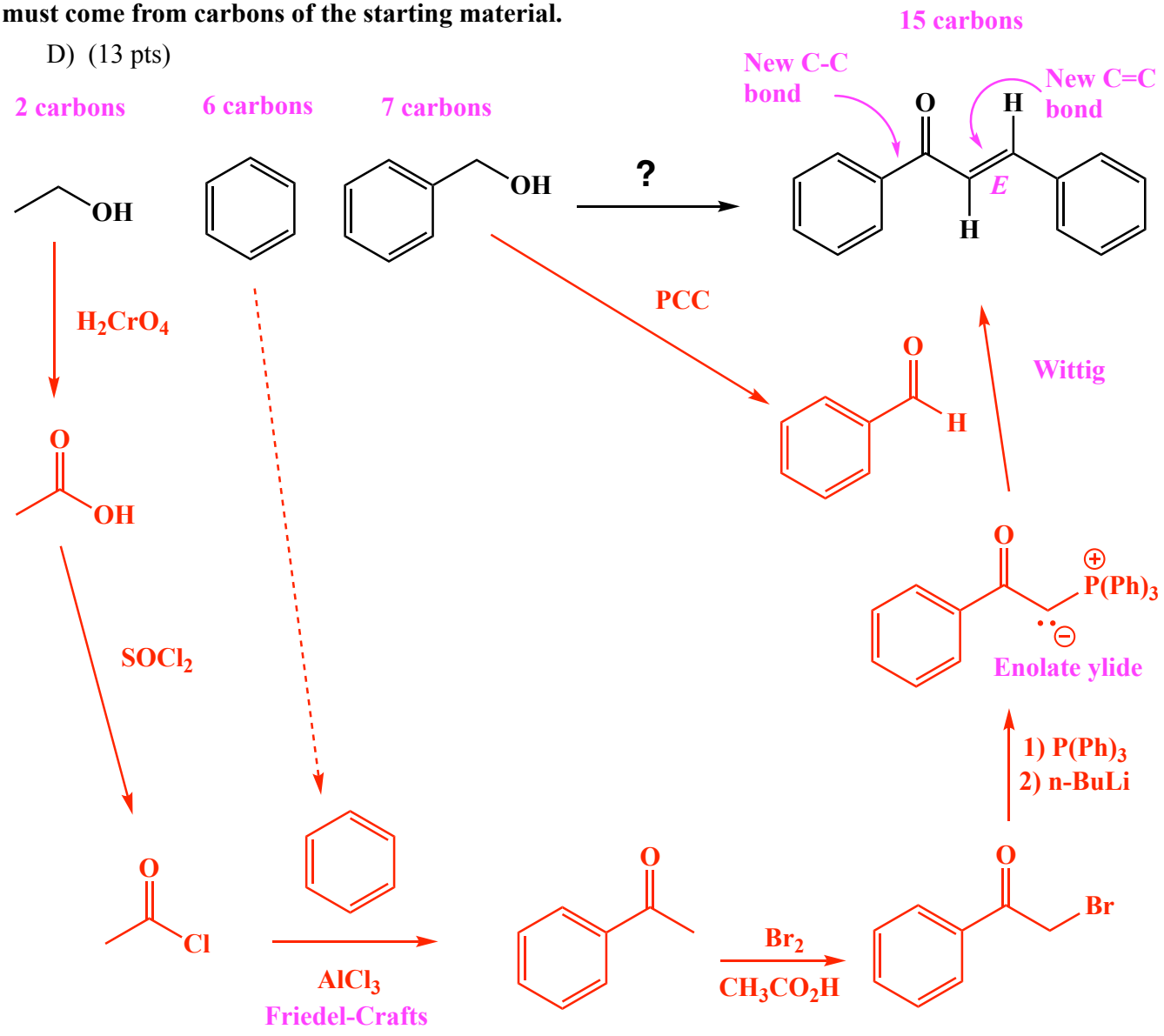
D) (13 pts)



Recognize that the product has 15 carbon atoms, while the starting materials have 2 carbons, 6 carbons, and 7 carbons (=15 carbons!). Therefore, assume each carbon of each starting material is part of the product, with new C=C and C-C bonds as indicated. **Recognize** the product as an α,β-unsaturated carbonyl, the KRE of an aldol reaction followed by dehydration. In this case, you need to see the aldol product is actually from a mixed aldol reaction as shown. This works because the required methyl ketone can make an enolate, but cannot react with itself while the aldehyde (benzaldehyde) can react with an enolate but it cannot make an enolate itself. We will therefore see a very high yield of the mixed aldol as shown. Note also that the product is *E* only and not a mixture of *E* and *Z*, because in this case the *E* stereoisomer (no steric strain at all) is so much more stable than the *Z* stereoisomer (significant steric strain). The benzaldehyde needed for the mixed aldol can be made from the starting benzyl alcohol using PCC. **Recognize** that the required methyl ketone can be made from the starting benzene using a Friedel-Crafts acylation reaction, and the required acid choride needed for that can be made by reaction of acetic acid with $SOCl_2$. The acetic acid can be made from the starting ethanol using H_2CrO_4.

13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. You must draw all stereoisomers formed, and use wedges and dashes to indicate chirality at each chiral center. Write racemic when appropriate. **All the carbons of the product must come from carbons of the starting material.**

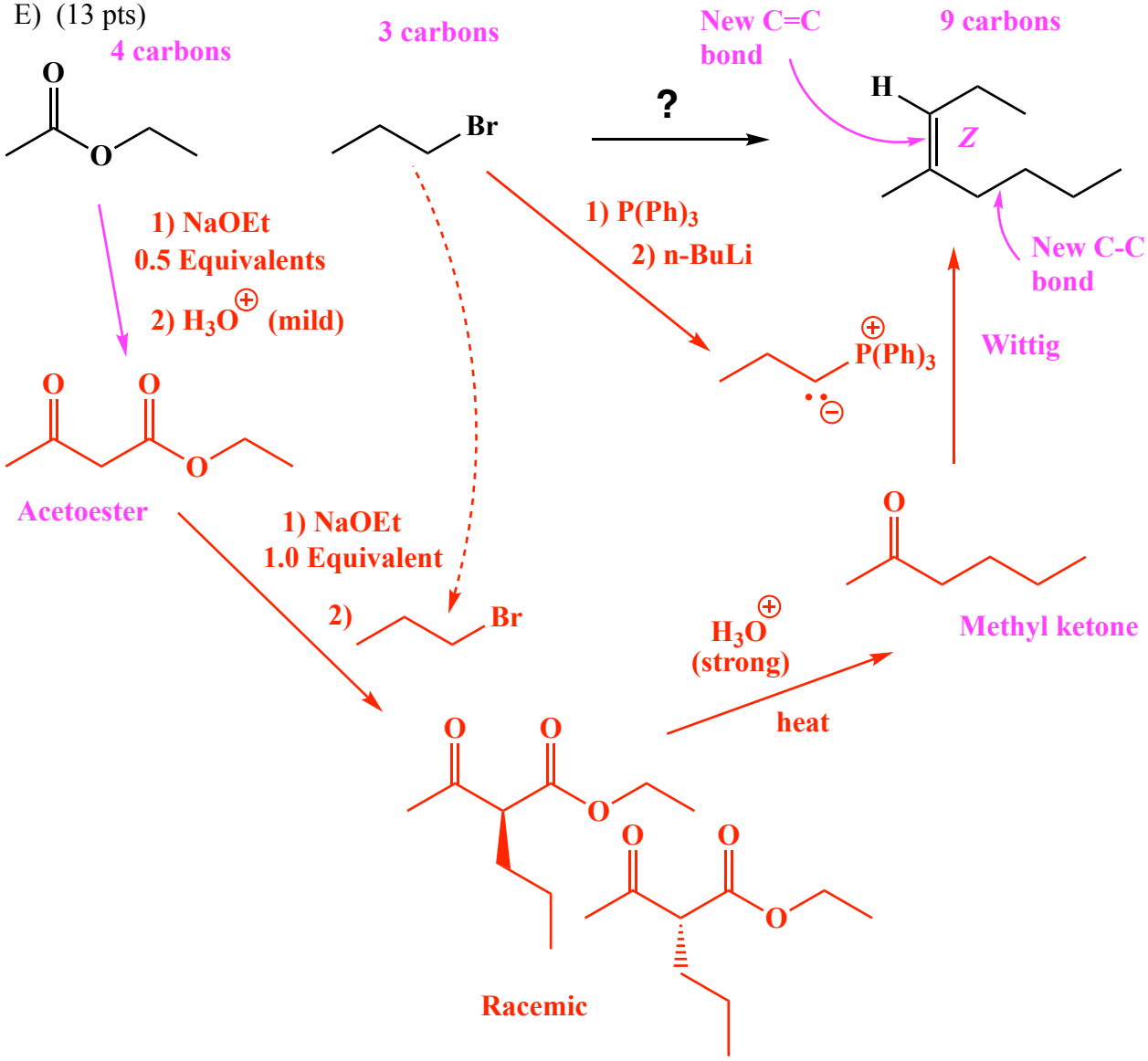
D) (13 pts)



There is an alternative way to make this product that gets full credit! **Recognize** again that the product has 15 carbon atoms, while the starting materials have 2 carbons, 6 carbons, and 7 carbons (=15 carbons!). Therefore, assume each carbon of each starting material is part of the product, with new C=C and C-C bonds as indicated. This time, **recognize** the product as an *E* alkene with a conjugated carbonyl, the KRE of a Wittig reaction using the enolate ylide Wittig reagent as shown (enolate ylides give *E* alkene products). **Recognize** that the enolate ylide Wittig reagent can be made from the corresponding bromomethyl ketone, which can be made from the methyl ketone using the alpha halogenation reaction with Br_2 and CH_3CO_2H. The benzaldehyde needed for the last Wittig step can be made from the starting benzyl alcohol using PCC. **Recognize** that the required methyl ketone can be made from the starting benzene using a Friedel-Crafts acylation reaction, and the required acid choride needed for that can be made by reaction of acetic acid with $SOCl_2$. The acetic acid can be made from the starting ethanol using H_2CrO_4.

13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. You must draw all stereoisomers formed, and use wedges and dashes to indicate chirality at each chiral center. Write racemic when appropriate. **All the carbons of the product must come from carbons of the starting material.**

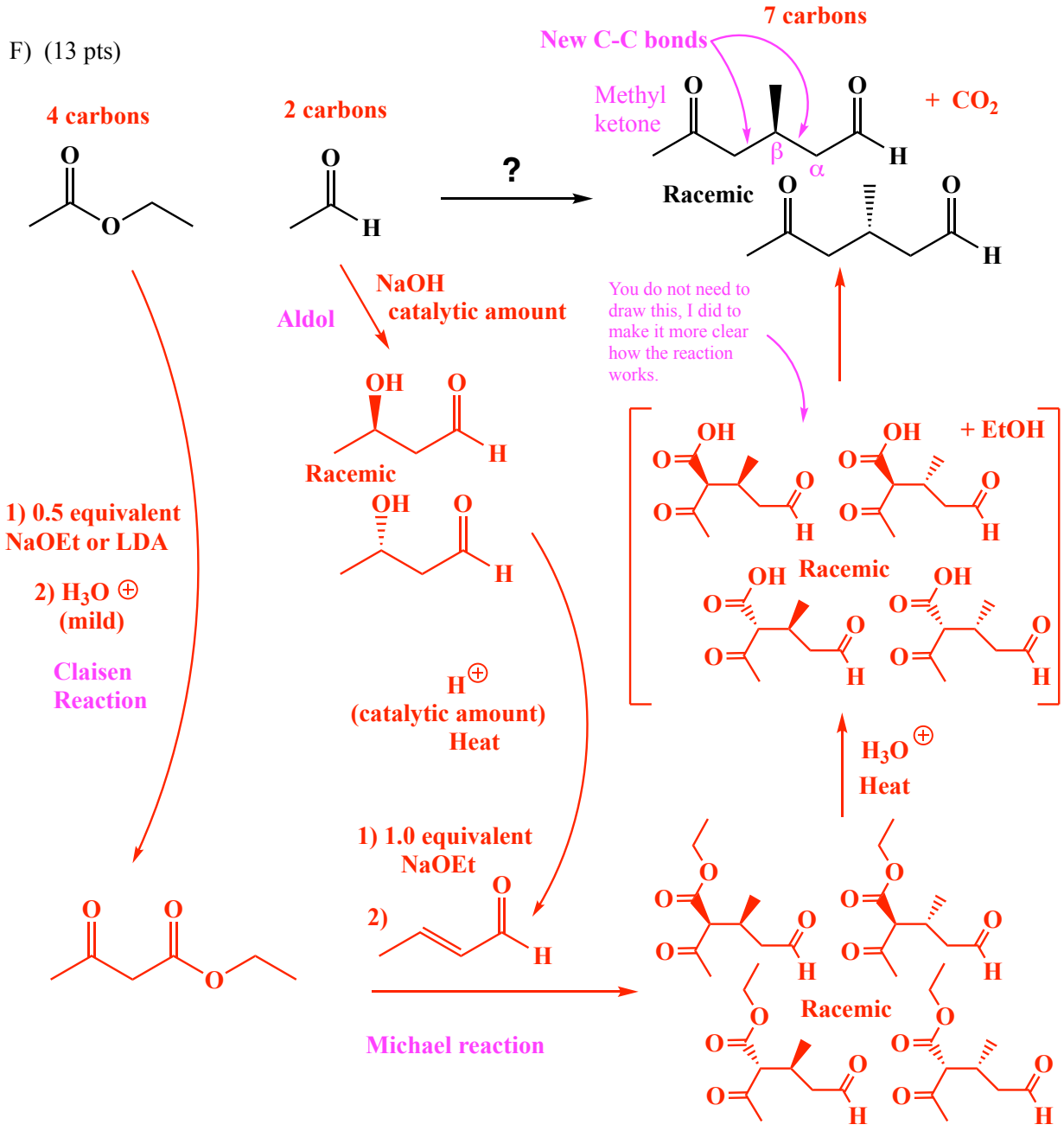
E) (13 pts)



Recognize That the final product has 9 carbons, while the starting materials have 4 and 3 carbons, respectively. Predict there are new C=C and C-C bonds as indicated because that involves adding three carbon units that can be derived from the 1-bromopropane starting material. **Recognize** the produce as a Z alkene, the KRE of a Wittig reaction between a three-carbon Wittig reagent and the methyl ketone shown. The three-carbon Wittig reagent can be made from the starting 1-bromopropane by reaction with $P(Ph)_3$ followed by n-BuLi. **Recognize** the methyl ketone as the KRE of an acetoester synthesis, following addition of 1-bromopropane to the enolate of acetoester followed by hydrolysis of the ethyl ester and decarboxylation. Acetoester is made from a Claisen reaction using the starting ester as shown.

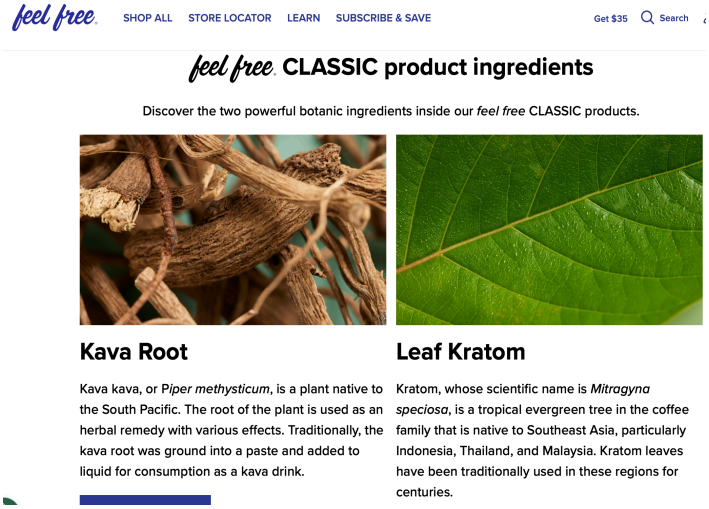
13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. You must draw all stereoisomers formed, and use wedges and dashes to indicate chirality at each chiral center. Write racemic when appropriate. **All the carbons of the product must come from carbons of the starting material. (Hint: This was on the third midterm!)**

F) (13 pts)

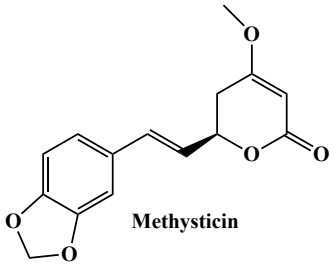


Recognize that the product is an ester with 7 carbon atoms, and the starting materials has 4 carbon atoms and 2 carbons, no much help here other than telling you there will be two new carbon-carbon bonds made somehow. Recognize the product as a methyl ketone, the KRE of an acetoester synthesis. **Recognize** further that the product has a new carbon-carbon bond that is at the ®-carbon of the aldehyde carbonyl on the other end of the molecule, the KRE of a Michael reaction. **Recognize** the acetoester as the nucleophile for the Michael reaction. Therefore propose the last step is an ester hydrolysis /decarboxylation after a Michael reaction using the ⟨,®-unsaturated aldehyde derived from the starting acetaldehyde through an aldol followed by dehydration. The acetoester is made from the starting ethyl acetate via a Claisen reaction.

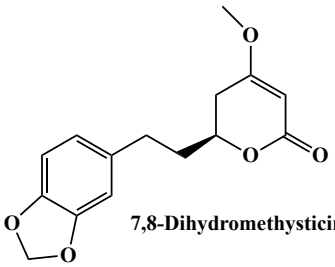
14. (8 pts) Here is an "apply what you know" problem with an important message. There is a long history of beverage companies selling drinks with addictive components before those components were studied and laws written to make the practice illegal. Coca cola started as a drink with around 9 milligrams of actual cocaine in it! Of course, that was outlawed and there is no cocaine in Coca Cola products today. The problem is that there are many different possible drinks or teas that can be made from plants that have pharmacologically active ingredients, and it takes a while for the science and the laws to catch up! **Currently, a number of these drinks, with known dangerous chemicals that are not yet illegal, are disguised and marketed as energy drinks.** One that is currently being marketed to college students **like you** is called Feel Free. *Until recently it was a sponsor of UT Athletics despite several of us raising concerns with the UT President at the time.* I wish I was making that up! Feel Free is packaged and marketed to college students to look exactly like a Red Bull or 5-Hour energy drink and the advertisements sound the same as well. BUT FEEL FREE IS NO ENERGY DRINK. Instead of caffeine and B vitamins, which are safe in reasonable amounts (do not drink too many energy drinks in one day, know your caffeine limits!), Feel Free has only dangerous plant extracts from Kava roots and Kratom leaves. These are very bad news as will be explained below.



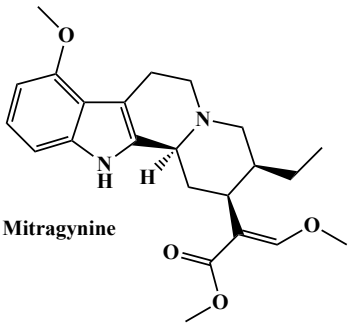
Both Kava and Kratom are well known to the people of the South Pacific Islands and Indonesia, respectively. Kava has a series of active ingredients, especially methysticin and 7,8-dihydromethysticin. Kratom has mitragynine, which is metabolized in your body to produce 7-hydroxymitragynine.



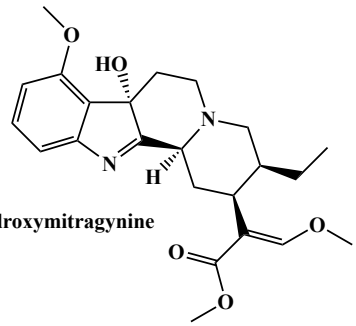
Methysticin



7,8-Dihydromethysticin



Mitragynine



7-Hydroxymitragynine

Methysticin and 7,8-dihydromethysticin are known to interact with GABA neurons, just like serious drugs such as vallium and other so-called benzodiazepines, which are pscychoactive and therefore only available legally with a doctor's prescription. Mitragynine and especially 7-hydroxy-mitragine are known to bind to the mu-opioid receptor, the exact target of the opioids morphine and fentanyl! Many people have reported being addicted to Feel Free, including experiencing serious withdrawal symptoms that are similar to opioid withdrawal. And at about $13 dollars per bottle, Feel Free is as expensive as a drug habbit, with addicts needing several bottles a day to avoid withdrawal symptoms.

Various Kava extracts are also known to cause serious liver damage as well as increasing your chances of cancer. And Feel Free will block the metabolism of other drugs by interacting with your P_{450} enzymes, thereby increasing the potency of these other drugs, so accidental overdoses involving Feel Free in combination with other drugs are all too common. Very sad.

Here are the questions:

Methysticin and 7,8-dihydromethysticin have two different functional groups that make the rings on either end of the molecule. Look at the structures on the previous page and fill in the circle that accurately describes the two functional groups that make two rings of methysticin and 7,8-dihydromethysticin. (Ignore the benzene ring)

- ◯ **hemiacetal and lactone**
- ● **acetal and lactone**
- ◯ **hemiacetal and acetal**
- ◯ **two acetals**

Mitragynine and 7-hydroxymitragine are chiral compounds. Look at the two structures and determine the number of chiral centers in each. Note, for this one you need to realize that a nitrogen bonded to three different carbon atoms cannot be chiral (the lone pair can move so the chirality of the N atom is not fixed)! In other words, only the carbon atoms of mitragynine and 7-hydroxymitragine can be chiral centers.

- ◯ **Mitragynine has 3 chiral centers and 7-hydroxymitragynine has 3 chiral centers**
- ◯ **Mitragynine has 4 chiral centers and 7-hydroxymitragynine has 3 chiral centers**
- ● **Mitragynine has 3 chiral centers and 7-hydroxymitragynine has 4 chiral centers**
- ◯ **Mitragynine has 4 chiral centers and 7-hydroxymitragynine has 4 chiral centers**

If you know someone who is drinking these so-called "botanical tonics" like Feel Free as if they were energy drinks, you should consider getting them help by calling SHIFT here at UT or any other substance misuse resource. **My friends at SHIFT tell me there has been a recent increase in the number of students trying to reduce their Kratom use, but they are having difficulty because of dependency (addiction).** And remember, you can get a dose of Narcan at the PCL circulation desk. It is free of charge and no questions will be asked. Please do this even if you don't think you will ever need it. **You could save a life.** As I mentioned last week, a former student in the class took my advice and saved their brother's life because when it was needed, they happened to have the very same dose of Narcan I had told them how to obtain from PCL.

Like I said at the beginning of this exam, it has been an honor to be on this journey of Organic Chemistry discovery and learning with you. Have a wonderful summer break and remember: **Go see something that truly takes your breath away and also….run every chance you get!**