NAME (Print): _____

EID _____

SIGNATURE: _____

Chemistry 320N
3rd Midterm Exam
April 16, 2026

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 this semester so far! 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!

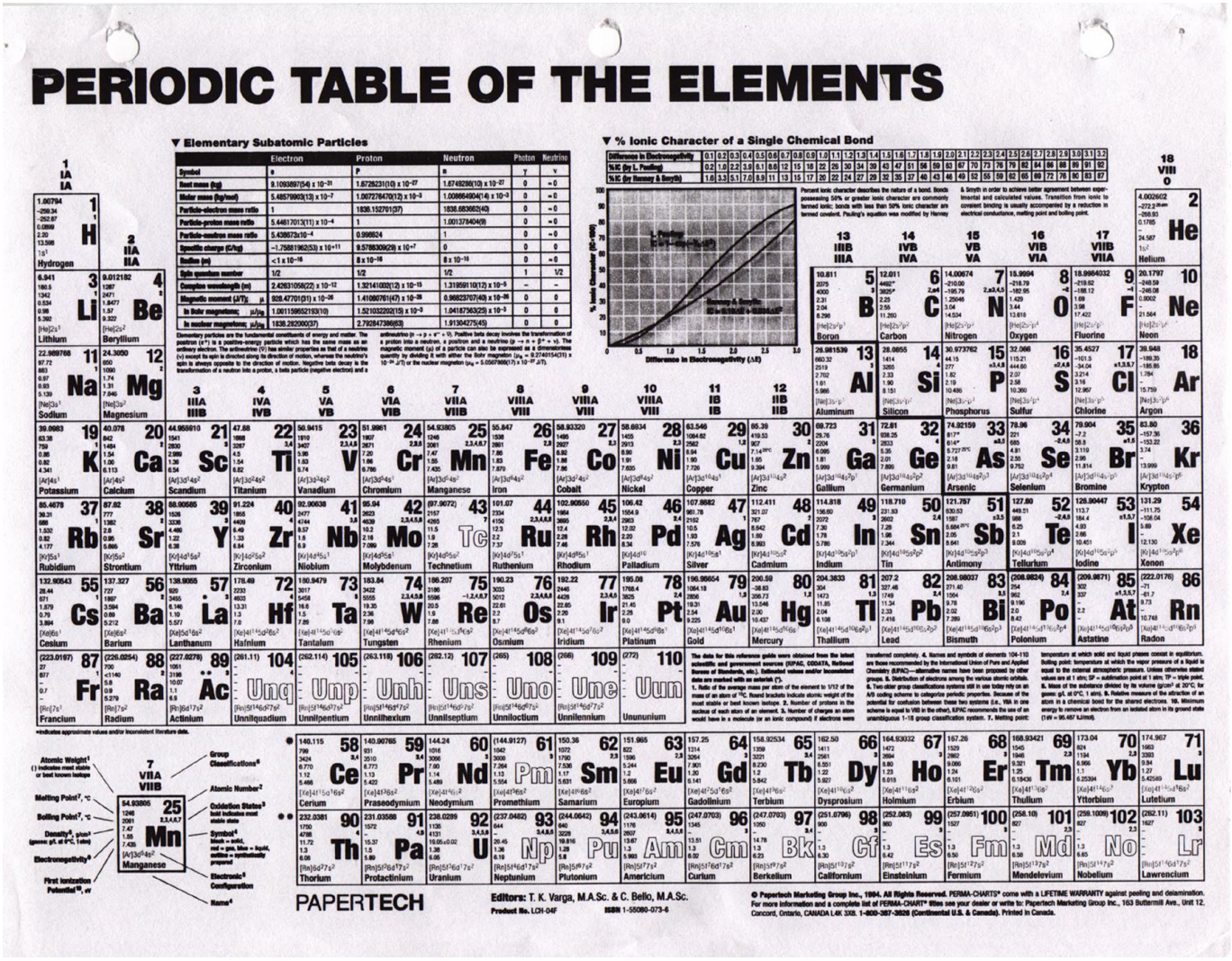
FINALLY, DUE TO SOME UNFORTUNATE RECENT INCIDENTS YOU ARE NOT ALLOWED TO INTERACT WITH YOUR CELL PHONE IN ANY WAY. IF YOU TOUCH YOUR CELL PHONE DURING THE EXAM YOU WILL GET A "0" NO MATTER WHAT YOU ARE DOING WITH THE PHONE. PUT IT AWAY AND LEAVE IT THERE!!!

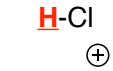
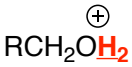
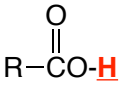
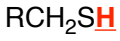
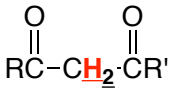
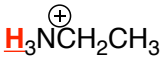
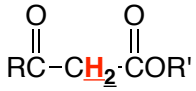
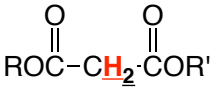
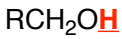
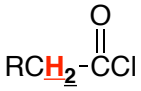
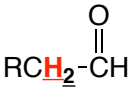
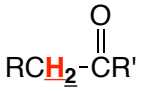
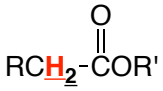
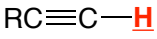
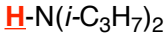
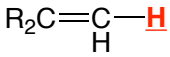
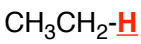
Student Honor Code

"As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity."

_____

(Your signature)

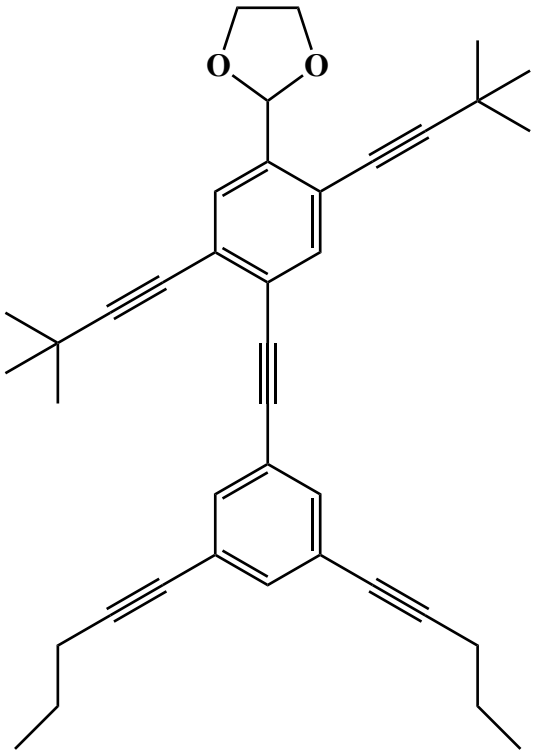


Compound		pK_a
Hydrochloric acid		-7
Protonated alcohol		-2
Hydronium ion		-1.7
Carboxylic acids		3-5
Thiols		8-9
Ammonium ion		9.2
β-Dicarbonyls		10
Primary ammonium		10.5
β-Ketoesters		11
β-Diesters		13
Water		15.7
Alcohols		15-19
Acid chlorides		16
Aldehydes		18-20
Ketones		18-20
Esters		23-25
Terminal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

Signature_____ Pg 1 _____(15)

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

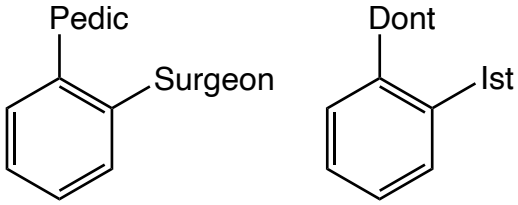
2. (10 pts) Amides are best represented as the hybrid of three contributing structures. Draw the second and third important contributing structures in the spaces provided. (No need to draw any arrows for this.)



2-(4-((3,5-di(pent-1-yn-1-yl)phenyl)ethynyl)-2,5-bis(3,3-dimethylbut-1-yn-1-yl)phenyl)-1,3-dioxolane

This is Fred (2-(4-((3,5-di(pent-1-yn-1-yl)phenyl)ethynyl)-2,5-bis(3,3-dimethylbut-1-yn-1-yl)phenyl)-1,3-dioxolane).

Fred is deciding on his future, and is choosing between either a medical or dental career while considering a couple specialties. Which should he choose?



3. (2 pts each) Fill in the the blanks with the word that best completes these sentences. You will recognize them as being Rules of the Day.

A. Think of electron density as _____, in which you can get extra stability when they add constructively, and you lose stability when they add destructively.

B. When adding wave equations, you generate as many new _____ orbitals as atomic orbitals used to create them.

C. For a reaction that is under _____ control, the major product is the product that is lower in energy.

D. For a reaction that is under _____ control, the major product is the product that is derived from the lower energy intermediate.

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

F. An _____ can be formed when a secondary amine reacts with a ketone or aldehyde at pH 4.

G. The energy absorbed by molecules when they absorb a photon is usually converted to _____ energy (they heat up)

H. _____ (glow in the dark) happens when the excited electron has flipped spins, and must reflip back before entering the original filled orbital while emitting a photon.

I. _____ occurs when there are not vibrations possible (a rigid molecule) so the photon is emited as the electron goes back to ground state.

J. The greater the number of pi bonds in conjugation, the _____ the energy difference between filled and unfilled orbitals, so the longer the wavelength of light that is absorbed.

3 (cont.). (2 pts each) Fill in the the blanks with the word that best completes these sentences. You will recognize them as being Rules of the Day.

K. The Robinson annulation is a _____ reaction followed by an _____ reaction to make a six-membered ring, ending with a _____ reaction.

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

M. The amount of base you add matters!! Only a _____amount of hydroxide is needed for an aldol to work, but at least _____ equivalents of alkoxide are needed for a Claisen to go to completion.

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

O. The 36 kcal/mol extra stability (unreactivity) of aromatic species derives from putting all the _____ electrons in low energy molecular orbitals that extend over the sp^2 hybridized ring atoms.

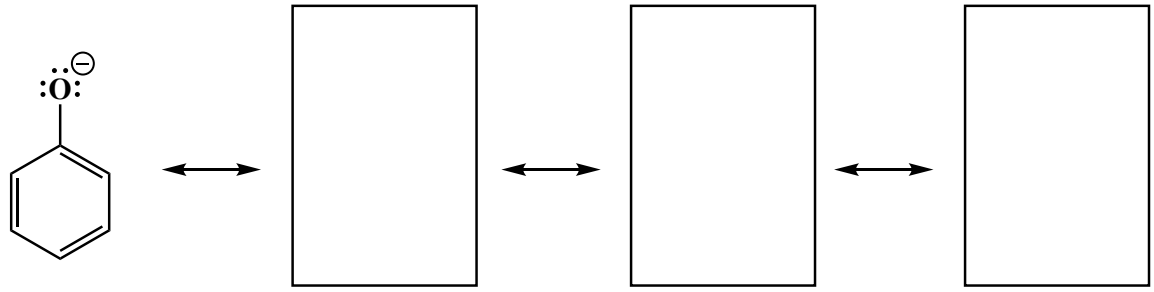
P. The _____ reaction creates two C-C bonds from a diene and dienophile, an alkene.

Q. If there are two groups on the ring, and they predict different products, then just like in the movie, _____ beats Ugly or Bad, and _____ beats Bad. Bad always loses. Because of steric hindrance, electrophiles never add between meta substituents.

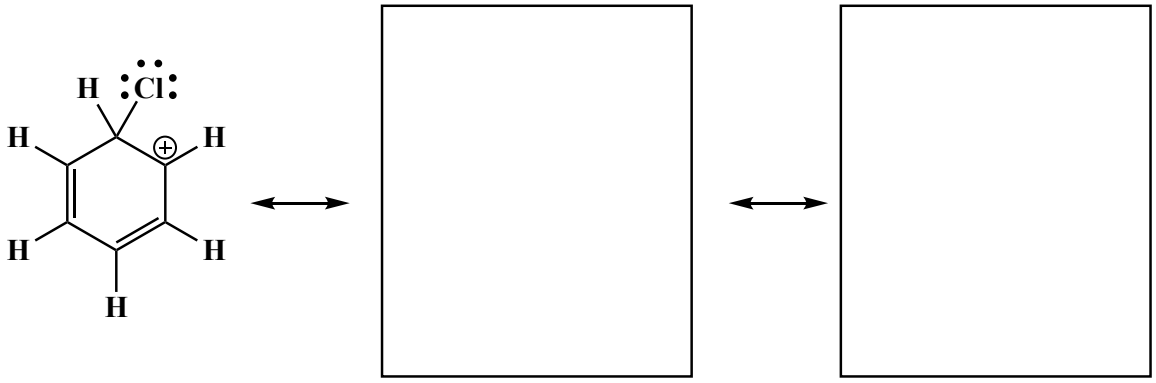
R. Because of pi delocalization, an amino group attached to a benzene ring is close to or fully _____. hybridized. This explains why the DNA bases are _____.

4. (18 pts) The following molecules are best represented as the hybrid of contributing structures. **Draw the other important contributing structure(s)** in the space(s) provided, including all lone pairs and formal charges. **For the structure(s) on the left, use arrows to indicate the movement of electrons to give the structure you drew immediately to the right.** You will not draw any arrows on each of the rightmost structures, but there will be arrows on all of the others.

A.

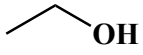


B.

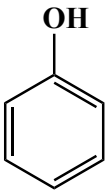


5. (2 pts each) For each pair of molecules, fill in the circle to indicate which one is the stronger acid.

A.

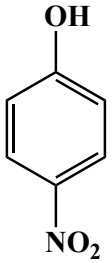


◯ **Stronger Acid**

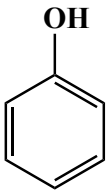


◯ **Stronger Acid**

B.

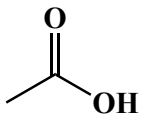


◯ **Stronger Acid**

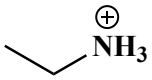


◯ **Stronger Acid**

C.

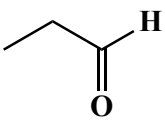


◯ **Stronger Acid**

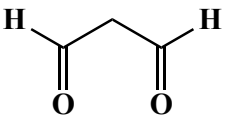


◯ **Stronger Acid**

D.



◯ **Stronger Acid**



◯ **Stronger Acid**

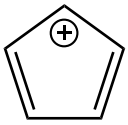
6. (1 pt each) Indicate whether each of the following molecules and ions is aromatic or not aromatic by filling in the appropriate circle.

◯ Aromatic
◯ Not aromatic

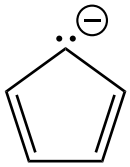
◯ Aromatic
◯ Not aromatic

◯ Aromatic
◯ Not aromatic

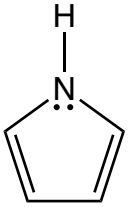
◯ Aromatic
◯ Not aromatic



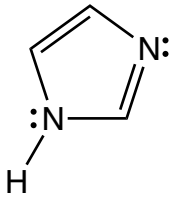
◯ Aromatic
◯ Not aromatic



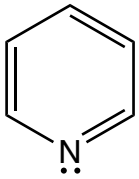
◯ Aromatic
◯ Not aromatic



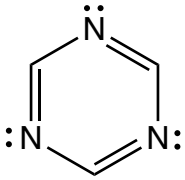
◯ Aromatic
◯ Not aromatic



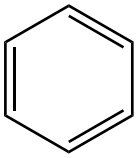
◯ Aromatic
◯ Not aromatic



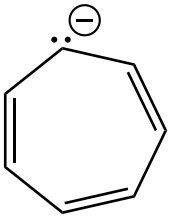
◯ Aromatic
◯ Not aromatic



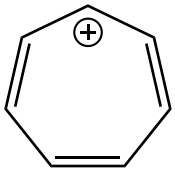
◯ Aromatic
◯ Not aromatic



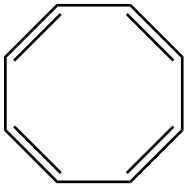
◯ Aromatic
◯ Not aromatic



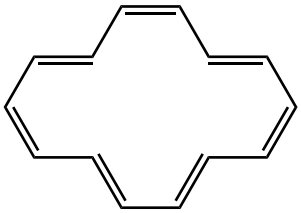
◯ Aromatic
◯ Not aromatic



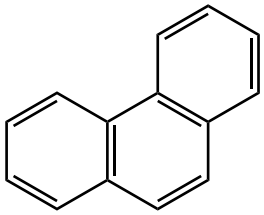
◯ Aromatic
◯ Not aromatic



◯ Aromatic
◯ Not aromatic

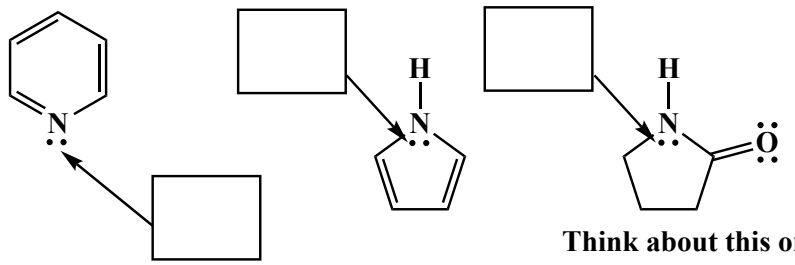


◯ Aromatic
◯ Not aromatic



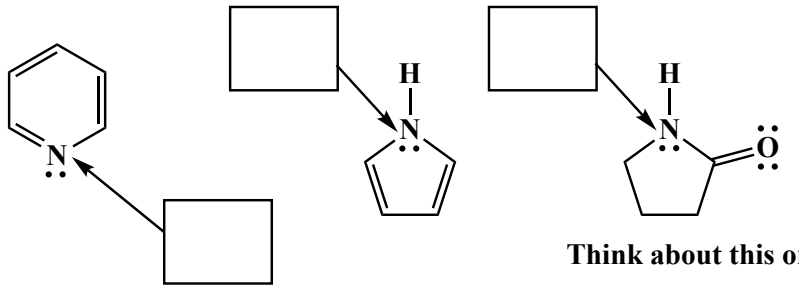
◯ Aromatic
◯ Not aromatic

7. (2 pts each) For each arrow, in the box 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.



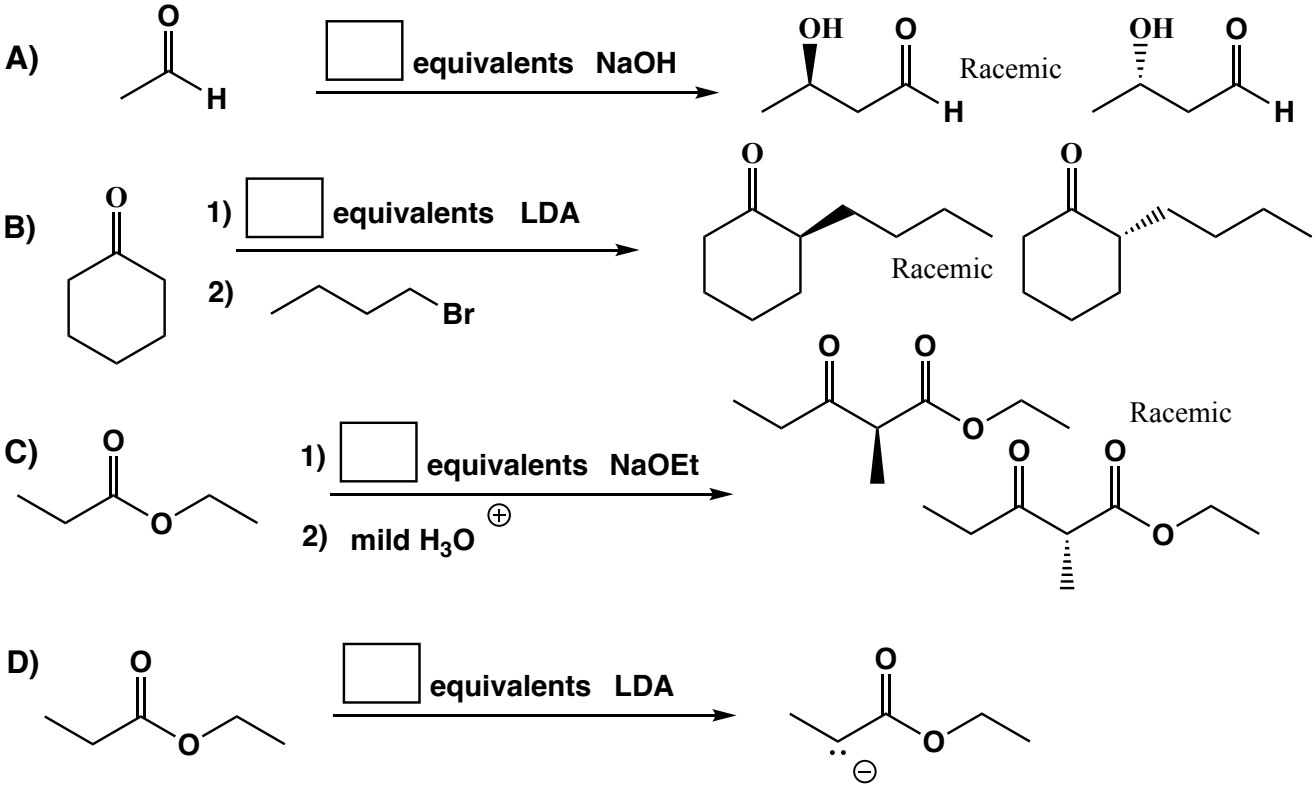
Think about this one!

8. (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.

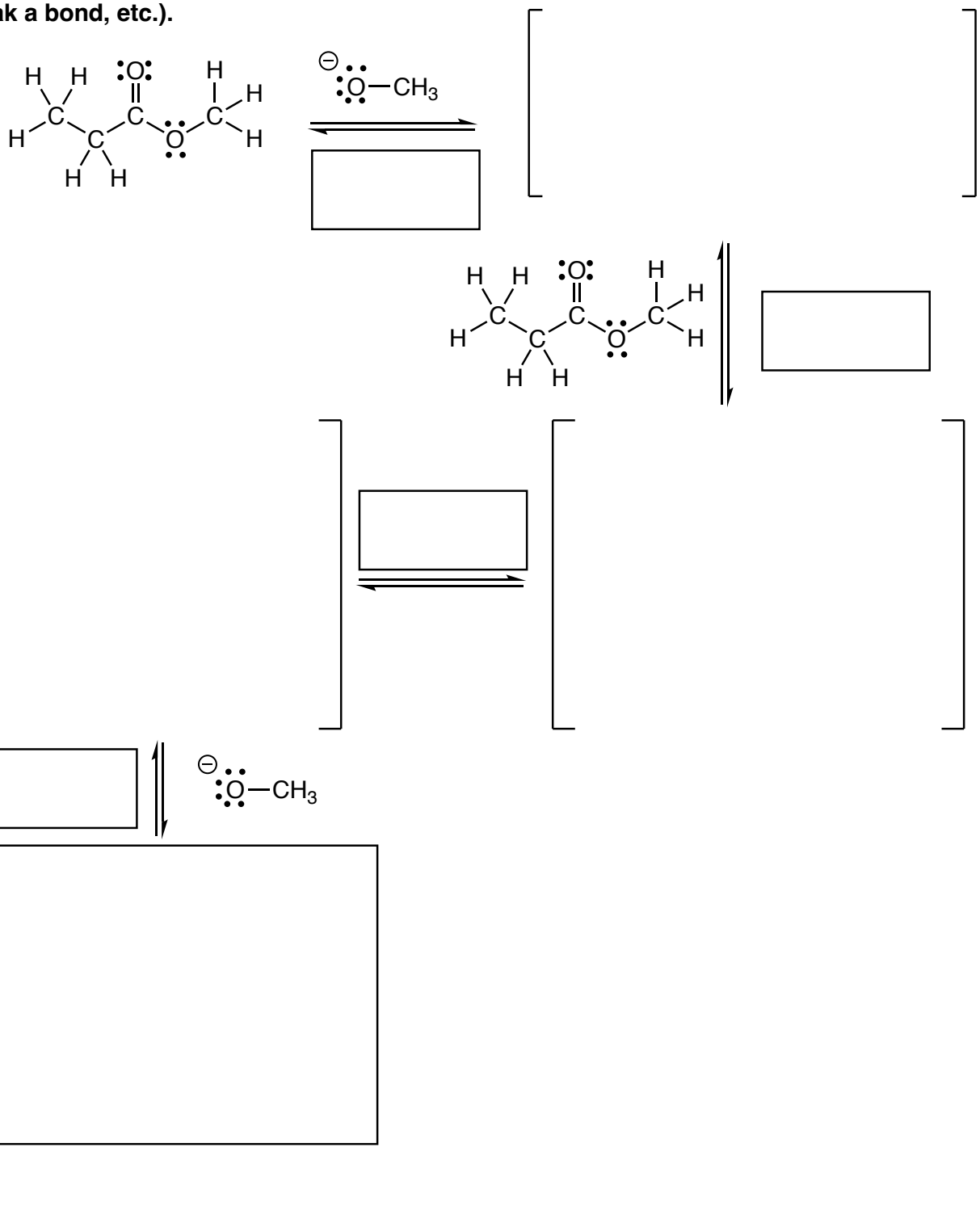


Think about this one!

9. (2 pts each) In each of the boxes over an arrow, write the minimum number of equivalents of the specified reagent required to carry out the reaction shown to completion. If only a catalytic amount is needed, write "CAT". **Note: You must assume the carbonyl compound starting material is initially present in an amount of 1.0 equivalent.**

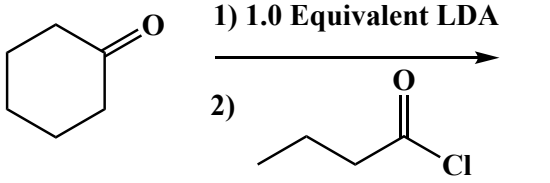


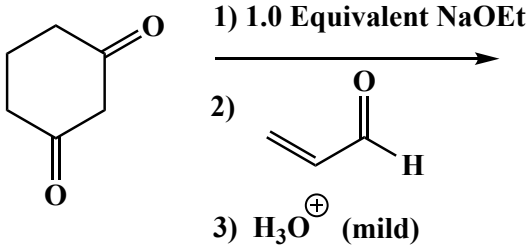
10. (25 pts) Complete the mechanism for the following Claisen condensation reaction. **Be sure to show arrows to indicate movement of <u>all</u> electrons, write <u>all</u> lone pairs, <u>all</u> formal charges, and <u>all</u> the products for each step.** Remember, I said <u>all</u> the products for 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.).**

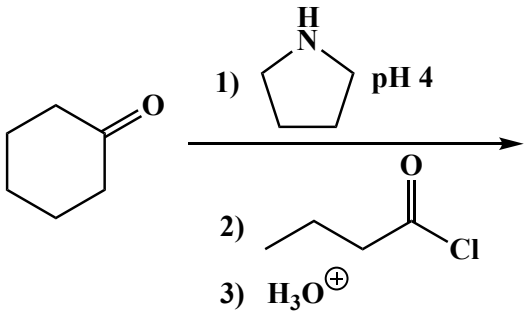


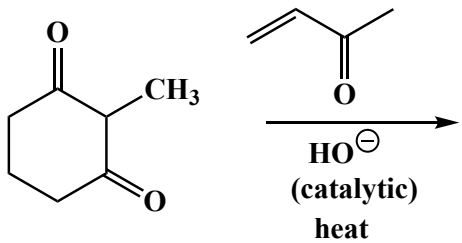
Signature_____ Pg 8 _____(18)

11. (3 or 5 pts.) Write the predominant product 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, you do not have to worry about metal salts in the products.

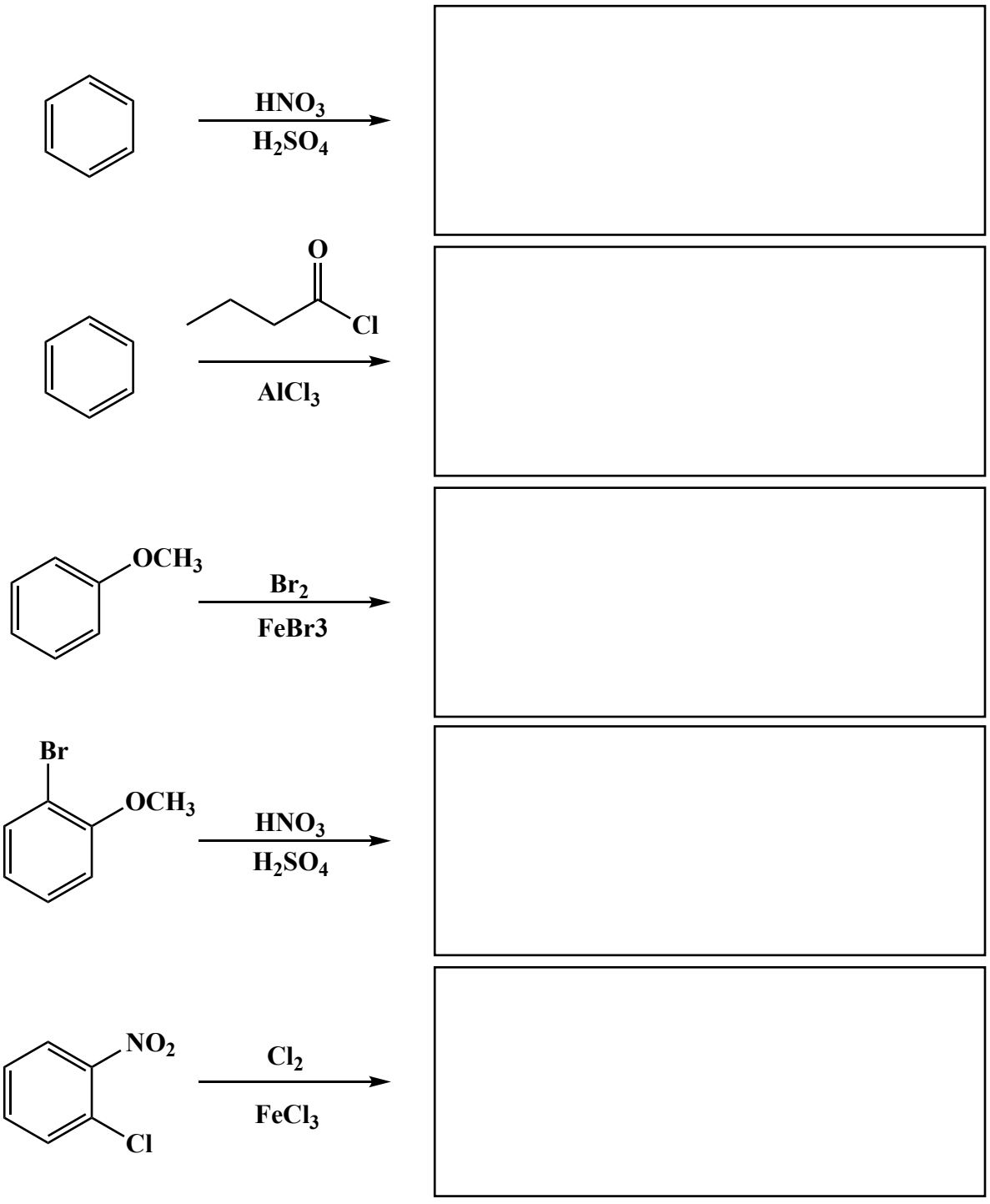




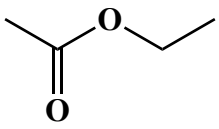




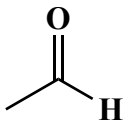
11. (3 or 5 pts.) Write the predominant product that will occur for each transformation. If a new chiral center is created and a racemic mixture is formed, **you must draw both enantiomers and write "racemic" under the structure**. Use wedges (◄) and dashes (····|||||) to indicate stereochemistry. For these, you do not have to worry about metal salts in the products.



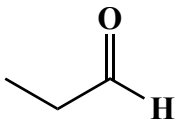
11. (3 or 5 pts.) Write the predominant product that will occur for each transformation. If a new chiral center is created and a racemic mixture is formed, **you must draw both enantiomers and write "racemic" under the structure**. Use wedges (◄) and dashes (····ıı) to indicate stereochemistry. For these, you do not have to worry about metal salts in the products.



1) NaOEt
0.5 equivalents
2) HCl / H_2O
mild

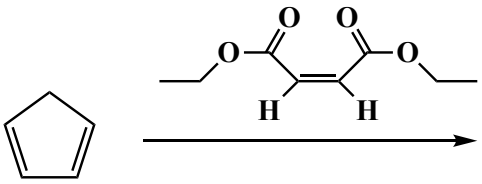


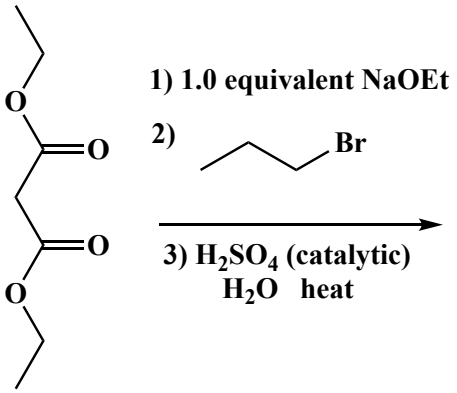
$HO^{\ominus}$
(catalytic)
(assume no dehydration)



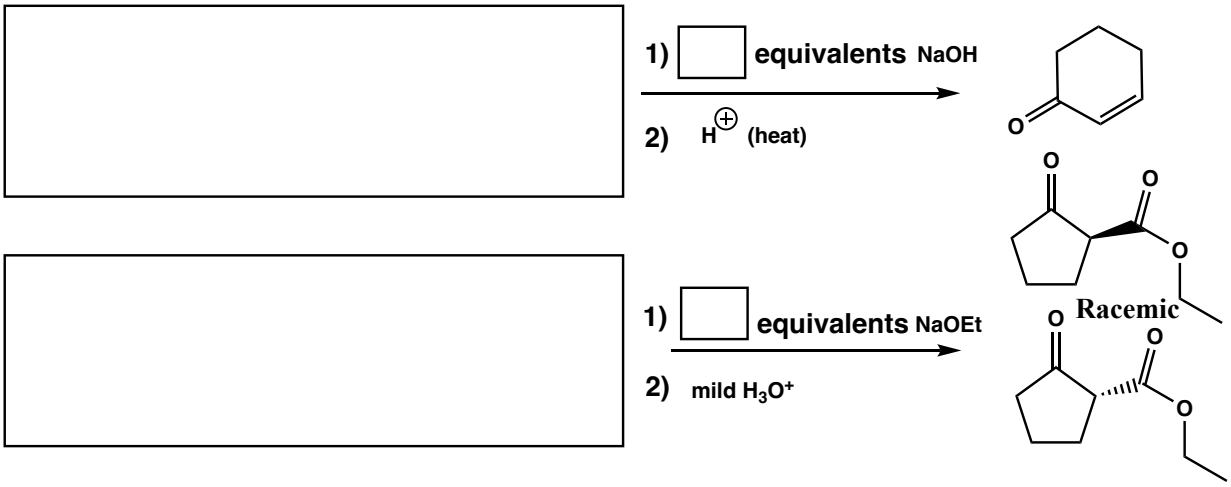
1) $HO^{\ominus}$
(catalytic)
2) $H^{\oplus}$
heat
(assume dehydration)

12. (4, 7 or 9 pts.) Write all of the organic 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, you need to write all of the products of the reactions except for the products containing metals.**



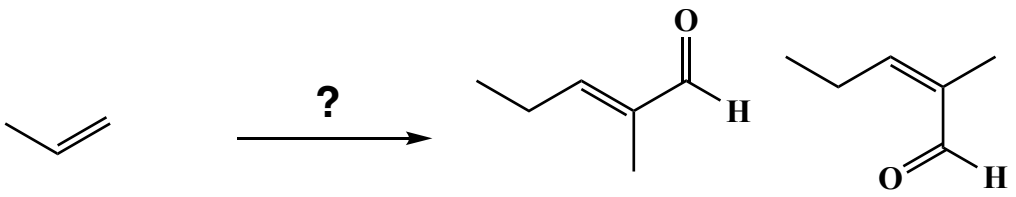


For the next two we have provided the product, you need to draw the starting material then fill in the minimum number of equivalents (or "Cat" if it is catalytic) for the reaction to occur.



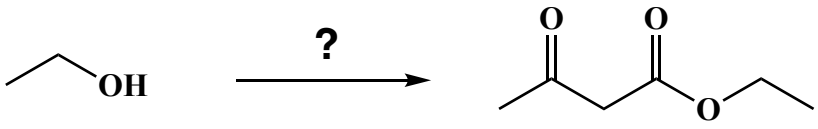
13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. **For this exam you do not need to draw each stereoisomer with wedges and dashes, you can just mark all chiral centers with an asterisk and write "racemic" when appropriate. All the carbons of the product must come from carbons of the starting material.**

A) (10 pts)



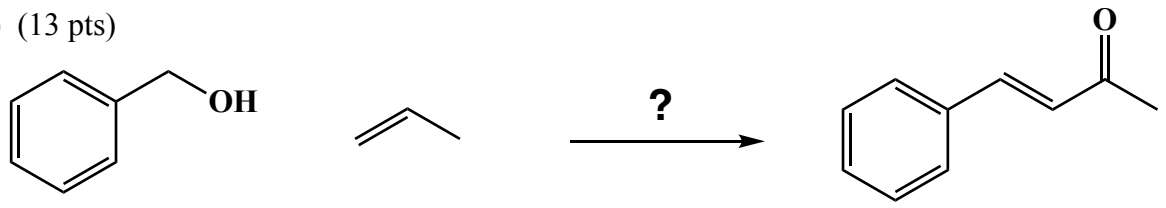
13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. **For this exam you do not need to draw each stereoisomer with wedges and dashes, you can just mark all chiral centers with an asterisk and write "racemic" whcn appropriate. All the carbons of the product must come from carbons of the starting material.**

B) (10 pts)



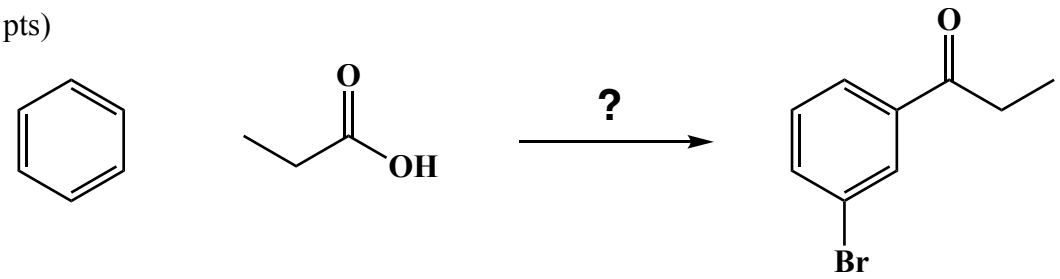
13. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned provided that the product(s) you draw for each step is/are the predominant one(s). Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. **For this exam you do not need to draw each stereoisomer with wedges and dashes, you can just mark all chiral centers with an asterisk and write "racemic" whcn appropriate. All the carbons of the product must come from carbons of the starting material.**

C) (13 pts)



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. **For this exam you do not need to draw each stereoisomer with wedges and dashes, you can just mark all chiral centers with an asterisk and write "racemic" whcn appropriate. All the carbons of the product must come from carbons of the starting material.**

D) (7 pts)



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. **For this exam you do not need to draw each stereoisomer with wedges and dashes, you can just mark all chiral centers with an asterisk and write "racemic" whcn appropriate. All the carbons of the product must come from carbons of the starting material.**

E) (16 pts)