

NAME (Print): _____

Chemistry 320N
Dr. Brent Iverson
1st Midterm
Feb. 13, 2014

SIGNATURE: _____

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

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Please Note: This test may be a bit long, but there is a reason. I would like to give you a lot of little questions, so you can find ones you can answer and show me what you know, rather than just a few questions that may be testing the one thing you forgot. **I recommend you look the exam over and answer the questions you are sure of first**, then go back and try to figure out the rest. Also make sure to **look at the point totals** on the questions as a guide to help budget your time.

You must have your answers written in PERMANENT ink if you want a regrade!!!! This means no test written in pencil or ERASABLE INK will be regraded.

Please note: We routinely xerox a number of exams following initial grading to guard against receiving altered answers during the regrading process.

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!!!

Page	Points
1	(14)
2	(19)
3	(15)
4	(5)
5	(5)
6	(5)
7	(24)
8	(17)
9	(18)
10	(20)
11	(14)
12	(23)
13	(10)
14	(19)
15	(13)
16	(16)
17	(12)
Total	(249)

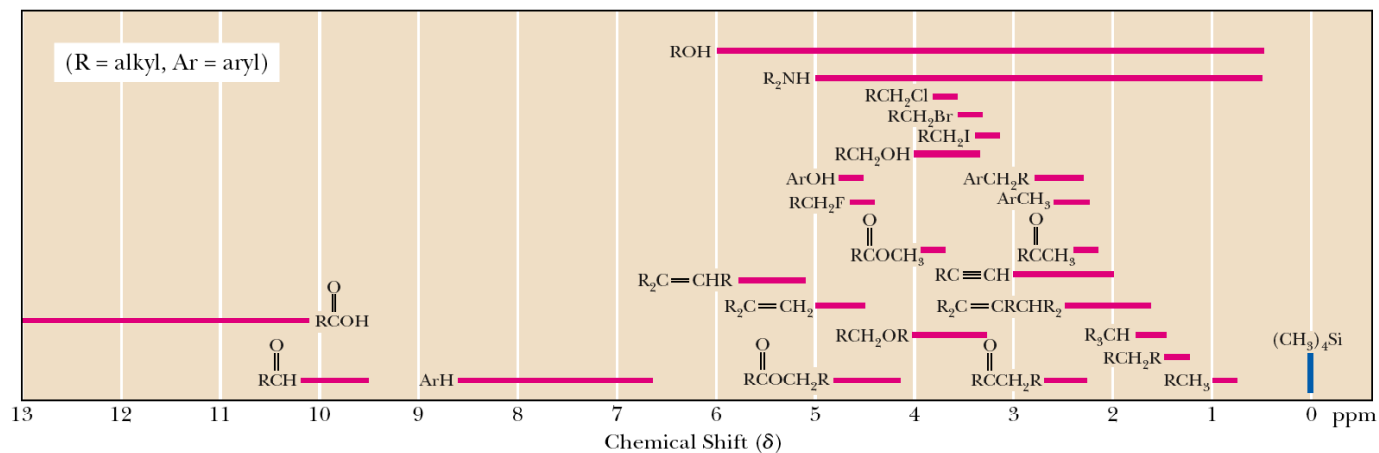
Student Honor Code

“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)

Type of Hydrogen (R = alkyl, Ar = aryl)	Chemical Shift (δ)*	Type of Hydrogen (R = alkyl, Ar = aryl)	Chemical Shift (δ)*
R_2NH	0.5-5.0	RCH_2OH	3.4-4.0
ROH	0.5-6.0	RCH_2Br	3.4-3.6
RCH_3	0.8-1.0	RCH_2Cl	3.6-3.8
RCH_2R	1.2-1.4	$\begin{array}{c} O \\ \\ RCOCH_3 \end{array}$	3.7-3.9
R_3CH	1.4-1.7	$\begin{array}{c} O \\ \\ RCOCH_2R \end{array}$	4.1-4.7
$R_2C=CRCHR_2$	1.6-2.6	RCH_2F	4.4-4.5
$RC\equiv CH$	2.0-3.0	$ArOH$	4.5-4.7
$\begin{array}{c} O \\ \\ RCCH_3 \end{array}$	2.1-2.3	$R_2C=CH_2$	4.6-5.0
$\begin{array}{c} O \\ \\ RCCH_2R \end{array}$	2.2-2.6	$R_2C=CHR$	5.0-5.7
$ArCH_3$	2.2-2.5	$\begin{array}{c} O \\ \diagup \quad \diagdown \\ H_2C \quad CH_2 \end{array}$	3.3-4.0
RCH_2NR_2	2.3-2.8	$\begin{array}{c} O \\ \\ RCH \end{array}$	9.5-10.1
RCH_2I	3.1-3.3	$\begin{array}{c} O \\ \\ RCOH \end{array}$	10-13
RCH_2OR	3.3-4.0		

* Values are relative to tetramethylsilane. Other atoms within the molecule may cause the signal to appear outside these ranges.



1. (1 pt each) Circle all the statements that are true. In other words, do not circle the statements that are false.

A. Moving charge generates a magnetic field, and a moving magnetic field causes charges to move.

B. Atomic nuclei have a quantum mechanical property of "spin" that can be thought of as a small magnetic field around the nucleus created as if the positive charge of the nucleus were circulating.

C. We care about the nuclei ^1H and ^{13}C since these are commonly found in organic molecules and they have spin quantum numbers of $3/2$.

D. Electromagnetic radiation of enough or more than enough energy can be absorbed by a nucleus and excite it from the lower energy $+1/2$ spin state to the higher energy $-1/2$ spin state, a process referred to as resonance.

E. Electromagnetic radiation of only the exactly right amount of energy can be absorbed by a nucleus and excite it from the lower energy $+1/2$ spin state to the higher energy $-1/2$ spin state, a process referred to as resonance.

F. The distance between peaks in a split signal is called chemical shift.

G. Different hydrogen atoms in a molecule take different amounts of energy to flip their spins, and the different energies can be correlated to structure of the molecule.

H. The distance between a signal and the standard TMS is called coupling constant.

I. For alkyl groups with freely rotating C-C bonds, splitting by n adjacent H atoms will give $n+1$ peaks.

J. For H atoms on the C atoms of three-membered rings or on the sp^2 hybridized C atoms of alkenes, splitting by n adjacent H atoms will always give $(n \times n)+1$ peaks.

K. The signal for a CH_2 group next to a chiral center will never be split, it will be a singlet.

L. All geminal H atoms split each other, giving rise to double peaks with large chemical shifts.

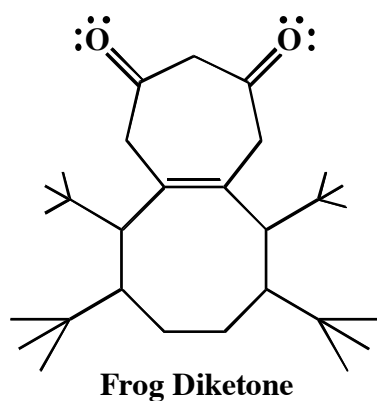
M. The H atoms of relatively acidic functional groups (alcohols, carboxylic acids, amines) exchange rapidly, so they often do not split the signals of adjacent hydrogens.

N. NMR stands for No More Regrets, time to develop a plan for lifelong physical fitness.

2. (cont.) (1 pt each)

In the FT NMR method, the FT stands for _____.

The basic idea is that a short pulse using a range of radio frequencies is used to flip the spins of all of the hydrogen _____ at once. Then, the nuclear spins _____ back to the +1/2 spin state and when they do, they _____ electromagnetic radiation at the precise frequency at which they absorb.



**This is not part of a question.
This little molecule creature is
simply supposed to make you
smile!**

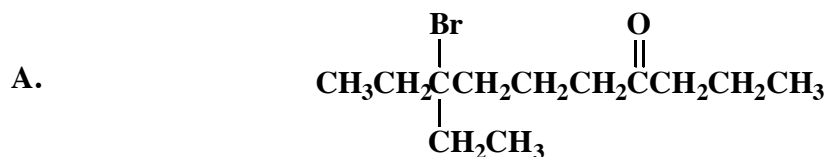
3. (14 points) Suppose a relative of yours is having an MRI. In no more than four sentences, explain to them what is happening when they have the MRI scan. We will be looking for a minimum of 7 key points here.

Signature _____

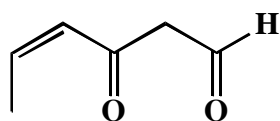
Pg 3 _____(15)

4. (3 pts) The most important question in organic chemistry is:

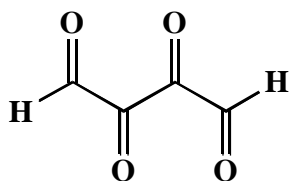
5. (3 pts each) For A)- C) write an acceptable IUPAC name for the structures. For D) draw a structural formula in the space provided corresponding to the IUPAC name.



B.



C.



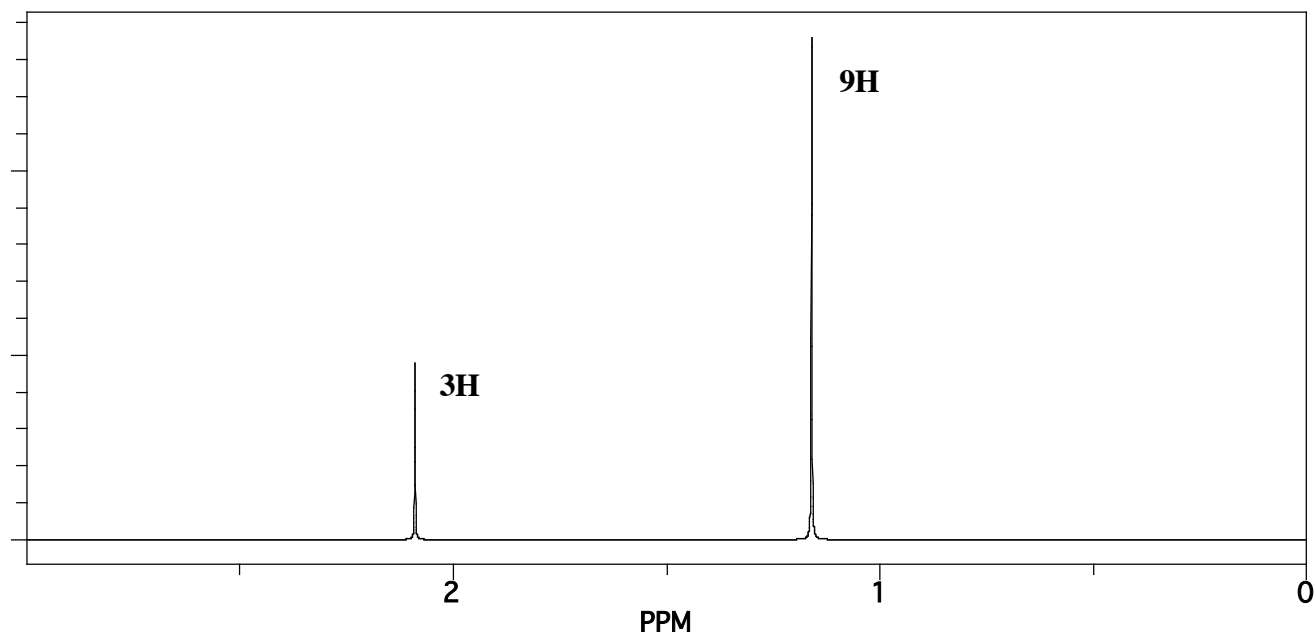
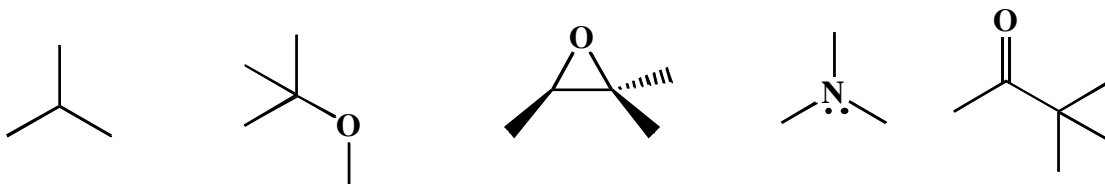
D. (3*S*,4*R*)-3-chloro-4-methylhexanal



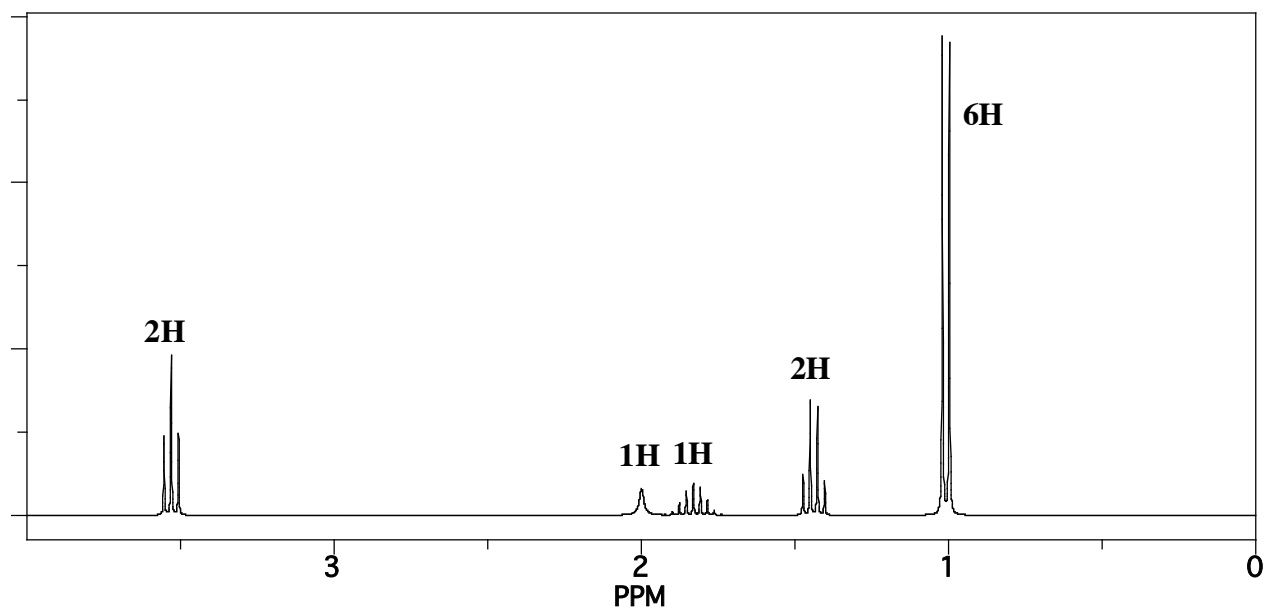
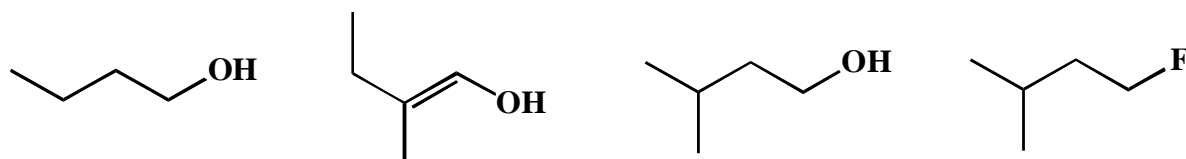
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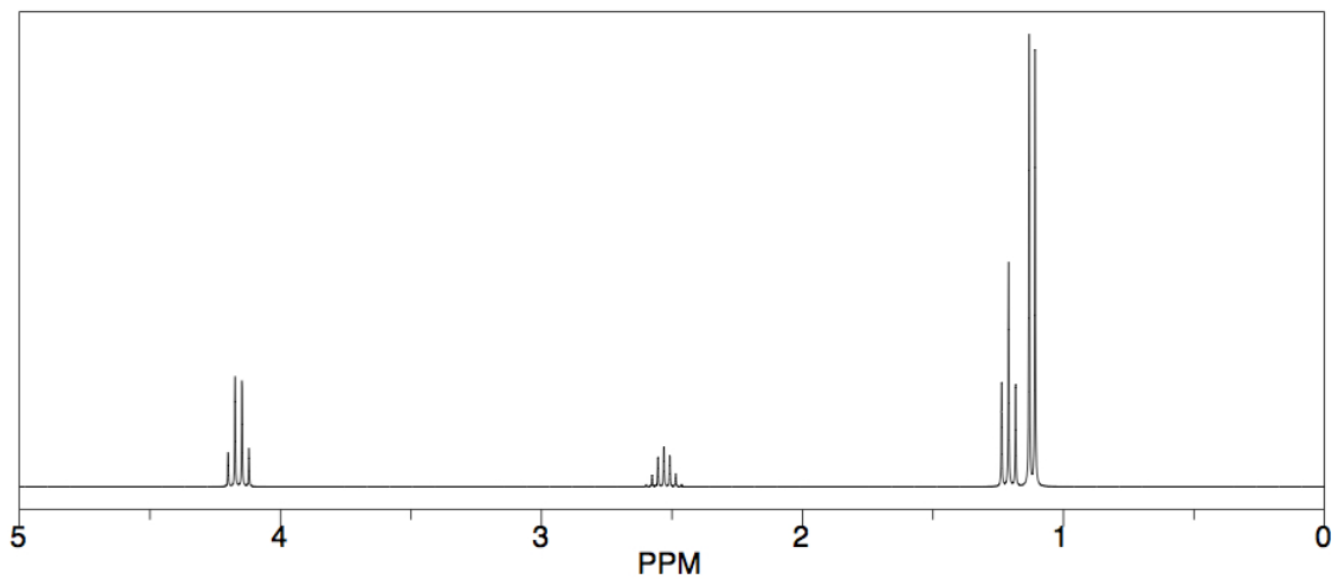
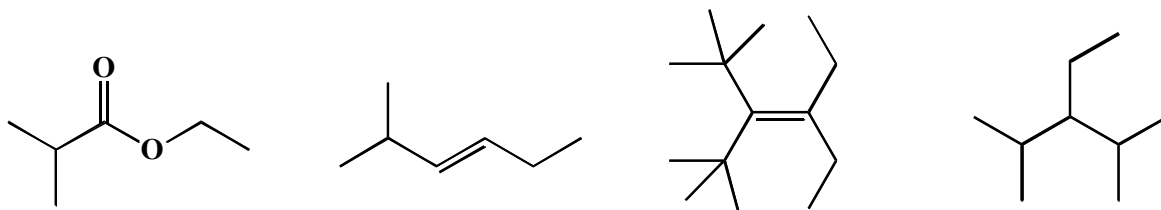
6. (5 pts) Circle the molecule that corresponds to the NMR spectrum shown below.



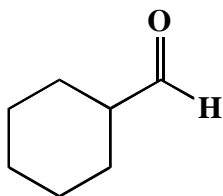
7. (5 pts) Circle the molecule that corresponds to the NMR spectrum shown below.



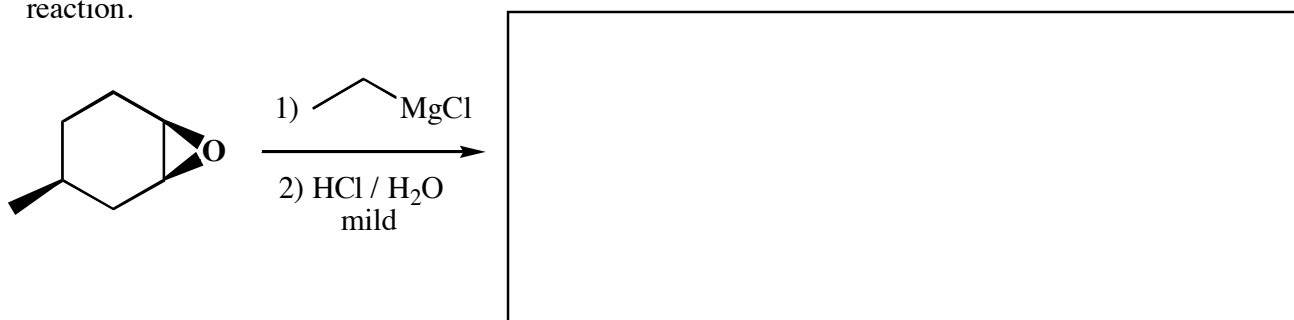
8. (5 pts) Circle the molecule that corresponds to the NMR spectrum shown below.



9. (4 pts) An important part of chemical understanding is being able to recognize the chemical reactivity of different functional groups. On the carbonyl group below, DRAW A BOX around the atom that will be attacked by nucleophiles and DRAW A CIRCLE around the atom that will be protonated in acid.

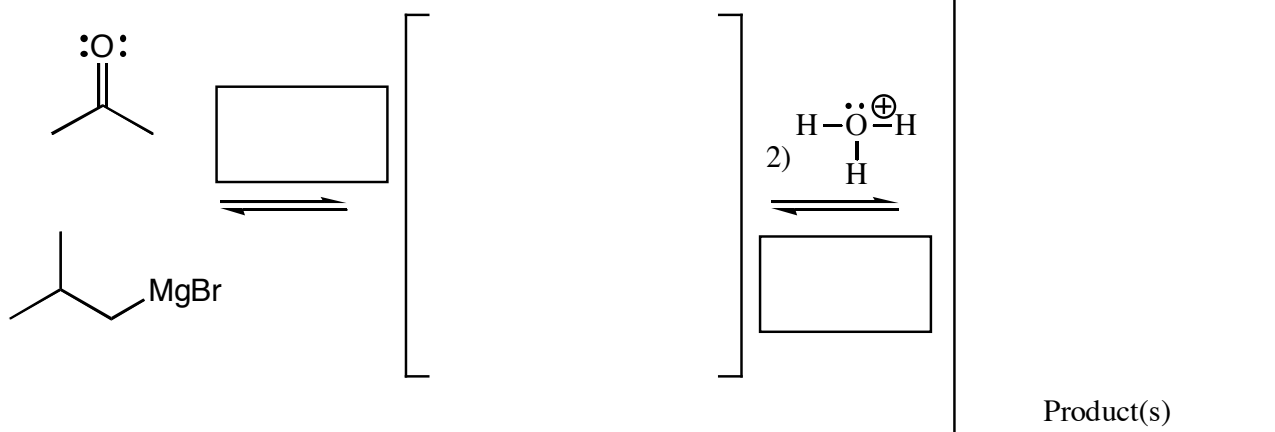


10. (8 pts) Stereochemistry is one of the most important concepts of organic chemistry. Using your knowledge of the reaction mechanism, draw the stereoisomers produced in the following Grignard reaction.



NOTICE THIS \implies Are the products you drew a racemic mixture of enantiomers? _____

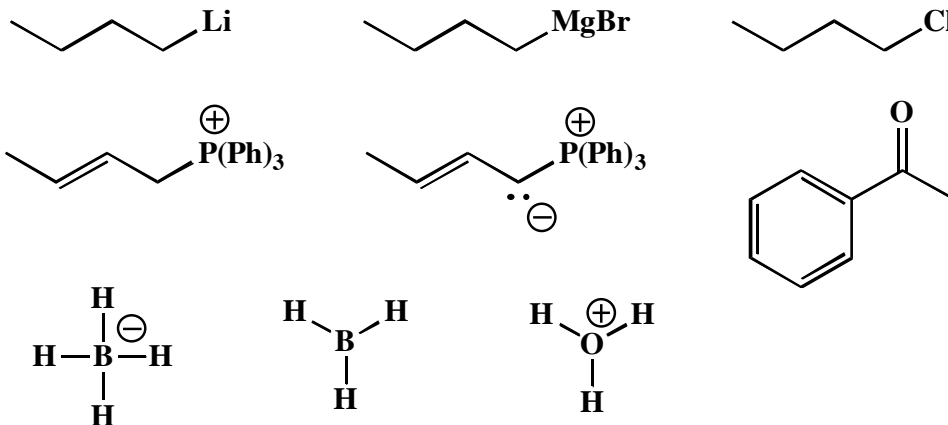
11. (12 pts. total) Complete the mechanism for the following Grignard reaction. **Be sure to show arrows to indicate movement of all electrons, write all lone pairs, all formal charges, and all the products for each step.** Remember, I said all the products for each step. **IF A NEW CHIRAL CENTER IS CREATED IN AN INTERMEDIATE, MARK IT WITH AN ASTERISK. IF A CHIRAL CENTER IS CREATED IN THE PRODUCTS YOU NEED TO DRAW BOTH ENANTIOMERS, AND LABEL THE PRODUCT MIXTURE AS RACEMIC IF RELEVANT.** I realize these directions are complex, so please read them again to make sure you know what we want.



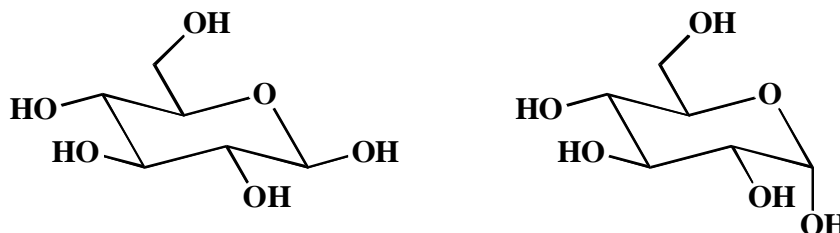
2 pts In the boxes provided adjacent to the first two sets of arrows, write which of the four basic mechanistic elements are involved (i.e. "Make a bond", "Add a proton", etc.)

↑↑
NOTICE THIS

12. (9 pts) From the list below, circle all the molecules that would be considered nucleophiles in reactions we have seen. Some of them might also be bases, but do not worry about that for this question.



13. (8 pts) Shown below are the two forms of D-glucose that are most commonly found in biological systems. Draw a circle around the anomeric carbon atom on each structure. Then answer the questions below the structures.



Circle the correct statement:

The structure on the left represents the α form of D-glucose, the structure on the right represents the β form of D-glucose.

The structure on the left represents the δ form of D-glucose, the structure on the right represents the γ form of D-glucose.

The structure on the left represents the β form of D-glucose, the structure on the right represents the α form of D-glucose.

Circle the correct statement:

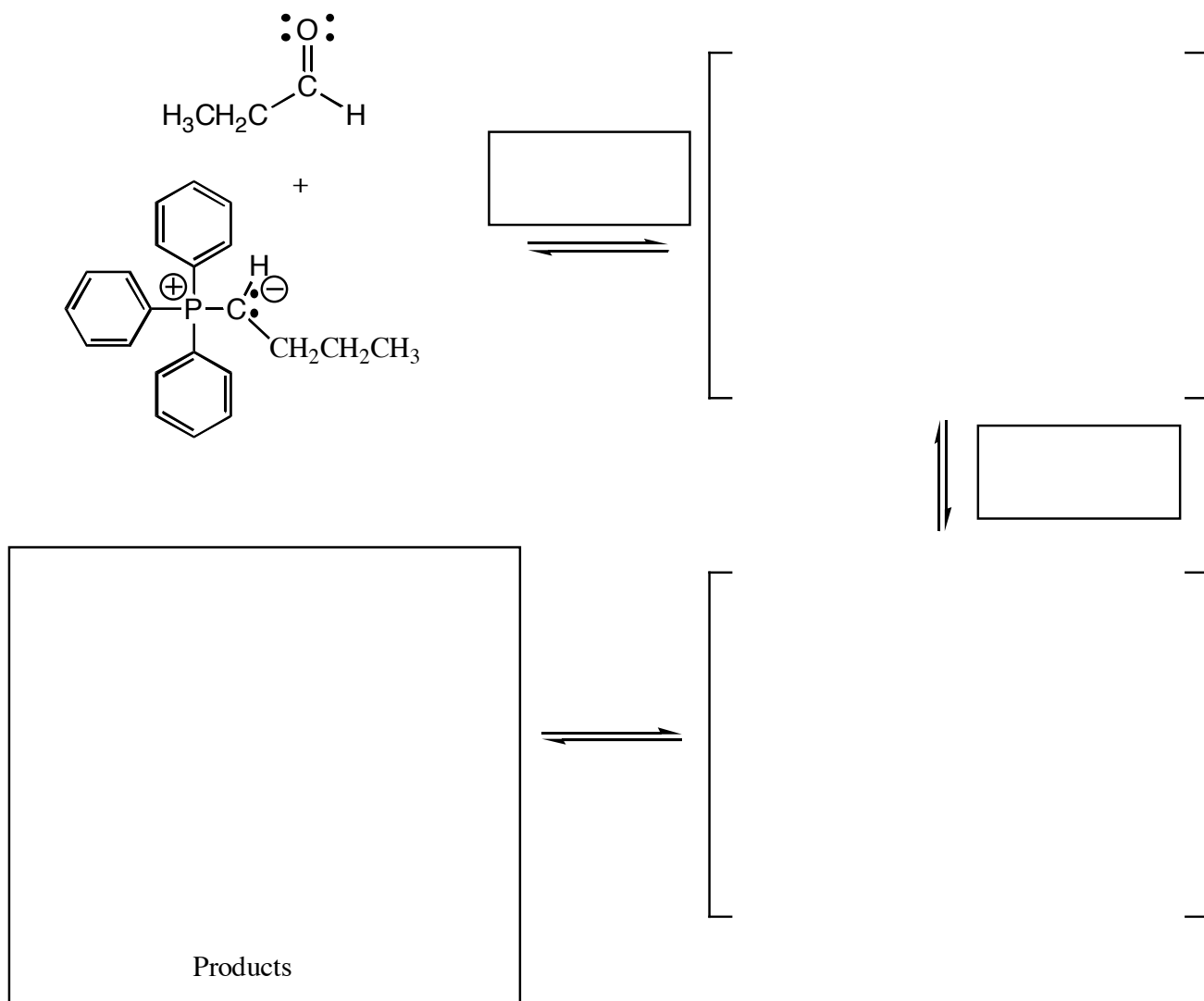
The above structures are examples of cyclic acetals.

The above structures are examples of cyclic hemiacetals.

The above structures are examples of cyclic hemispheres.

The above structures are examples of psychic acetals.

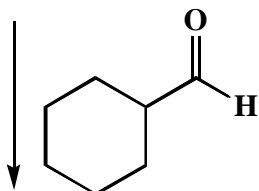
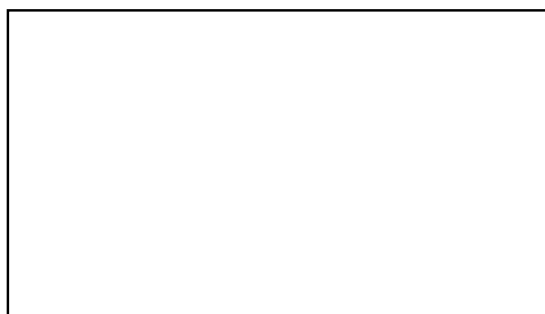
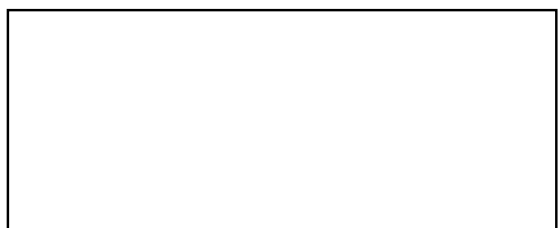
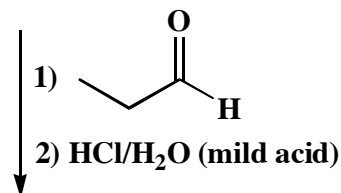
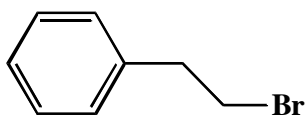
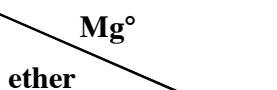
14. (18 pts. total) Complete the mechanism for the following Wittig reaction. **Be sure to show arrows to indicate movement of all electrons, write all lone pairs, all formal charges, and all the products for each step.** Remember, I said all the products for each step. **IF A RACEMIC MIXTURE IS CREATED IN AN INTERMEDIATE, MARK ALL CHIRAL CENTERS WITH AN ASTERISK AND WRITE RACEMIC. IF A RACEMIC MIXTURE IS CREATED IN THE FINAL PRODUCTS, YOU NEED TO DRAW BOTH ENANTIOMERS, AND WRITE RACEMIC.** I realize these directions are complex, so please read them again to make sure you know what we want.



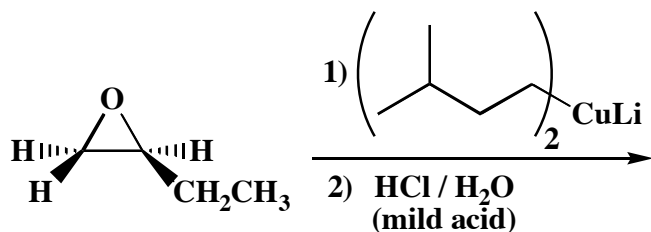
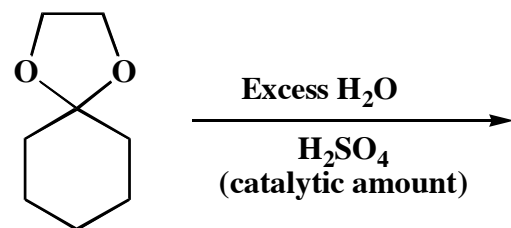
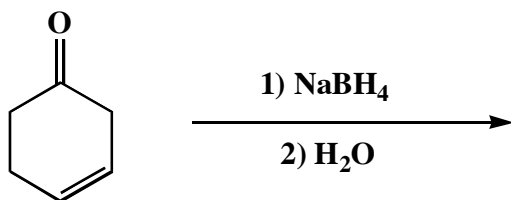
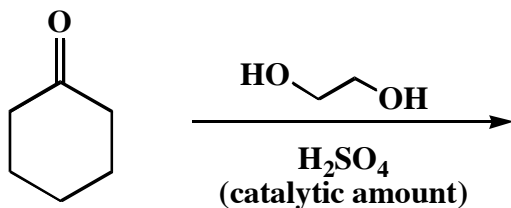
2 pts In the boxes provided adjacent to the first two sets of arrows, write which of the four basic mechanistic elements are involved (i.e. "Make a bond", "Add a proton", etc).

↑↑
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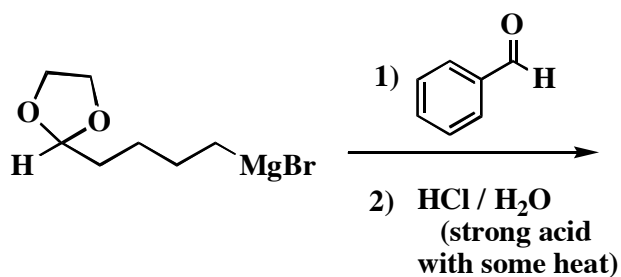
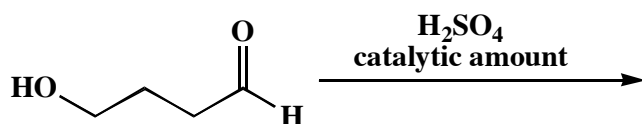
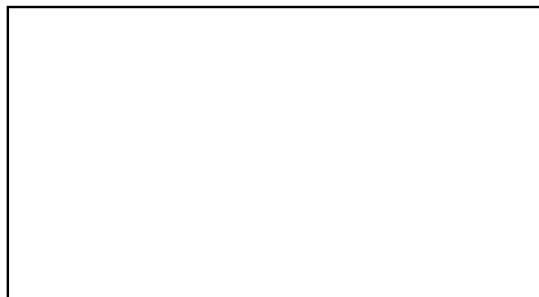
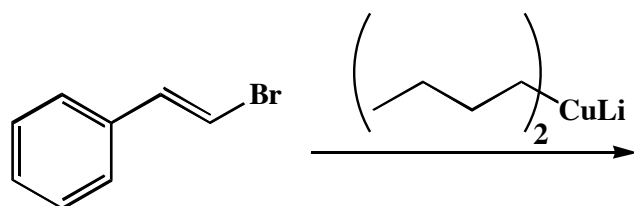
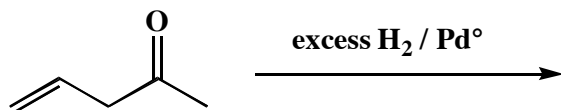
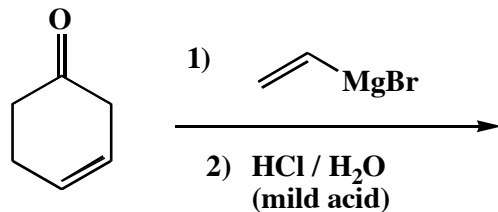
15. (3 or 5 pts.) Write the predominant product or products that will occur for each transformation. If a new chiral center is created and a racemic mixture is formed, you must draw both enantiomers and write "racemic" under the structure. Use wedges (\blacktriangleleft) and dashes (\dashv) to indicate stereochemistry. To get full credit, you only need to write the the major organic product for these. You do not have to worry about the other products.



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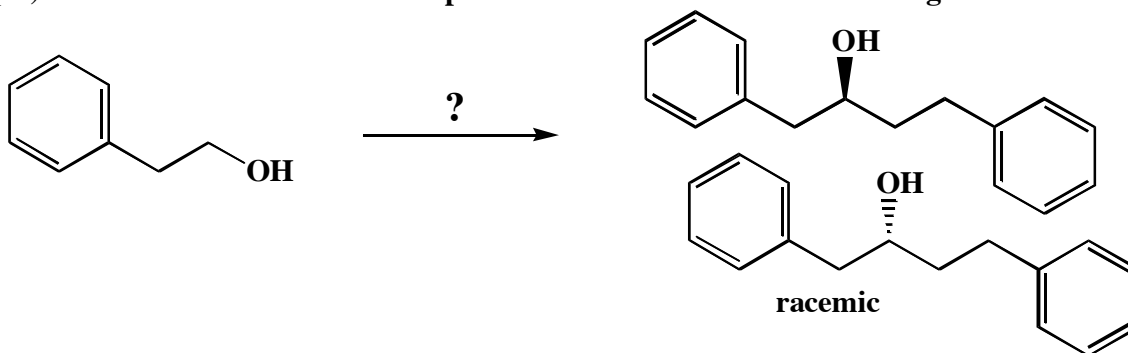


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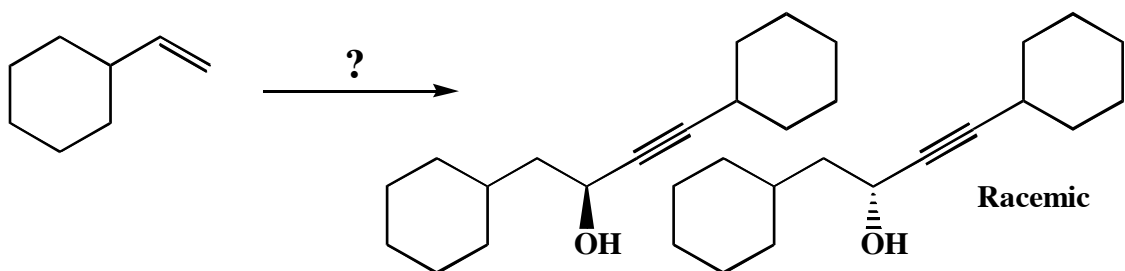
16. These are synthesis questions. You need to show how the starting material can be converted into the product(s) shown. You may use any reactions we have learned. Show all the reagents you need. Show each molecule synthesized along the way and be sure to pay attention to the regiochemistry and stereochemistry preferences for each reaction. If you make a racemic mixture, draw both structures and make sure to write "racemic" next to them.

(10 pts) All of the carbon atoms of the products must come from the starting materials for this one!



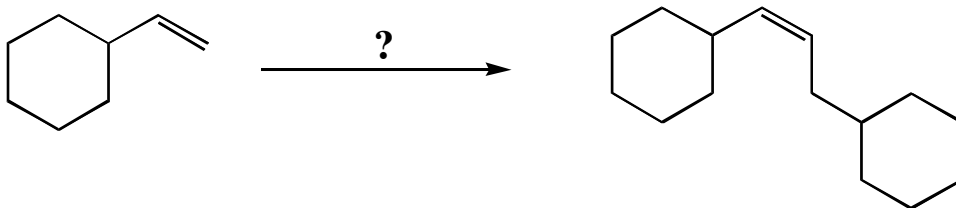
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(19 pts) All of the carbon atoms of the products must come from the starting materials for this one!



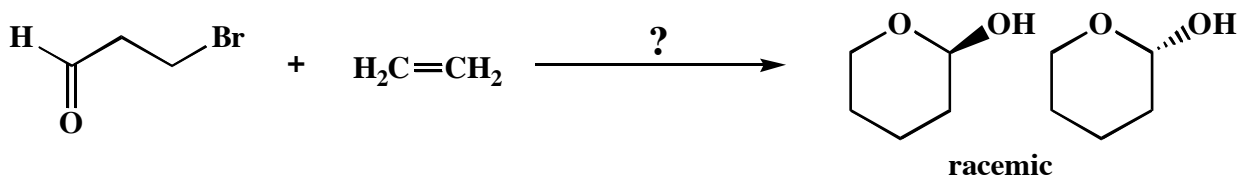
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(13 pts) **All of the carbon atoms of the products must come from the starting materials for this one!**

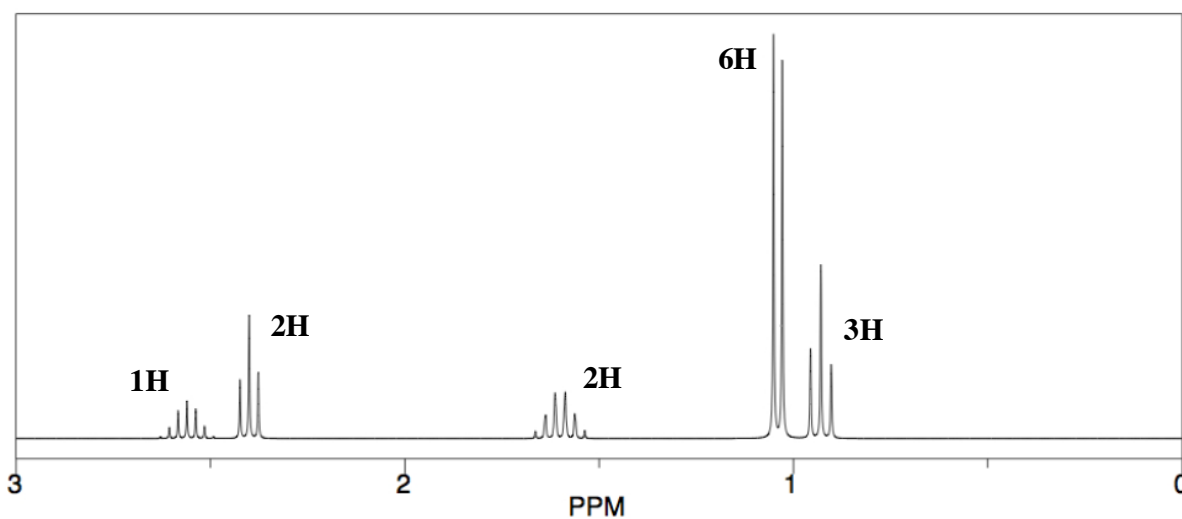
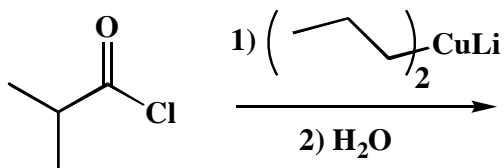


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(16 pts) All of the carbon atoms of the products must come from the starting materials for this one!



17. (5 pts) You have not seen the following reaction before, it comes from chapter 18. The NMR spectrum is of the predominant product. Using your growing intuition about chemical reactivity as well as the NMR, draw the structure of the product of this reaction.



18. (7 pts) Reactions in context: Following is a Wittig reaction used in the published synthesis of a pharmaceutical candidate. Draw the product of the reaction

