NAME (Print): _____

SIGNATURE: _____

Chemistry 610A/618A
Dr. Brent Iverson
Final
Dec. 13, 2003

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

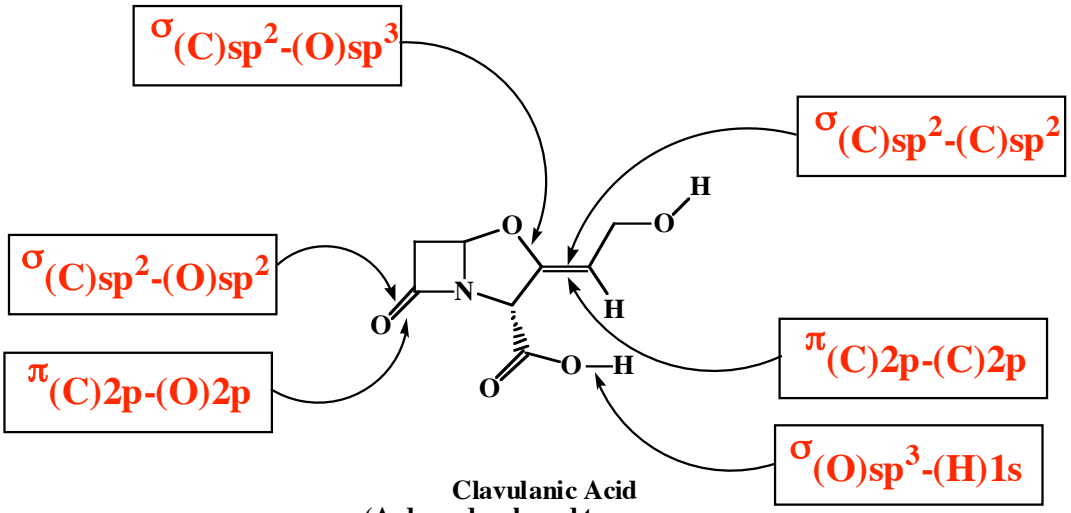
Please Note: This test may be a bit long, but there is a reason. I would like to give you a lot of little questions, so you can find ones you can answer and show me what you know, rather than just a few questions that may be testing the one thing you forgot. **I recommend you look the exam over and answer 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. **I recommend saving questions marked "challenge" until you are finished with all of the other questions.**

For synthesis problems GO FOR PARTIAL CREDIT EVEN IF YOU DO NOT KNOW THE ENTIRE ANSWER!!!WRITE DOWN WHAT YOU DO KNOW IS IN THE REACTION SEQUENCE SOMEWHERE. YOU WILL GET PARTIAL CREDIT IF IT IS CORRECT

Note: You must have your answers written in pen if you want a regrade!!!!

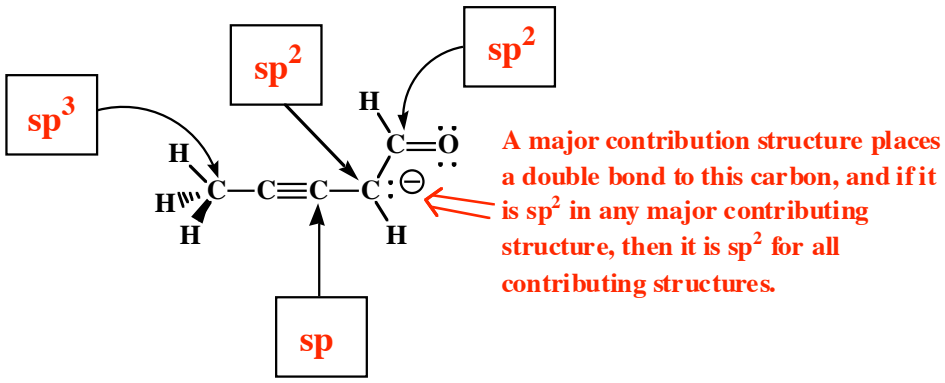
Page	Points	
1		(25)
2		(16)
3		(20)
4		(26)
5		(24)
6		(19)
7		(28)
8		(17)
9		(29)
10		(30)
11		(21)
12		(10)
13		(13)
14		(13)
15		(9)
16		(28)
17		(16)
Total		(344)
T Score		

1. (2 pts each) In the spaces provided, indicate the type of bond, and the hybridized orbitals that overlap to form the bond. For example, one answer could be: σ(C)sp^3-(H)1s



Clavulanic Acid
(A drug developed to overcome certain types of antibiotic resistance)

2. (2 pts each) In the spaces provided write the hybridization state of the atoms indicated by the arrow.



A major contribution structure places a double bond to this carbon, and if it is sp^2 in any major contributing structure, then it is sp^2 for all contributing structures.

3. (5 pts) The most important question is chemistry is:

Where are the electrons?

4. (1 pt each) Circle all of the true statements.

A. More electronegative atoms attract the majority of electron density in a bond, thereby answering the most important question in chemistry,

B. A sigma bond has the majority of electron density between atomic nuclei, while a pi bond has the majority of electron density above and below the bond axis.

C. Constitutional isomers are molecules with the same molecular formula, but have the atoms connected differently to each other.

D. The preferred staggered conformations of butane are the "gauche" conformations, rather than the "anti" conformation.

E. Stereoisomers have the same connectivity (they are the same constitutional isomer), but the atoms are arranged differently in space.

F. Dispersion forces are proportional to surface area , so the smaller the surface area of an alkane, the greater the attraction between molecules and the higher the boiling point.

G. Substituted cyclohexanes prefer to have as many substituents axial as possible, with the larger substituents dominating.

H. Trans alkenes are more stable than cis alkenes because cis alkenes have some non-bonded interaction strain.

I. Hammond's postulate says that the transition state for an exothermic reaction more closely resembles the starting materials, and the transition state for an endothermic reaction more closely resembles the products.

J. The enol form of a compound rapidly tautomerizes to the more stable keto form.

K. The keto form of a compound rapidly tautomerizes to the more stable enol form.

L. The keto form of a compound rapidly mesmerizes to the more stable enol form.

M. Epoxides (called an oxirane in IUPAC nomenclature) are ethers within three-membered rings.

N. Ethers can be synthesized using an S_N2 reaction between a primary alkyl halide and an alkoxide (called the Williamson ether synthesis)

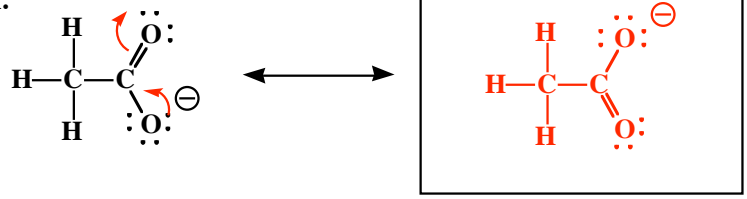
O. Ethers are synthesized using an S_N1 reaction between a tertiary alkyl halide and an alkoxide (called the Williamson County ether synthesis)

P. Epoxides are important because the ring strain within epoxides allows them to react with nucleophiles.

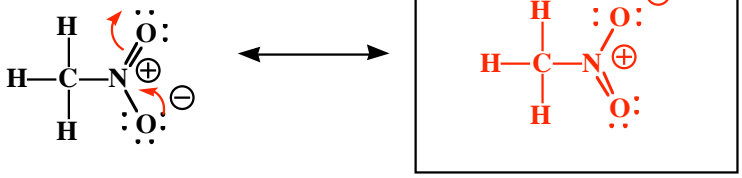
Q. Running 3-5 miles a week EVERY WEEK as an adult dramatically increases your fitness level and improves your heatlh throughout your life. Doing this and enjoying a healthy life is even more important than getting an A on this organic final!

5. (4 pts each) The following are contributing structures for important resonance hybrids. Draw the other important resonance contributing structure in the box provided. Draw arrows on the structures on the left that indicate the flow of electrons that produce the contributing structures you drew. Be sure to show all lone pairs and formal charges.

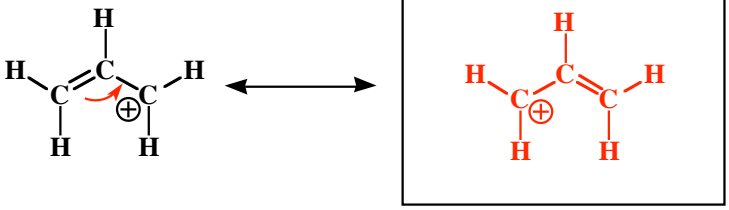
A.



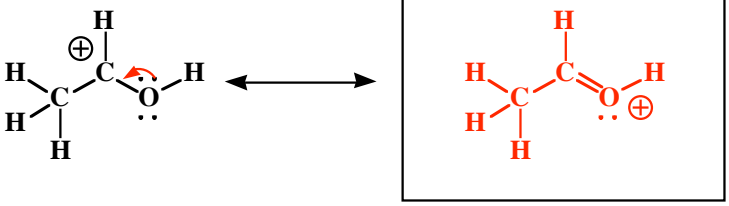
B.



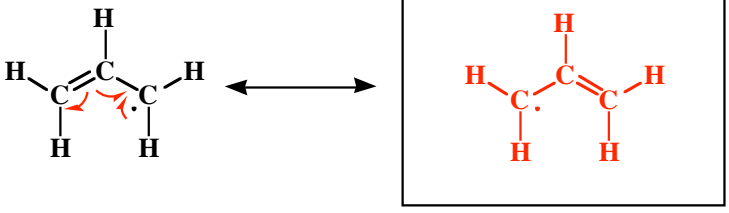
C.



D.



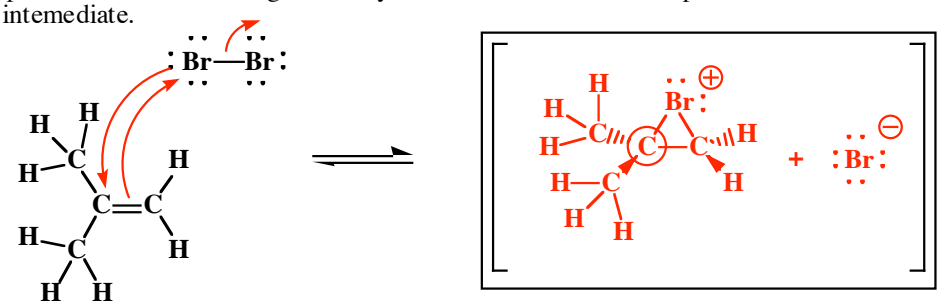
E.



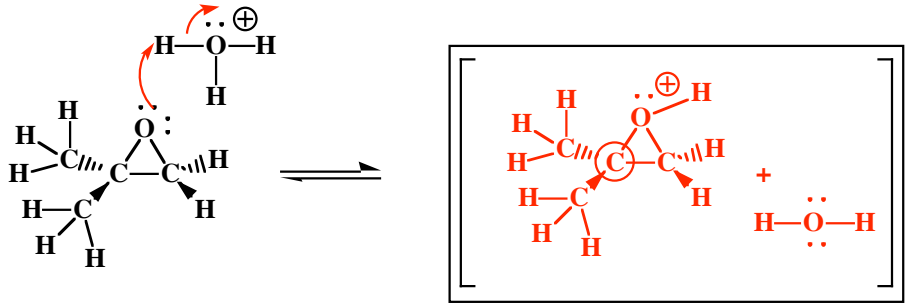
Did you remember to put arrows on the structures on the left?

6. (6 or 7 pts each) Many of the reactions we have studied involve a characteristic intermediate. For the reactants given, draw the characteristic intermediate in the box provided. Draw arrows on the structures on the left that indicate the flow of electrons that leads to the intermediates you drew. Make sure to draw all lone pairs and all formal charges. Note you do not need to draw the products of these reactions, only the first intemediate.

A.

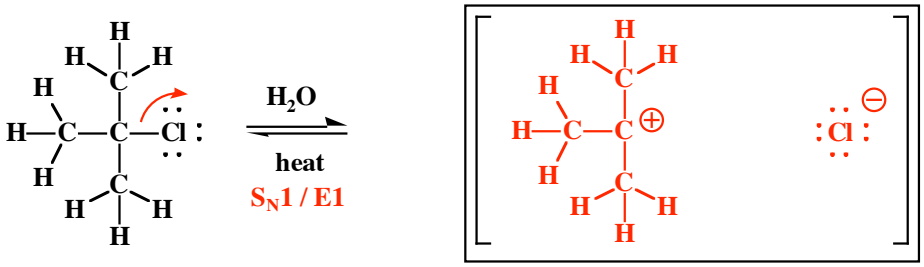


B.

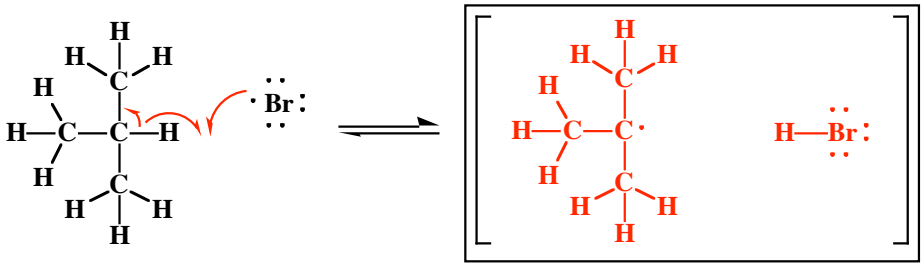


For the above two reactions, draw a circle around the atom of the intermediate that will be the predominant site of attack by a nucleophile in the next step of the mechanism.

C.



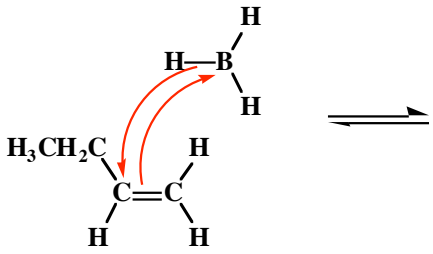
D.

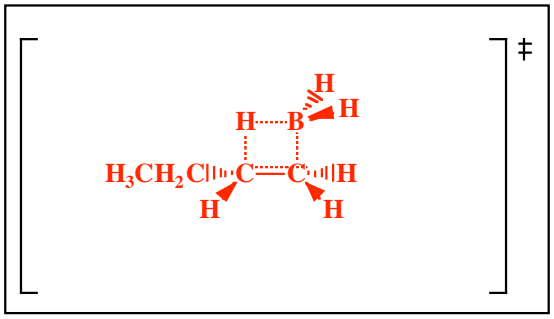


Did you remember to put arrows on the structures on the left?

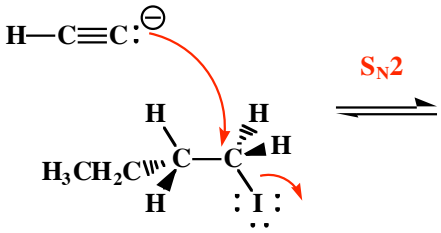
7. (6 pts each) Many of the reactions we have studied involve a characteristic transition states. For the reactants given, draw the characteristic transistion state in the box provided. Draw arrows on the structures on the left that indicate the flow of electrons that leads to the transition states you drew. Draw bonds being made or broken in the transition states as broken lines (- - - - -). Note you do not need to draw the products, just the transition states.

A.

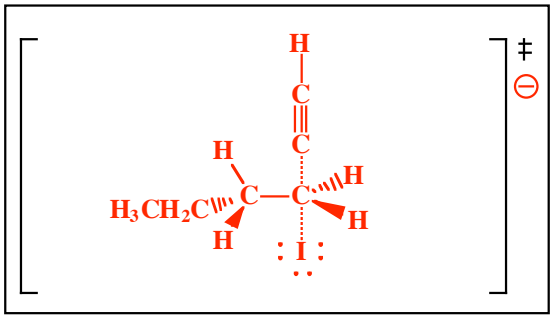




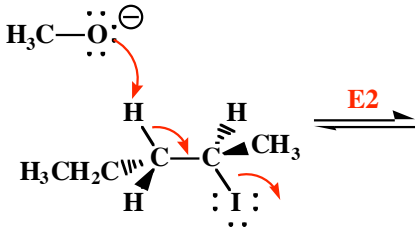
B.



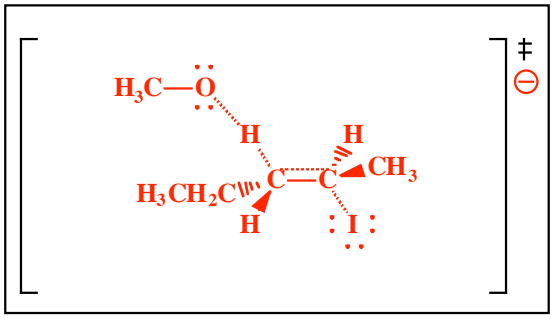
1° alkyl halide



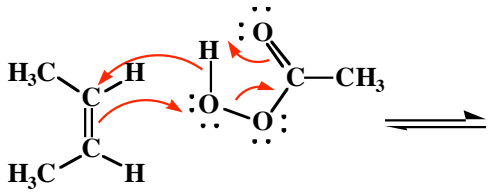
C.

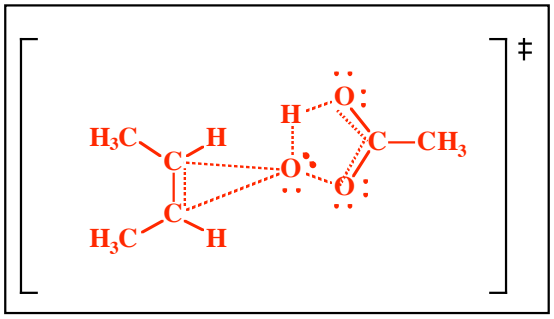


2° alkyl halide



D.

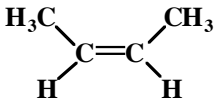




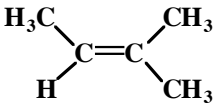
Did you remember to put arrows on the structures on the left?

8. (19 pts total) Rank the following species in terms of the stated property from 1 to 4 (or 3) as described, with intermediate numbers to rank the species of intermediate stability activity. **Please make sure you know what we want, as you will get no credit if you get the numbers backwards!**

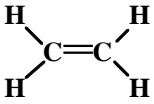
Stability of alkene: Place a **1** under the most stable (i.e. least reactive to H_2/Pt) and a **4** under the least stable (i.e. most reactive to H_2/Pt)



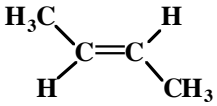
3 (cis)



1

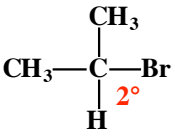


4

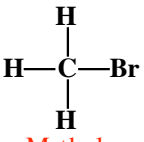


2 (trans)

Relative reaction rate with a nucleophile in an S_N2 reaction, with a **1** under the fastest and a **4** under the slowest.

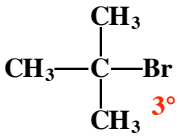


3

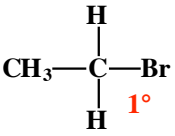


Methyl

1

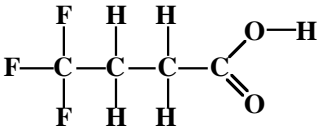


4

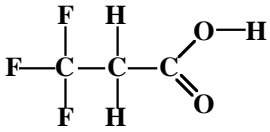


2

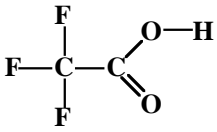
Relative Acidity: Place a **1** under the most acidic molecule and a **3** under the least acidic molecule.



3

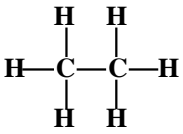


2

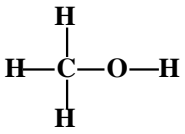


1

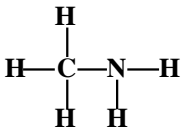
Relative Acidity: Place a **1** under the most acidic molecule and a **4** under the least acidic molecule.



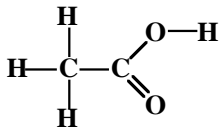
4



2

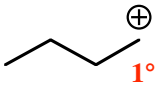


3

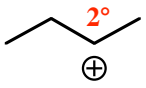


1

Relative carbocation stability: Place a **1** under the most stable carbocation and a **4** under the least stable carbocation.

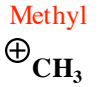


3



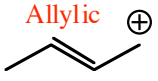
2

Methyl



4

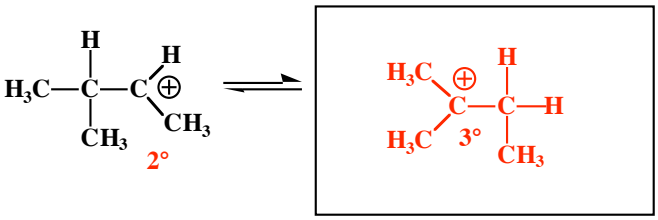
Allylic

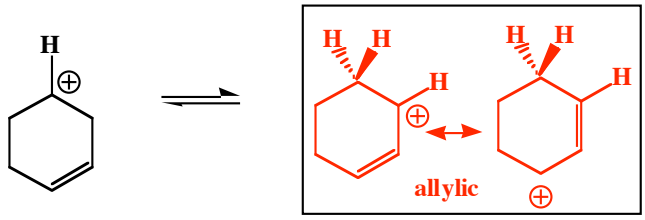


1

Are you sure you ranked them in the correct order according to the directions????

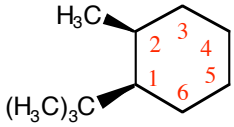
9. (8 pts total) The following two carbocations can rearrange. In the space provided draw the most reasonable rearranged carbocation.

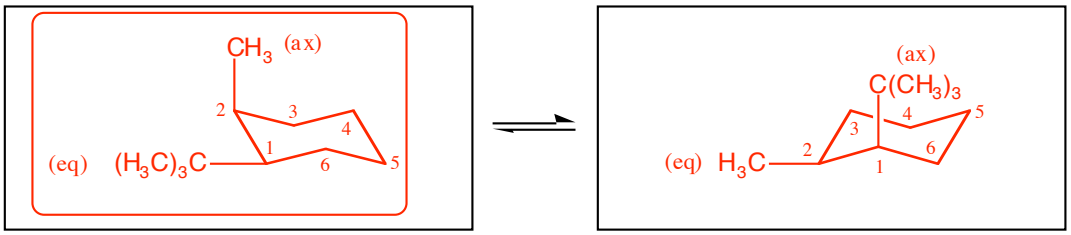




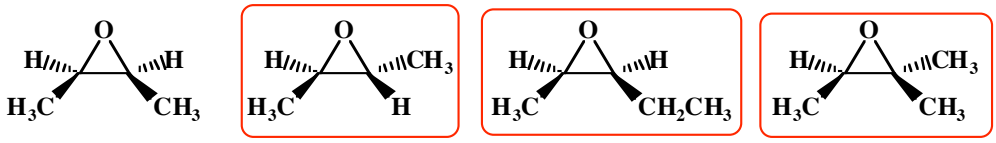
You did not have to draw both contributing structures, just one of them.

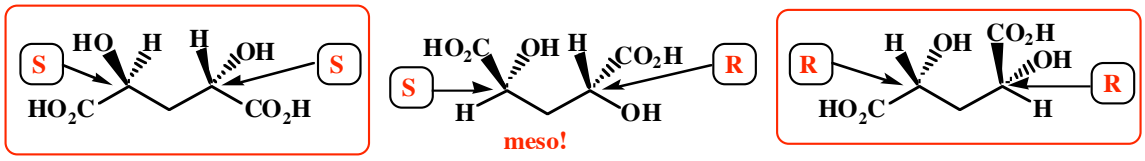
10. (10 pts) **Draw the two chair conformations of the following cyclohexane derivative, and circle the one that is lower in energy,** i.e. predominates at equilibrium. You do not need to show all of the hydrogen atoms on the ring, but you may if it helps. Make sure your drawing clearly indicates which groups are equatorial and which are axial. If we cannot interpret your drawing we will have to mark it wrong.





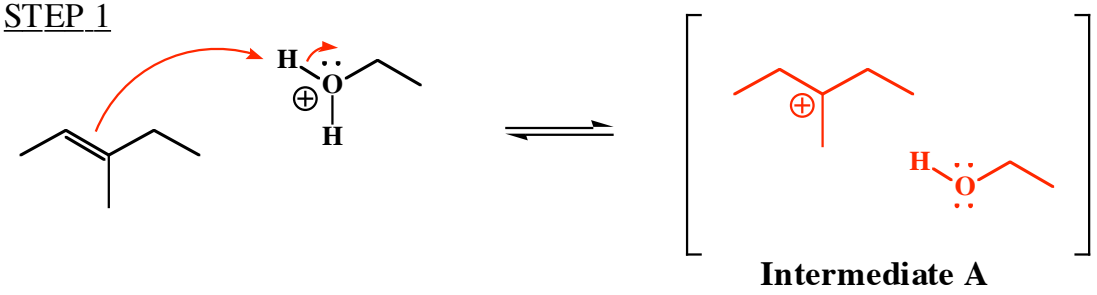
11. (10pts) Draw a circle around all of the chiral molecules. Label the stereocenters as R or S if indicated by an arrow and box.





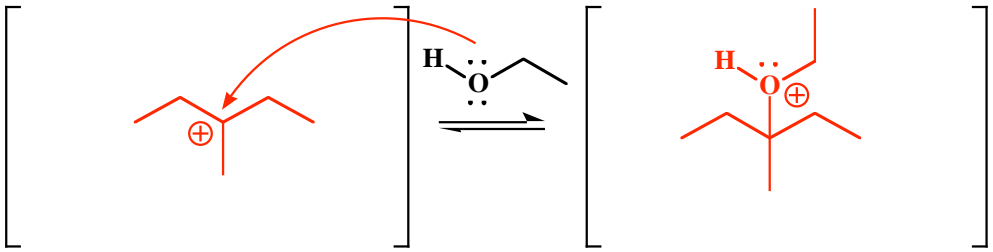
10. (17 pts.) Read these directions carefully. Read these directions carefully. (It was worth repeating) **For the reaction shown below, fill in the details of the mechanism. Draw the appropriate chemical structures and use arrows to show how pairs of electrons are moved to** make and break bonds during the reaction of the indicated alkene with H_2SO_4 in CH_3CH_2OH (no H_2O!!) Make sure to draw all lone pairs of electrons, all formal charges, and all products (including stereoisomers) produced **at each step**.

STEP 1



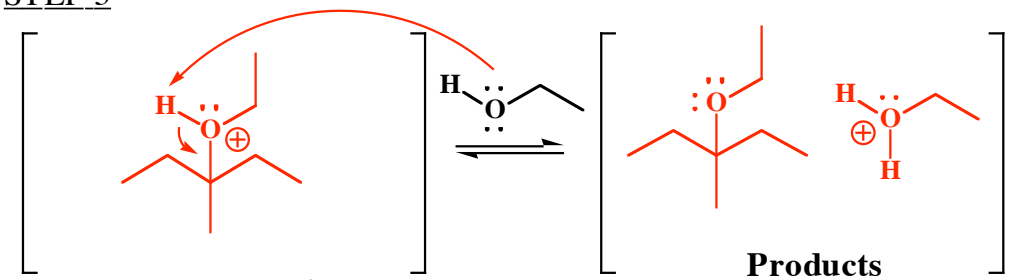
Intermediate A

STEP 2



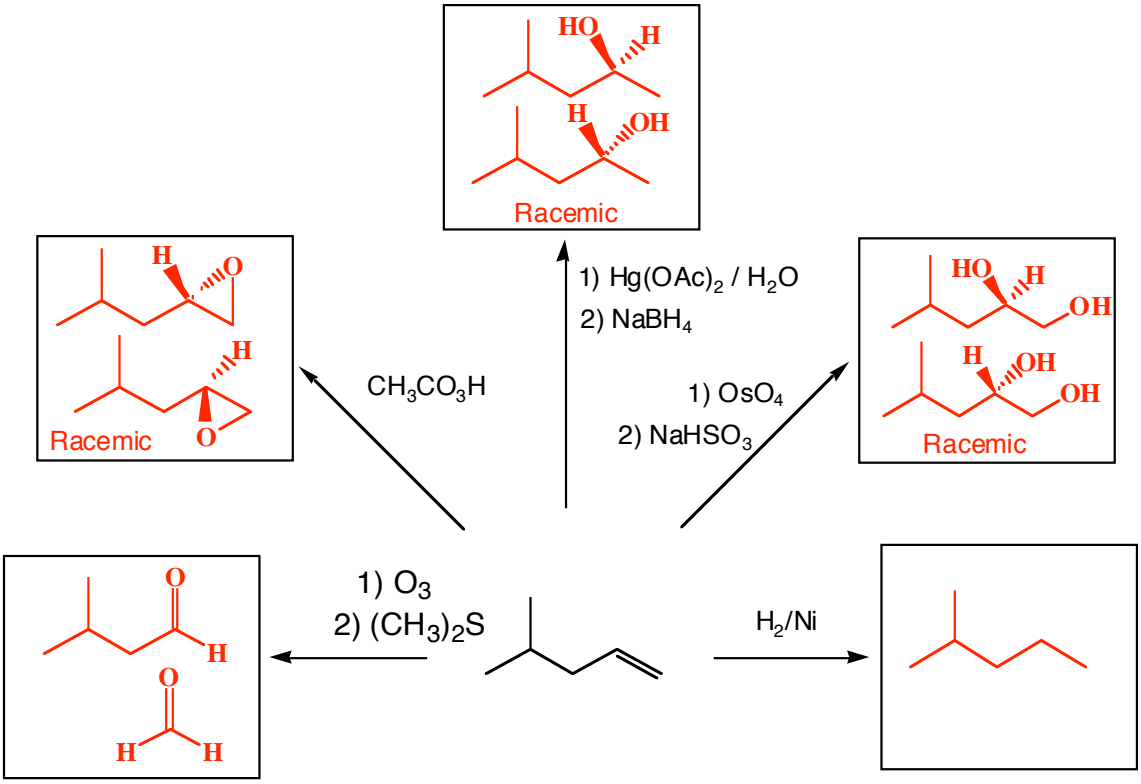
Redraw Intermediate A **Intermediate B**

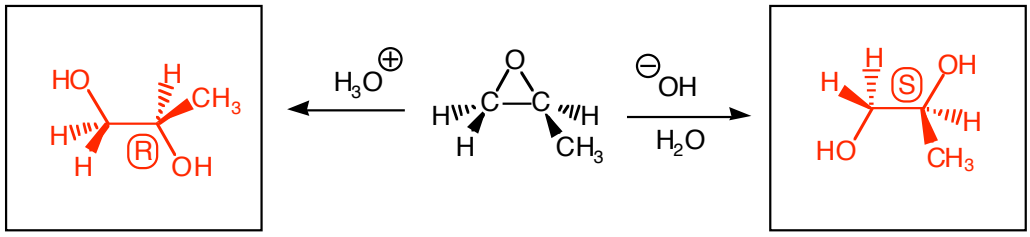
STEP 3



Redraw Intermediate B **Products**

12. (3 or 5 pts each) Fill in the box with the product or products that are missing from the following chemical reaction equations. **Draw only the predominant product or products** and please remember that **you must draw the structures of all the predominant product stereoisomers**. When a racemic mixture is formed, **you must write "racemic" under both structures EVEN THOUGH YOU DREW BOTH STRUCTURES**. If a scrambled mixture is produced, you need to write "scrambled".





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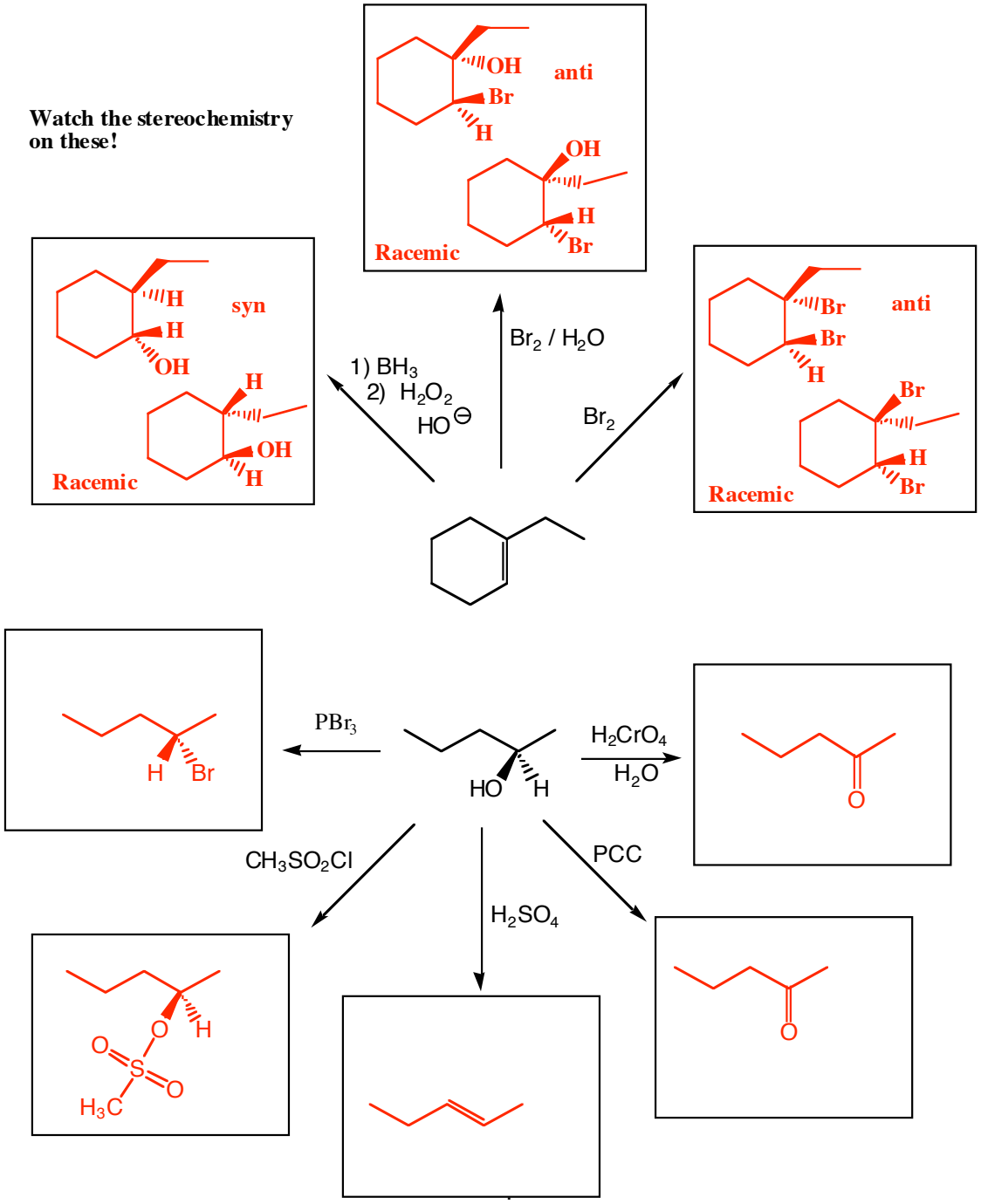
Watch the stereochemistry on these!



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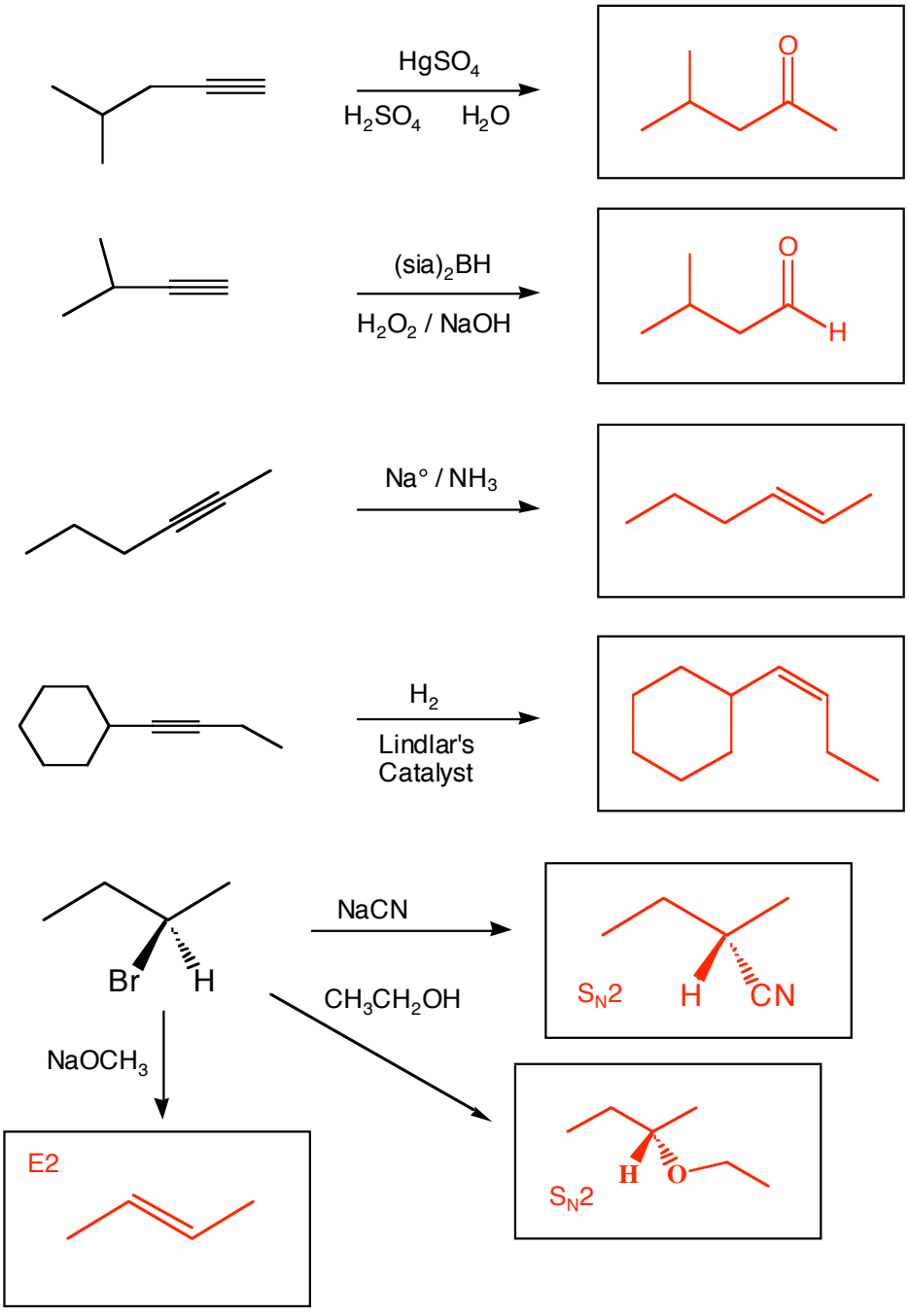
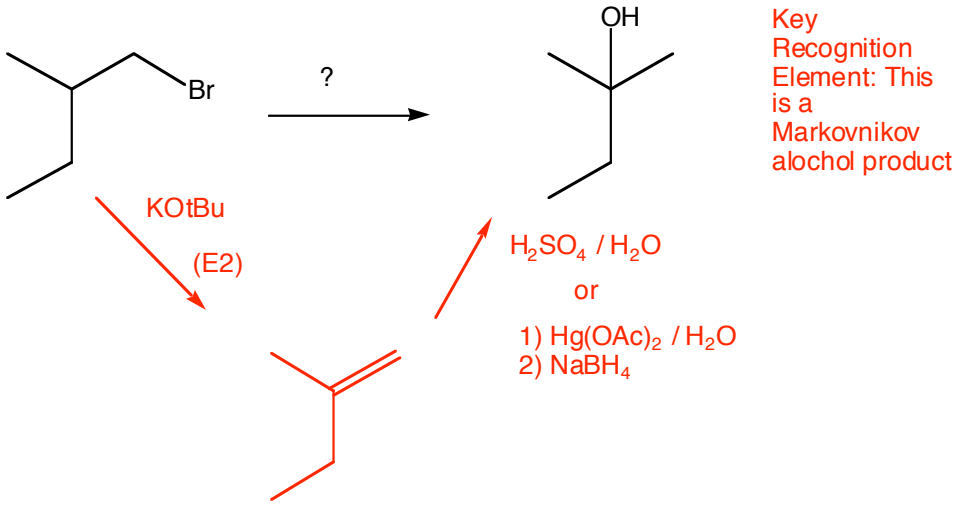
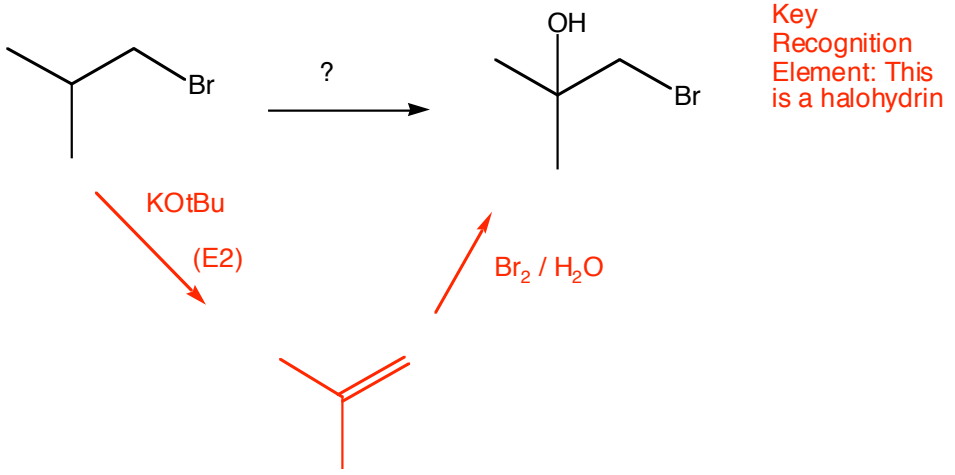


12. Here are the synthesis problems I promised! Using any organic or inorganic reagents, show how to synthesize the molecule on the right from the molecule on the left. **You must show all molecules synthesized along the way and the reagents you need for each step**. It is acceptable to use abbreviations found in the book or class notes. Note that you can only use the most predominant product of each transformation, if a complex mixture or other predominant products are formed in one of your steps, you should find another approach.

a. (5 pts)



b. (5 pts)



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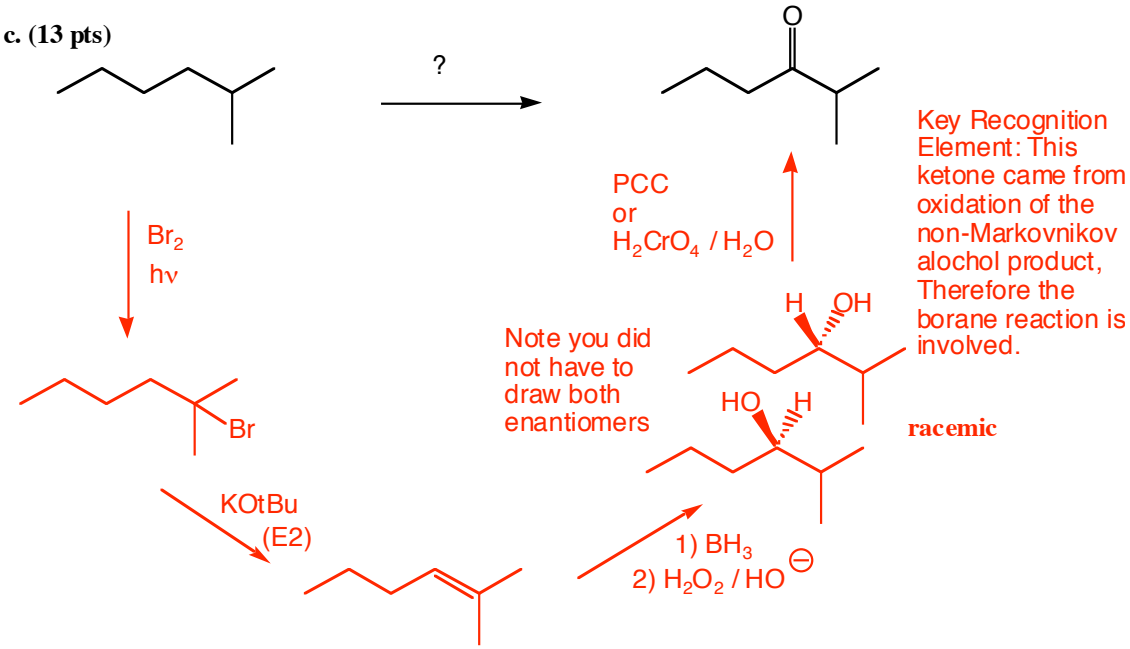
c. (13 pts)



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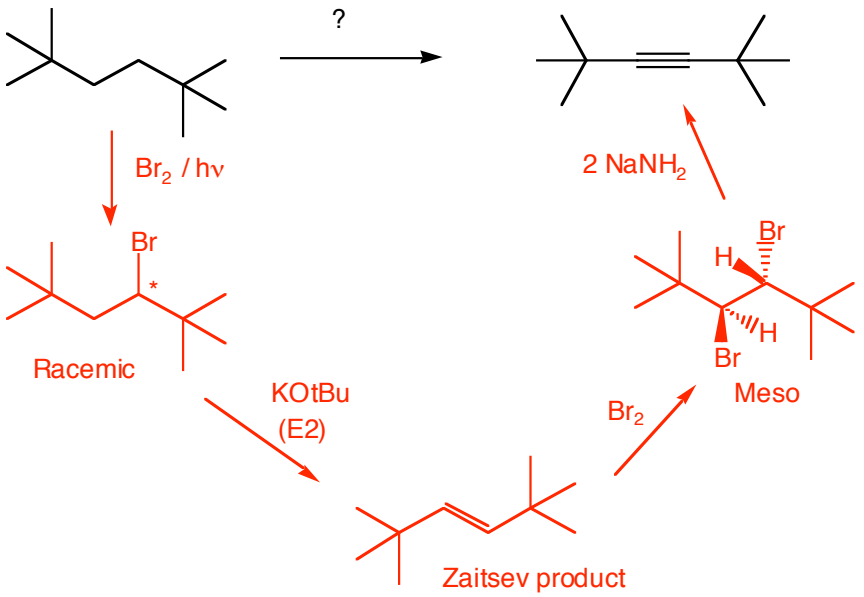
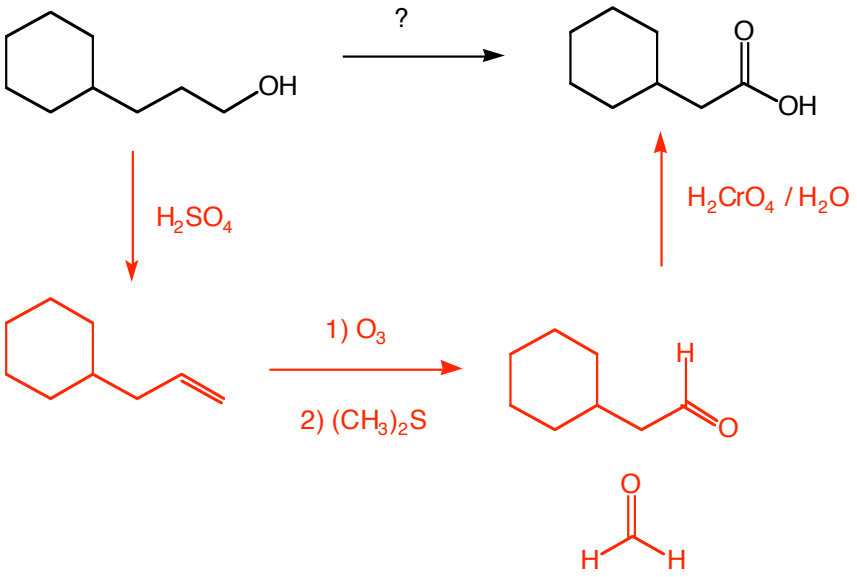
d. (13 pts)



Key Recognition Element: You can only make alkynes via vicinal dihalides which come from alkenes. Note also the starting material is an alkane, and you only know one reaction with alkane starting materials: free radical halogenation.

12 (cont). Here are the synthesis problems I promised! Using any organic or inorganic reagents, show how to synthesize the molecule on the right from the molecule on the left. **You must show all molecules synthesized along the way and the reagents you need for each step**. It is acceptable to use abbreviations found in the book or class notes. Note that you can only use the most predominant product of each transformation, if a complex mixture or other predominant products are formed in one of your steps, you should find another approach.

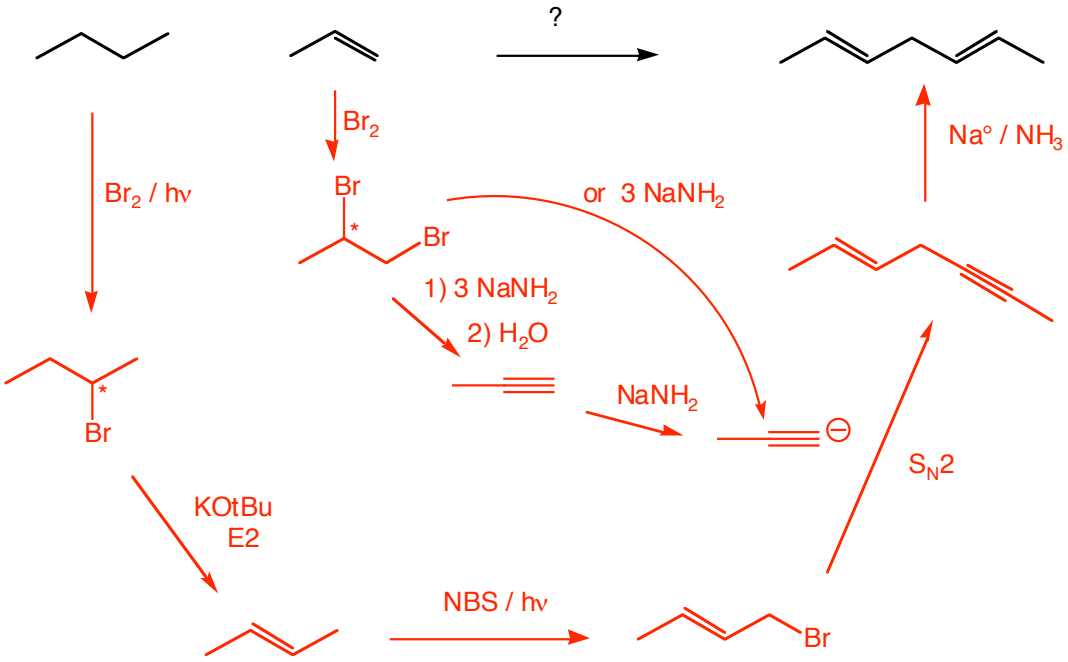
e. (9 pts) This may take you a while to figure out.



Key Recognition Element: This lost one carbon atom so the ozone reaction is involved. Also, you only know one reaction that makes a carboxylic acid, the chromic acid oxidation, so that must be the last reaction. The twist is that you go from an aldehyde, not a primary alcohol in the last step.

12 (cont). Here are the synthesis problems I promised! Using any organic or inorganic reagents, show how to synthesize the molecule on the right from the molecule on the left. **You must show all molecules synthesized along the way and the reagents you need for each step**. It is acceptable to use abbreviations found in the book or class notes. Note that you can only use the most predominant product of each transformation, if a complex mixture or other predominant products are formed in one of your steps, you should find another approach.

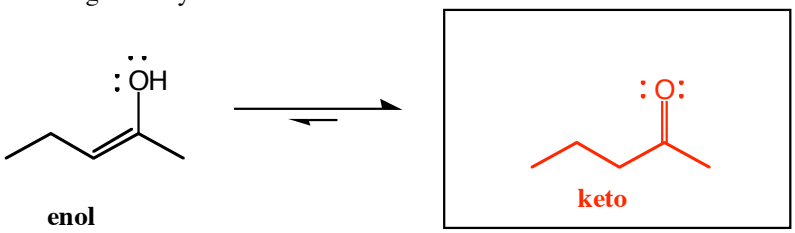
e. (28 pts) Challenge! All of the carbon atoms of the products must come from one of the starting materials. (Hint: Look for the key recognition elements and keep calm. You actually know this chemistry. **Go for partial credit even if you don't get the whole thing!**) You have a lot of room, so make sure we can understand your answer!



Key Recognition Element: There are seven carbon atoms in the product, and a total of seven in the starting material. Therefore, an alkyne anion and primary alkyl halide must react. The trans double bonds in the product indicate a sodium in ammonia reduction is the last step. The rest of the chemistry is along I-35 on your roadmaps!

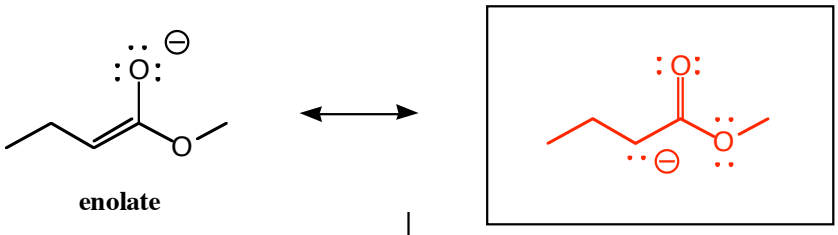
13 . This is an apply what you know question that allows you to use the information you learned this semseter in a new way.

A. (4 pts) Here is what you already know. The following molecule is not the most stable and immediately rearranges to a more stable molecule. Draw the rearranged product including all lone pairs and formal charges if any.

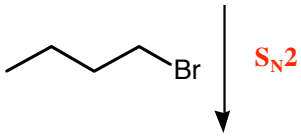


enol

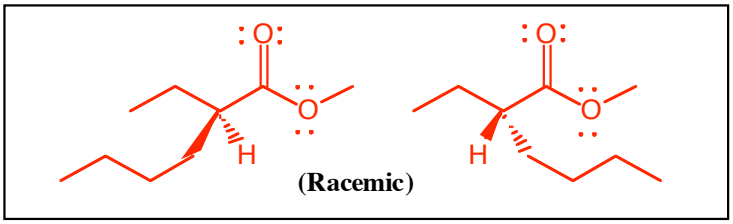
B. (4 pts) Here is what you do not know yet The following anion has another important contributing structure. Draw the other important contributing structure including all lone pairs and formal charges if any.



enolate



S_N2



(Racemic)

C. (4 pts) The resonance stabilized anion you drew is called an enolate and acts as a nucleophile. It will react with a primary alkyl halide such as 1-bromobutane to give a single pair of enantiomers as product. Draw this pair of enantiomers in the space immediately above.

D. (4pts) If you made it this far then you realized that the enolate anion could react at one of two possible atoms, (i.e. the ones with the negative charges in the contributing structures). In **ONE OR TWO SIMPLE SENTENCES** explain why you chose one atom over the other as the site of reaction. Hint: look at part A and think about which of those is more stable and why.

Reacting at the carbon atom gives a product with a C=O bond, which is a stronger bond than a C=C bond (which would have been in the product if the S_N2 reaction occured at the oxygen atom). Since reaction at carbon gives the product with the stronger bonds, there is a greater "motive", that is driving force, for this reaction.

Welcome to Organic Chem. Euphoria,
It has all become clear,
You're outta here!

The final tally was 320 lbs of food collectd last Thursday. Great job!!! I has been delivered to the Caritas House food pantry on 7th street. Many people will benefit from your generosity.

I very much enjoyed getting to know you this semester. I hope you look at organic chemistry and the molecules around you differently now. Have a safe and restful holiday. Remember, running a few miles a week will help keep extra pounds off this time of year.