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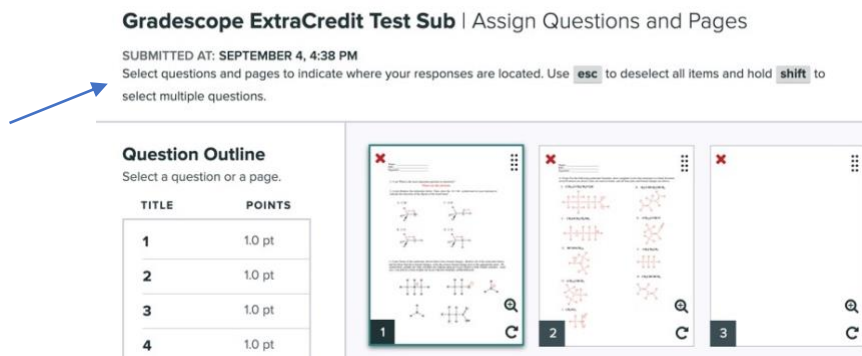
For the Gradescope portion of both weekly homework and midterm exams, you will be required to write answers to all questions, either on paper or using an electronic tablet (e.g. an iPad) and upload them to the appropriate grade scope assignment.

This is the Gradescope portion of your Midterm Exam 3. For this assignment, solve the problems on a separate sheet, and then only upload clearly labeled answers. Failure to clearly indicate the correct answer, providing multiple answers, mislabeling of problems, uploading answers in horizontal orientation, or not assigning problems to pages will result in the loss of points, so please, do this correctly!

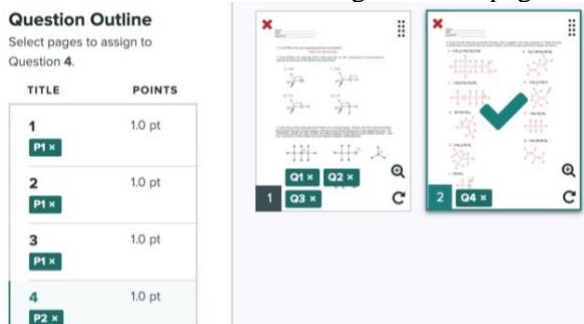
You must include your name, UT EID, and signature on each page you upload.

After answering all questions on a blank sheet and properly numbering answers, upload your work under the appropriate assignment on Gradescope.

After you upload, **you must assign where each question is on the page(s) you uploaded** so we can grade it. Note that assigning questions to specific pages in your upload does not affect your submission time: the assignment is turned in once you have uploaded the assignment and reached the Gradescope webpage below. This means you have no reason to not spend a minute or so and tell us where answers are within your submission pages. *Failure to do this will result in losing points on the assignment.* Note the blue arrow pointing out instructions.



In the picture below, you can see that questions 1-3 were assigned to page 1, and question 4 was assigned to page 2. You are required to assign all question numbers in the 'Question Outline' to the pages you uploaded, so that we always grade what you want us to grade for each question. If a question is answered on multiple pages, assign that question to all relevant pages! If the images are not rotated to be upright in your submission, please rotate them using the arrow shown on the bottom right of each page.



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An example showing what a Gradescope submission could look like is below:

- Name
- UT EID
- Signature
- Properly numbered answers on a blank page, no need to copy the question
- Uploaded in vertical direction

Name: Student McStudent pants

UT EID: abc123

Signature: Student McStudent pants

Assignment: Weekly HW #1, Gradescope Portion

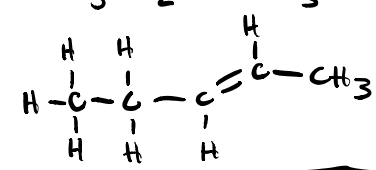
1. Where are the electrons?

~~2A. 13~~ 2A. 13 ← *If you make a mistake, clearly erase/scribble it out and note what you want to be graded.*

2B. 4

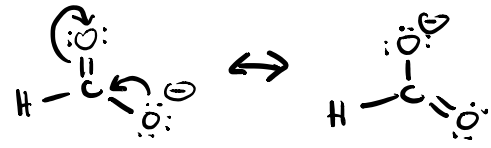
3A. ↑ 3B. ↘ 3C. No dipole

4A. $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$



Feel free to box answers/ add lines to clearly separate your answers

5.



6A. $\pi_{\text{C}_{2p}-\text{C}_{2p}}$ 6B. $\sigma_{\text{C}_{\text{sp}^3}-\text{H}_{1s}}$

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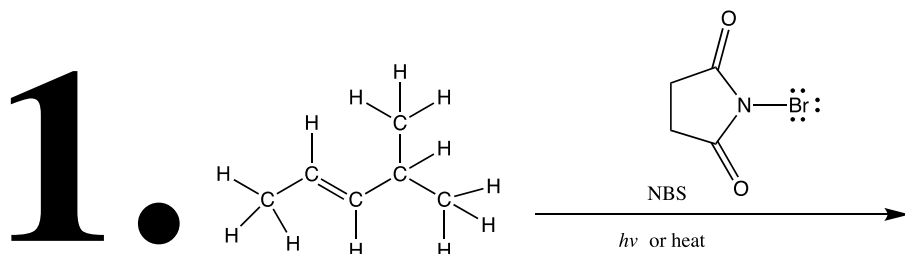
The Midterm 3: Gradescope Portion is worth a total of 143 points.

Questions 1 is a mechanism questions and worth 28 points.

1. Complete the following allylic halogenation mechanism. Be sure to show arrows to indicate movement of all electrons, draw all electrons, all formal charges, and all the products for each step. Remember, I said all the products for each step. **YOU ONLY NEED TO DRAW ONE STEREOISOMER OF A CHIRAL INTERMEDIATE OR PRODUCT** (using wedges and dashes as appropriate) **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.**

Note the following instructions that are unique to this mechanism:

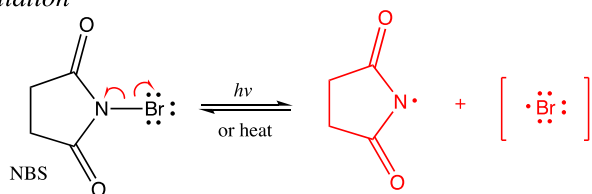
- We want to see the three different types of steps involved in radical chain mechanisms: (1) initiation, (2) propagation, and (3) termination – *but you only need to draw one of the three possible examples of termination.*
- If you create a resonance stabilized intermediate, you need to draw all relevant resonance contributing structures. You do not need to use arrows to show how one contributing structure becomes the other – *only use arrows to show how one of the contributing structure reacts to give the product.*



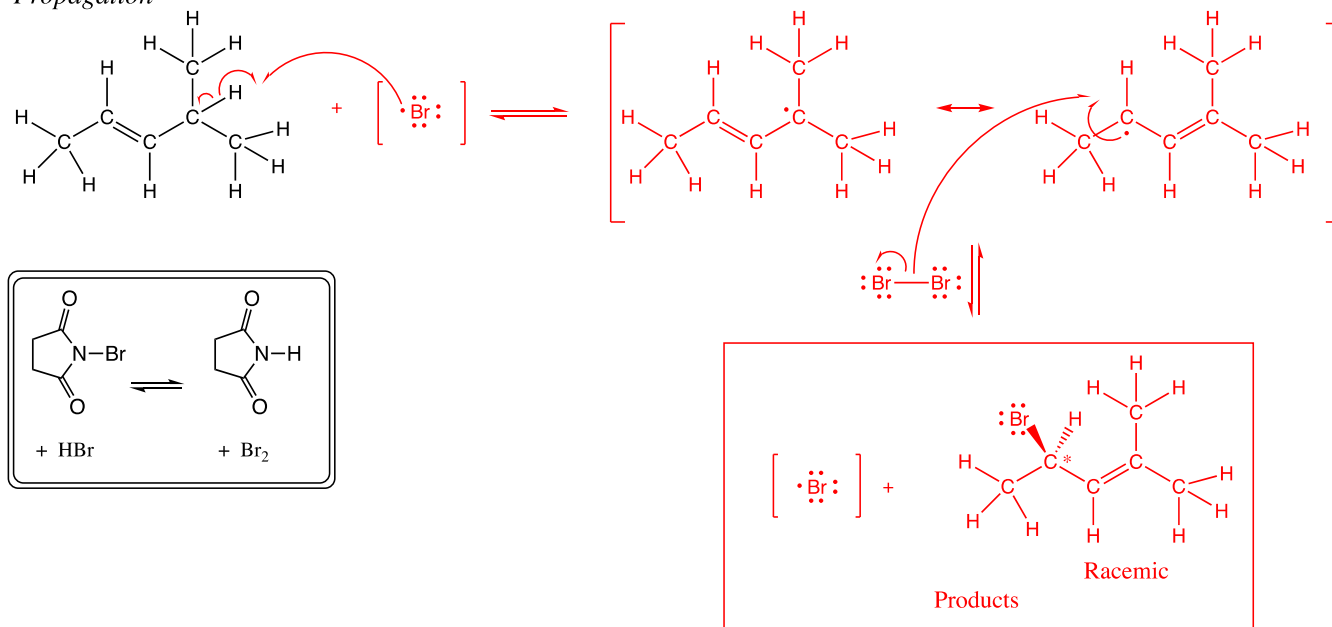
Draw the complete reaction mechanism for this reaction.

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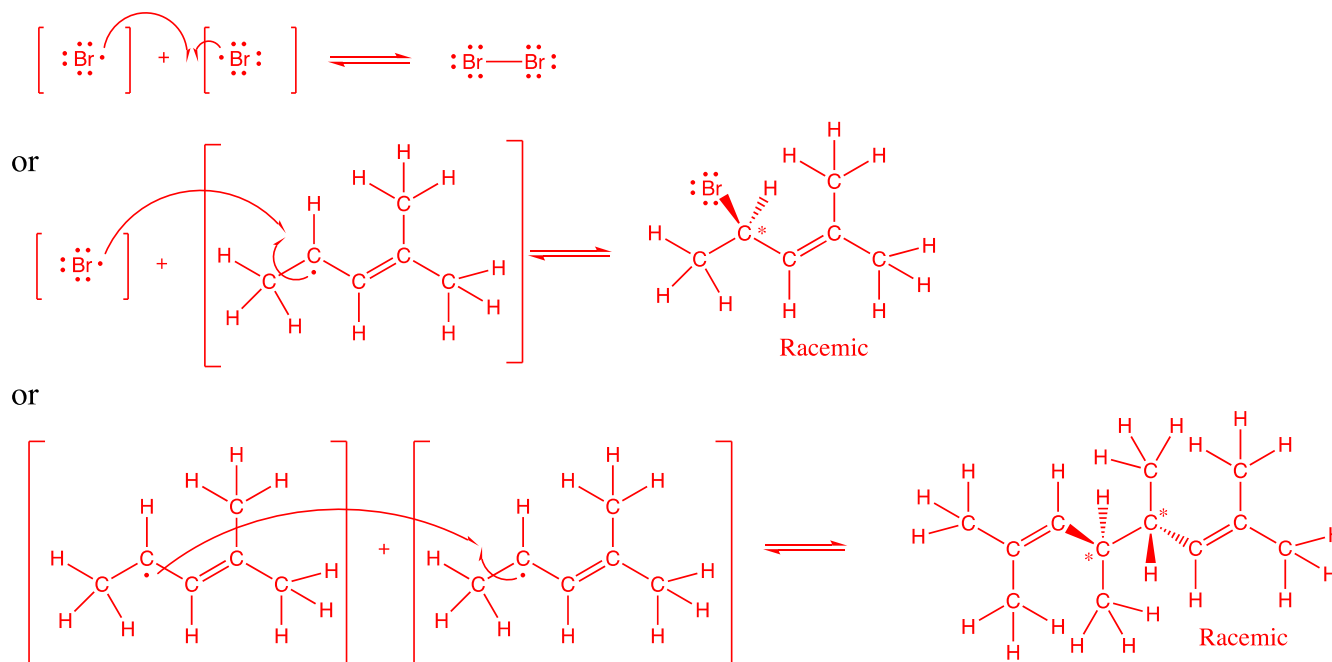
Initiation



Propagation

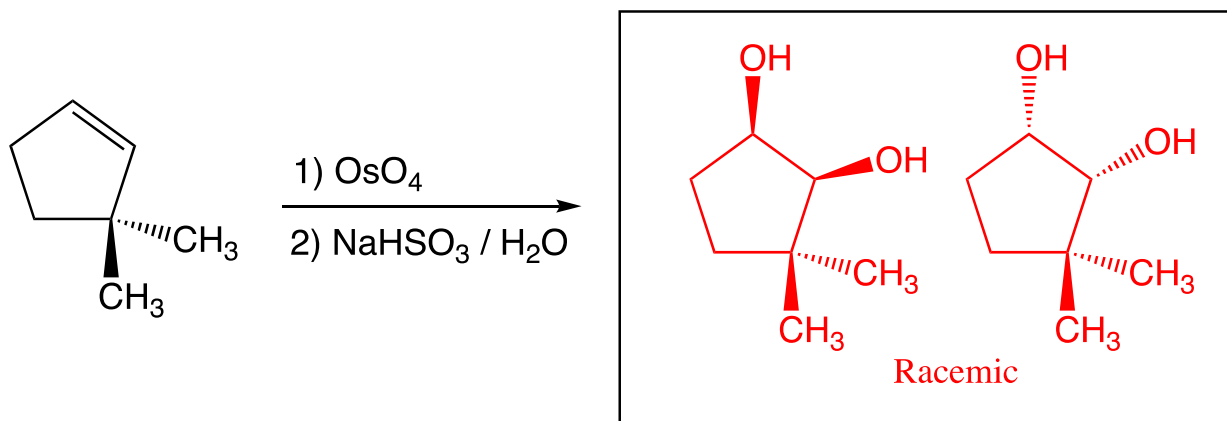
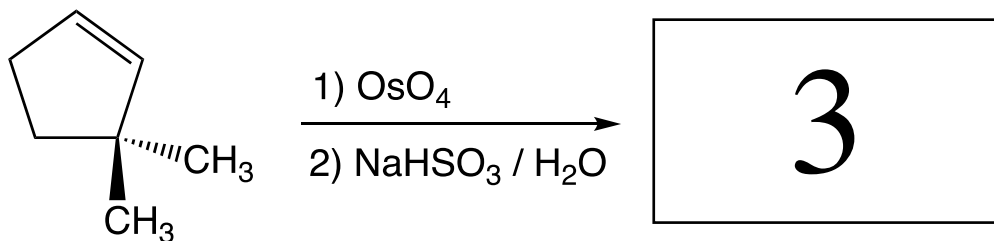
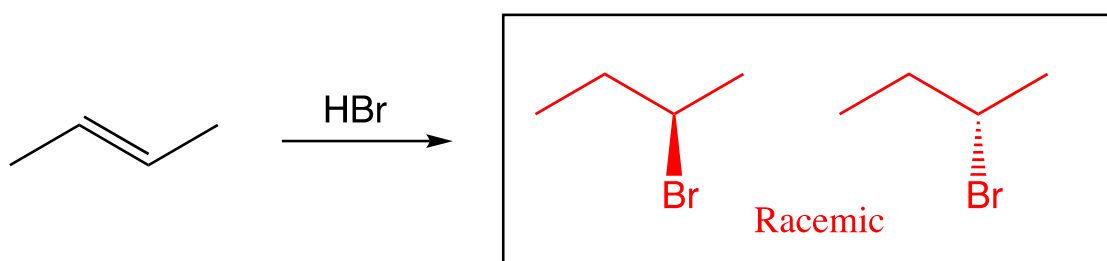
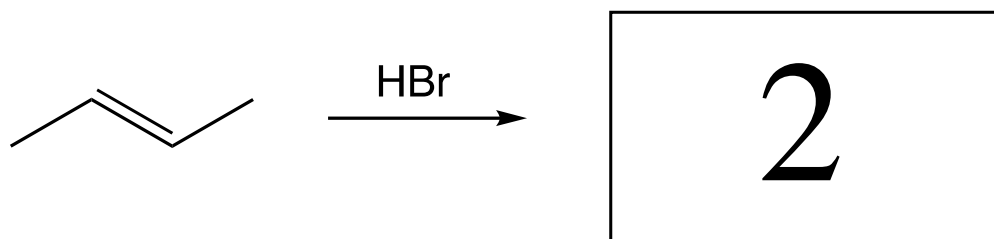


Termination

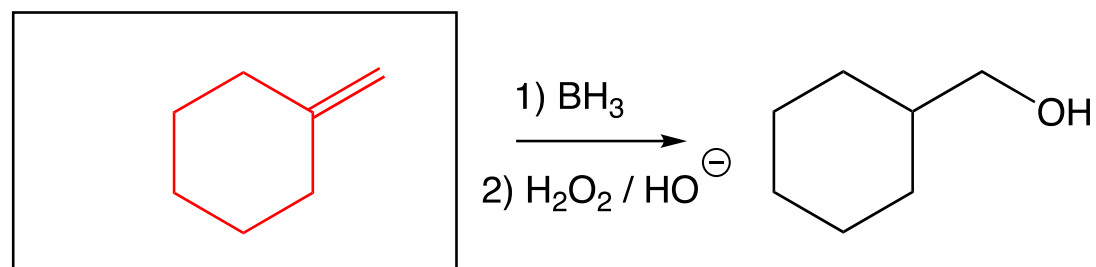
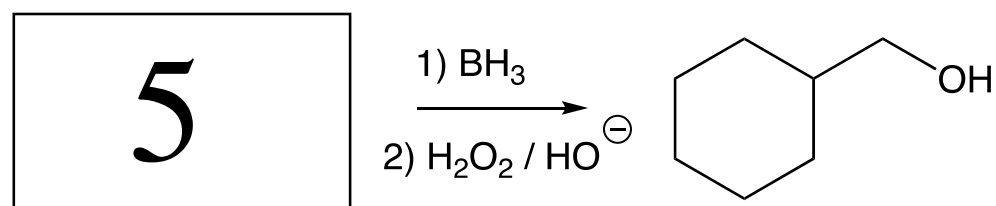
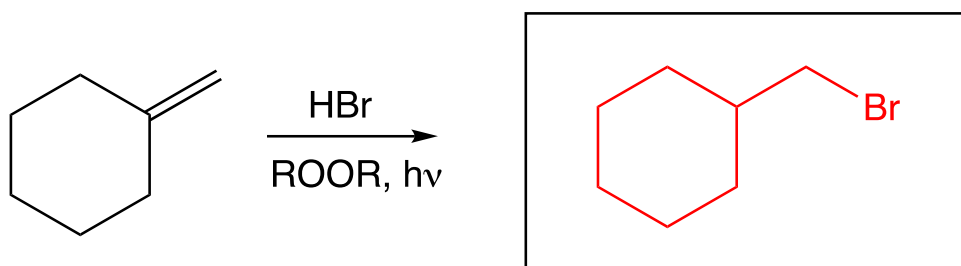
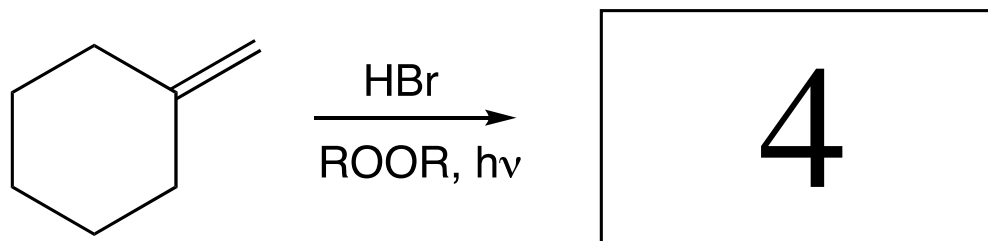


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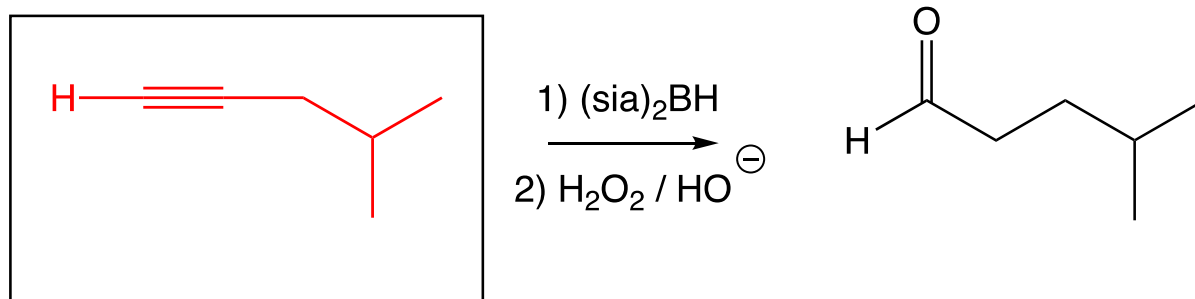
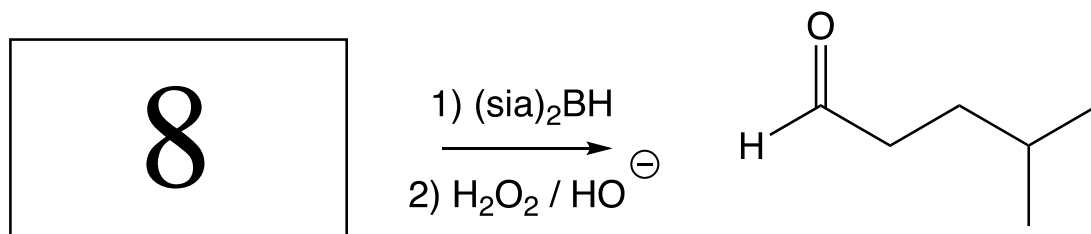
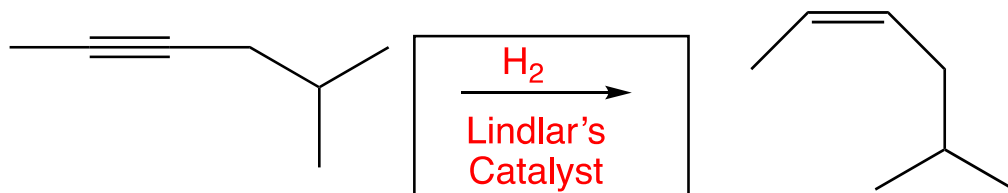
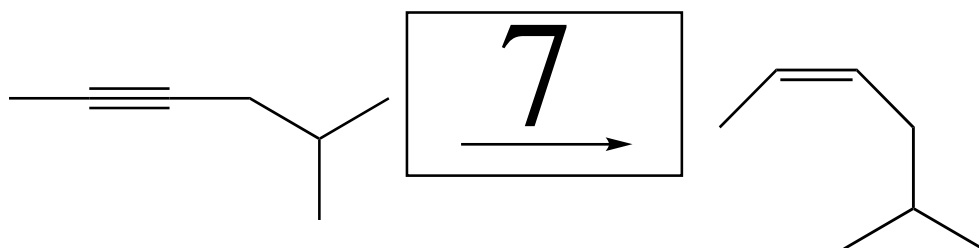
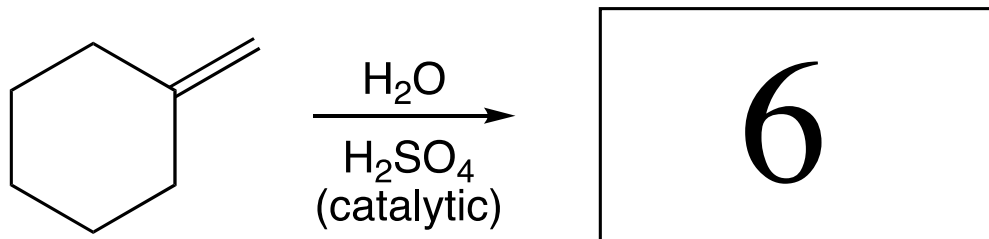
Questions 2 – 19 are worth 75 points total. For the following reactions, fill in the box with the predominant **starting materials**, **product(s)**, or **reagent(s)** necessary to complete the following reactions. **You must indicate stereochemistry with wedges and dashes.** **You must draw all stereoisomers** produced as predominant products **and write "racemic"** under the structures when appropriate.



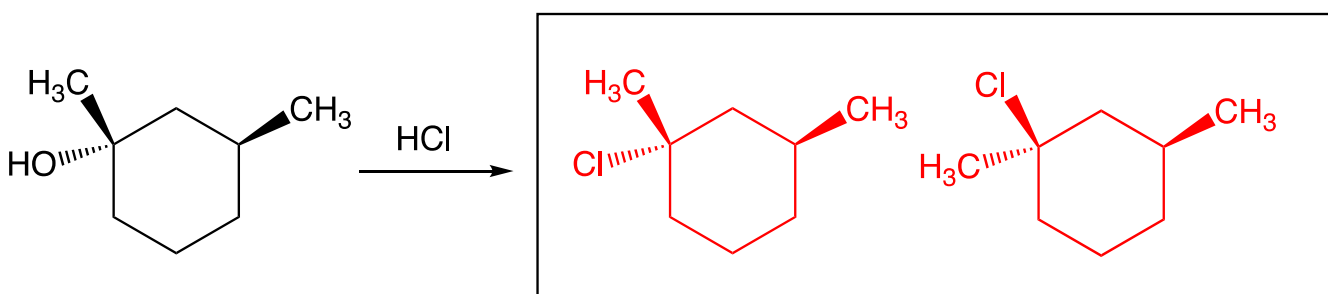
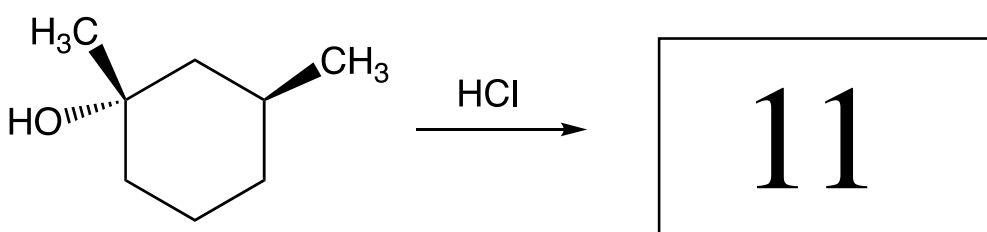
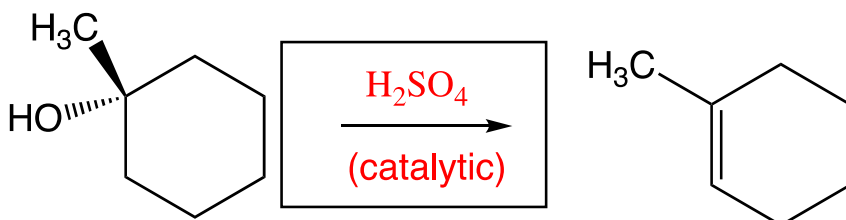
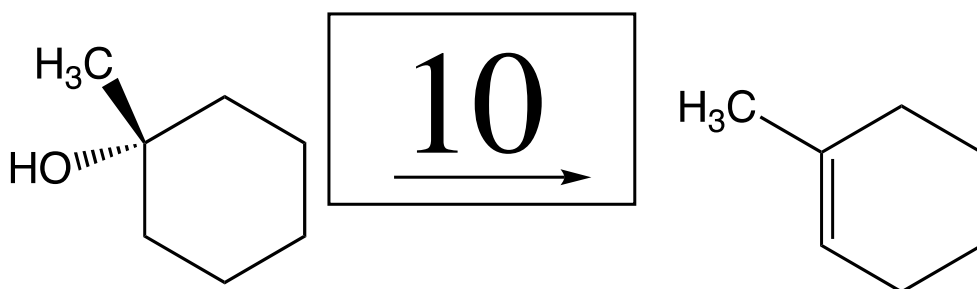
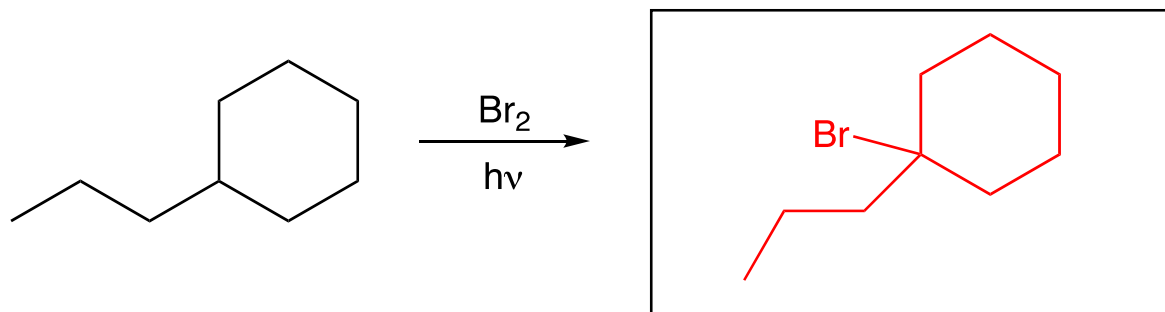
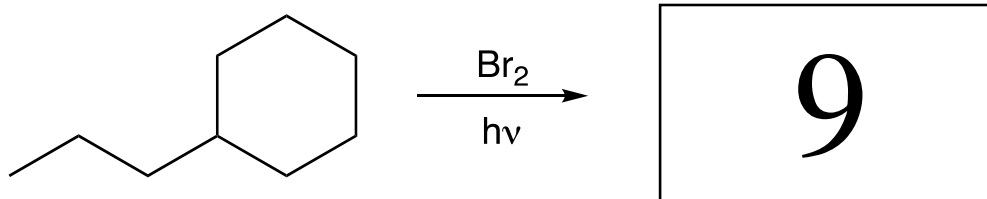
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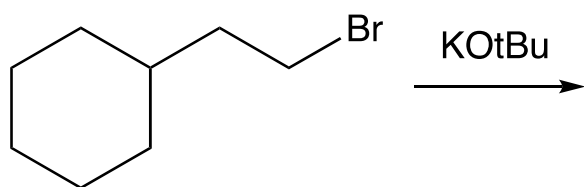
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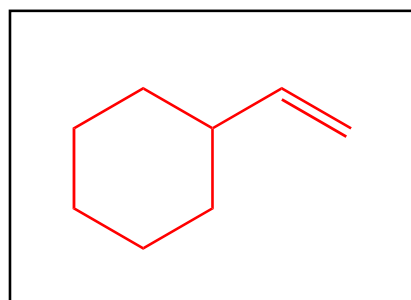
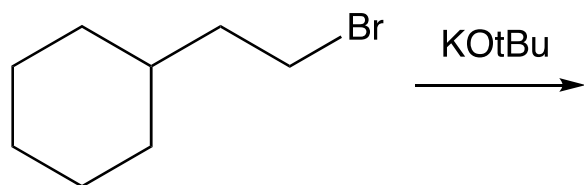
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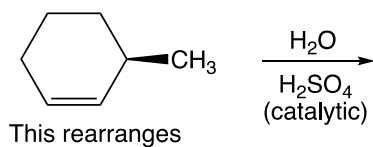
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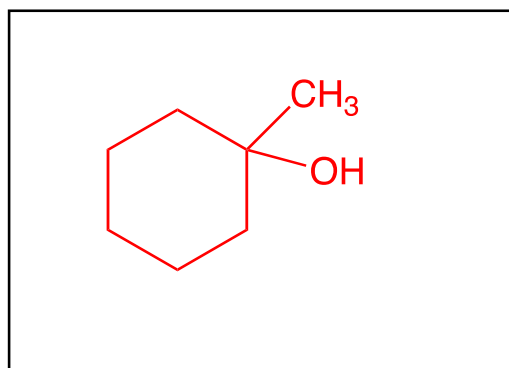
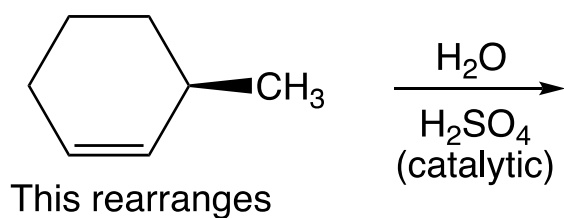
12



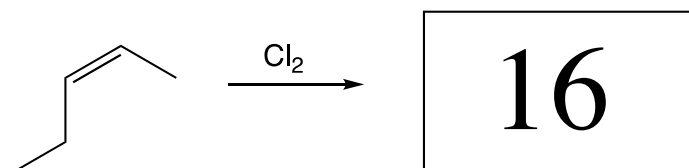
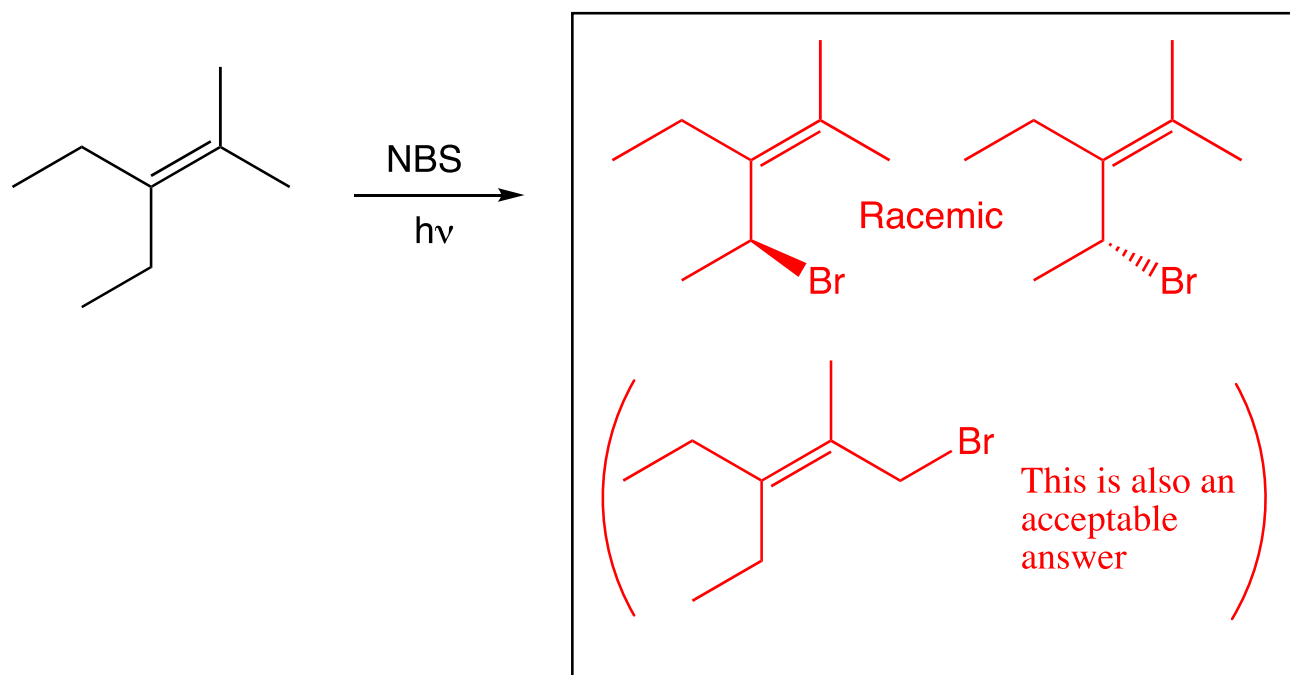
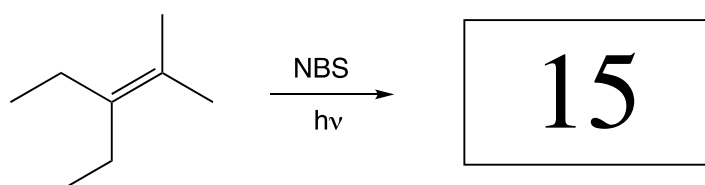
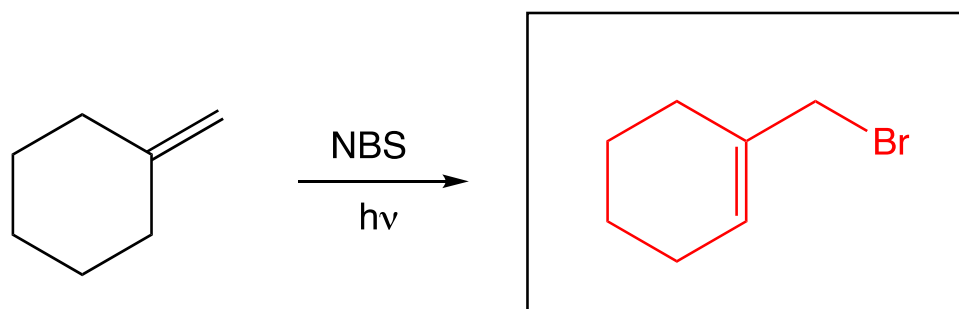
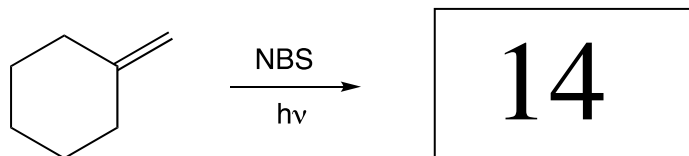
These next ones might take you some more time to think through all of the details (The same directions for the problems 2-12 still apply).



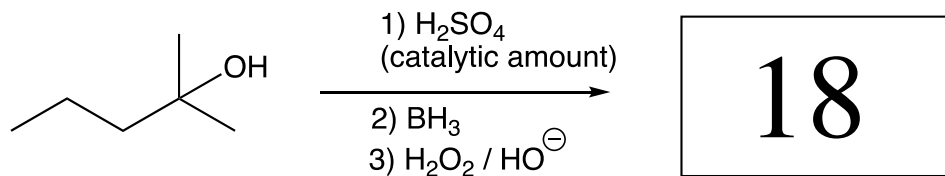
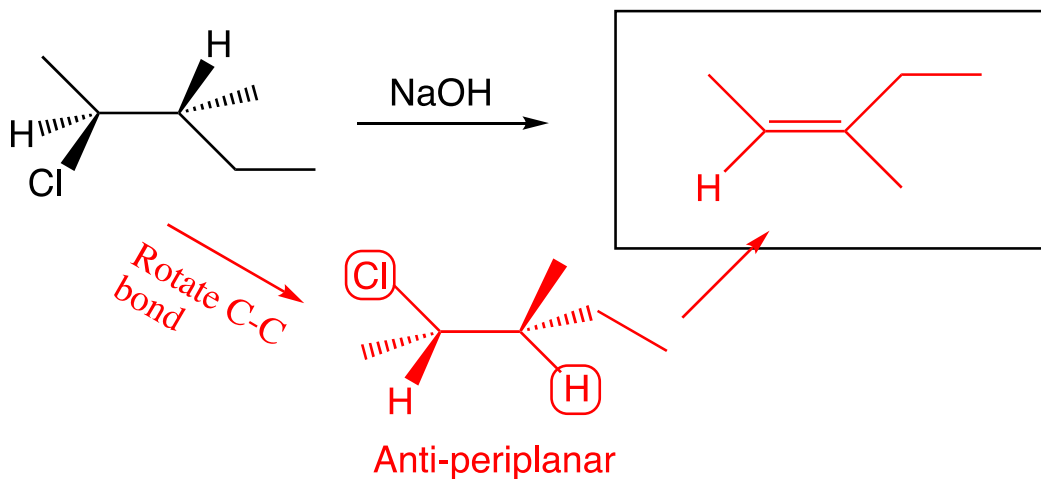
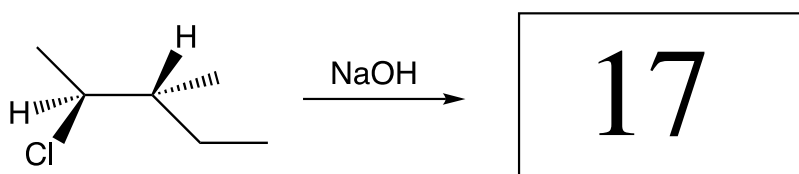
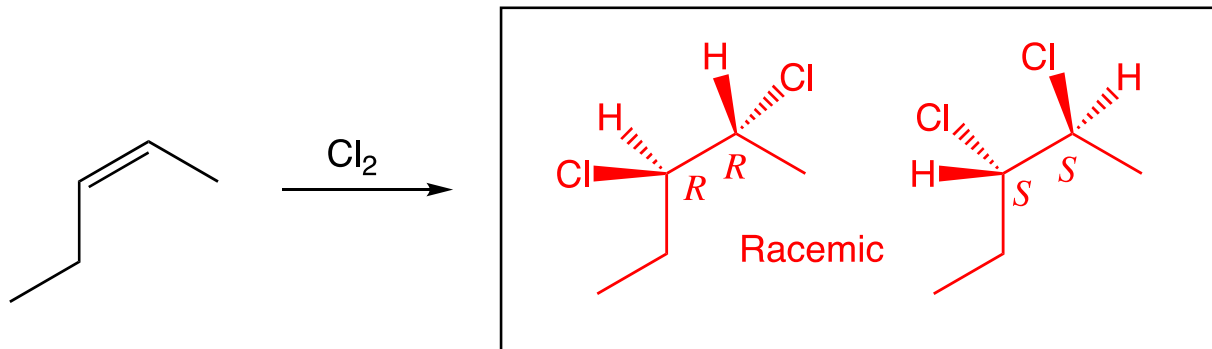
13
Draw the Rearranged Product(s) Only



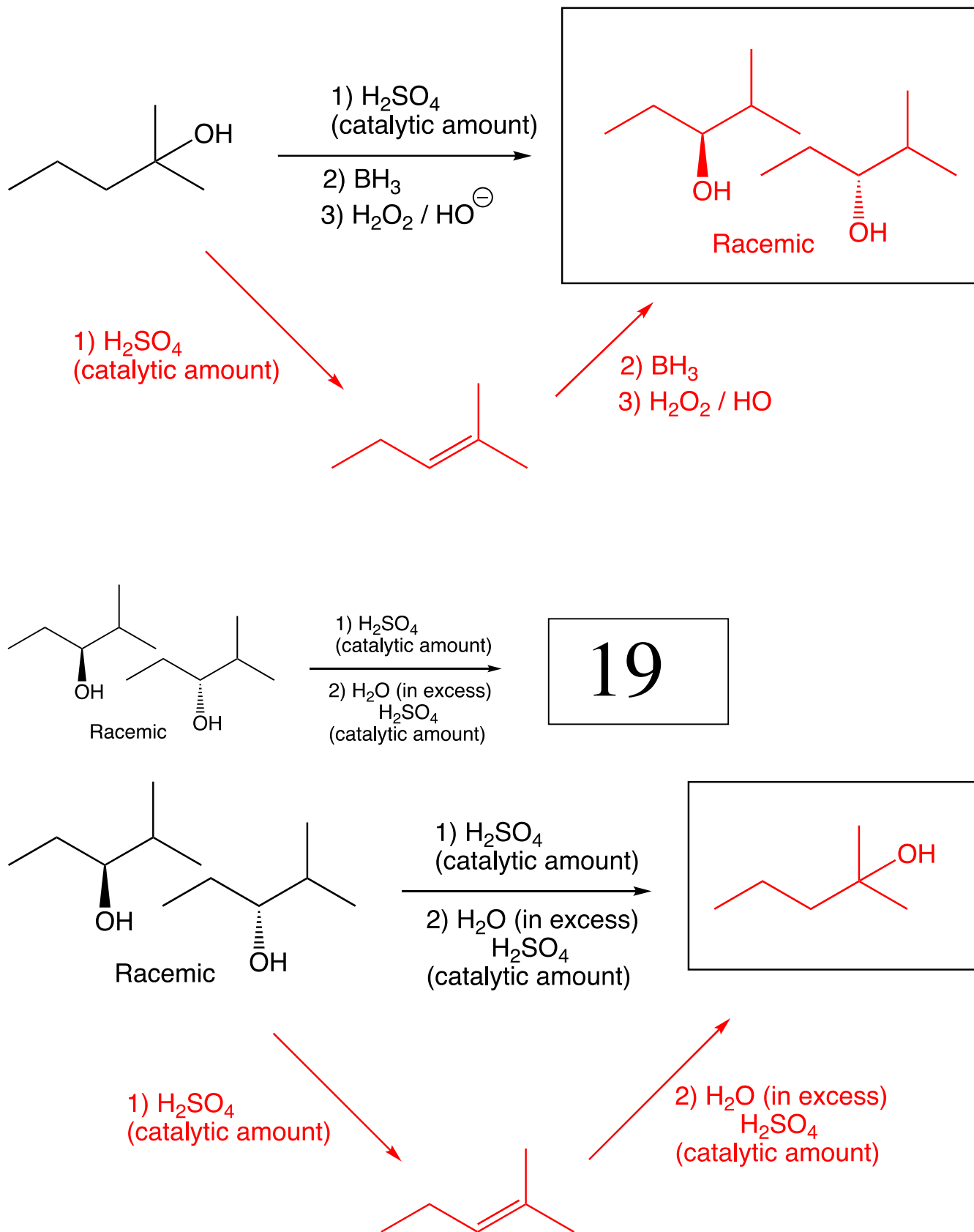
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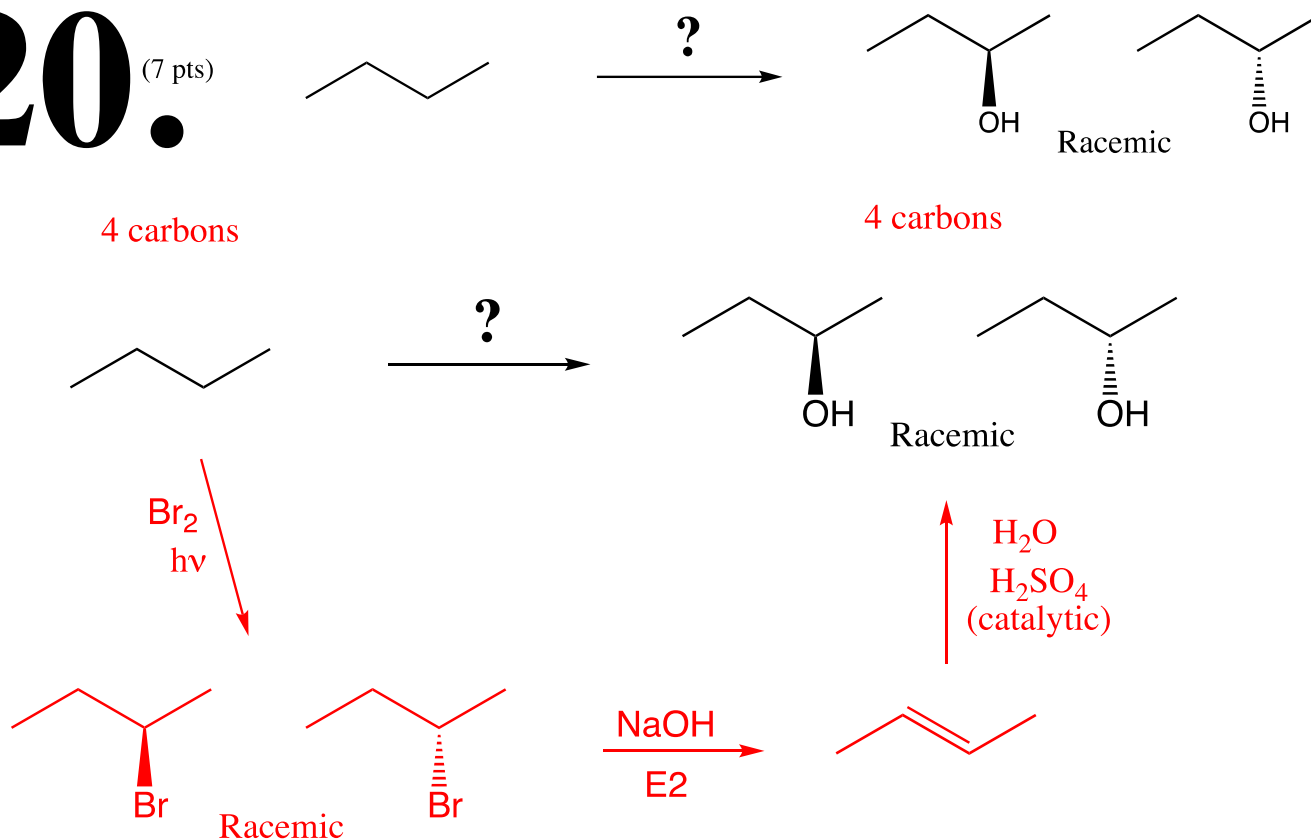
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Questions 20 – 23 are synthesis questions worth a total of 40 points.

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 materials.**

20.

(7 pts)

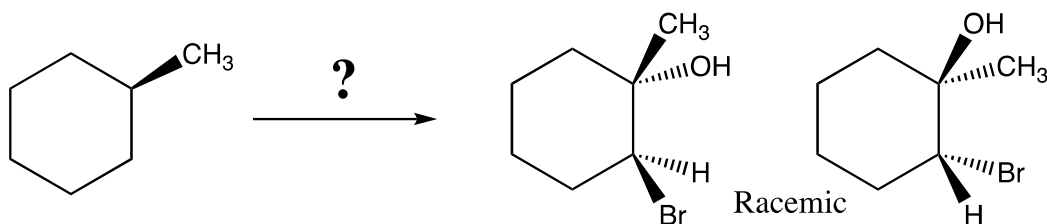


Recognize the product is a secondary alcohol. According to the roadmap, a great way to make an alcohol is from an alkene. Since alkenes are made from alkanes (I-35) using $\text{Br}_2/h\nu$ followed by an E2 reaction using strong base (such as NaOH). Therefore, assume the alkene used in the last reaction is the Zaitsev product of an E2 reaction, *E*-2-butene. Note that because of symmetry of the alkene, you also could have used 1) BH_3 followed by 2) H_2O_2 , HO^- in place of the $\text{H}_2\text{O}/\text{H}_2\text{SO}_4$ (catalytic amount).

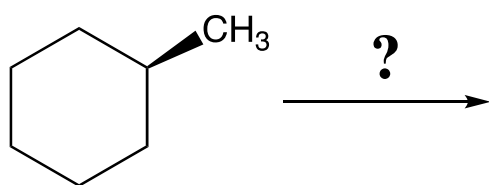
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21.

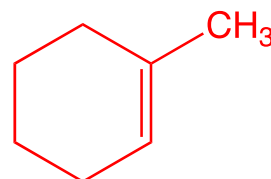
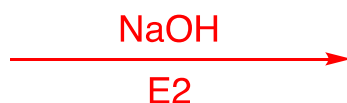
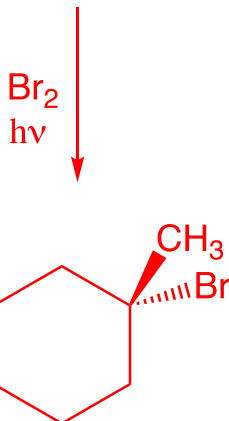
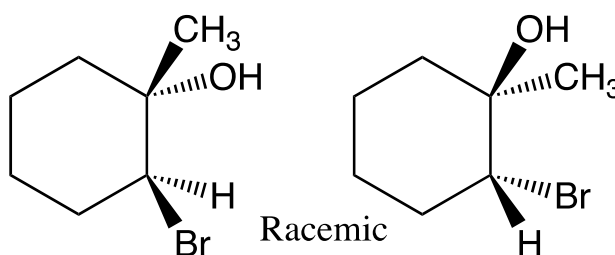
(7 pts)



7 carbons



7 carbons

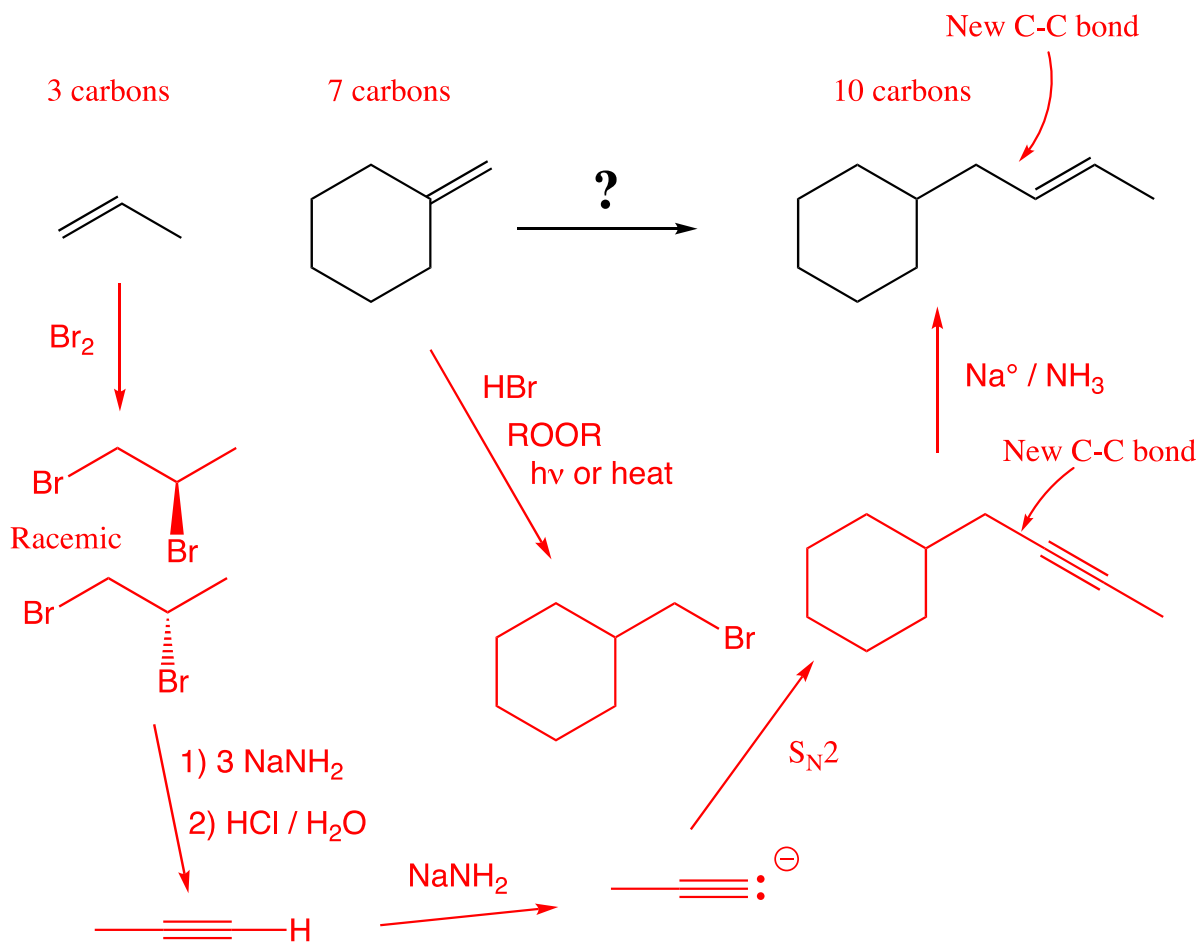
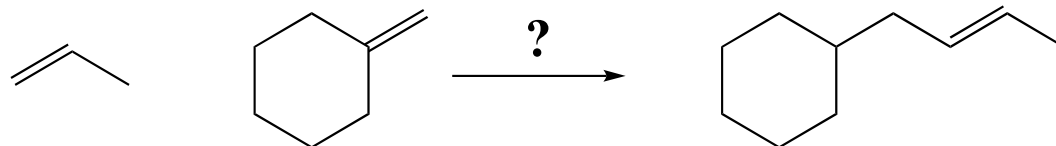


Recognize that the product is a halohydrin, and the OH is on the more substituted C atom as predicted by Markovnikov's rule. Therefore, predict the last reaction uses $\text{Br}_2/\text{H}_2\text{O}$ reacting with the corresponding alkene. The starting alkene can be converted to the alkene by a trip up I-35 from alkane to an alkene using $\text{Br}_2/h\nu$ followed by an E2 reaction with strong base

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22.

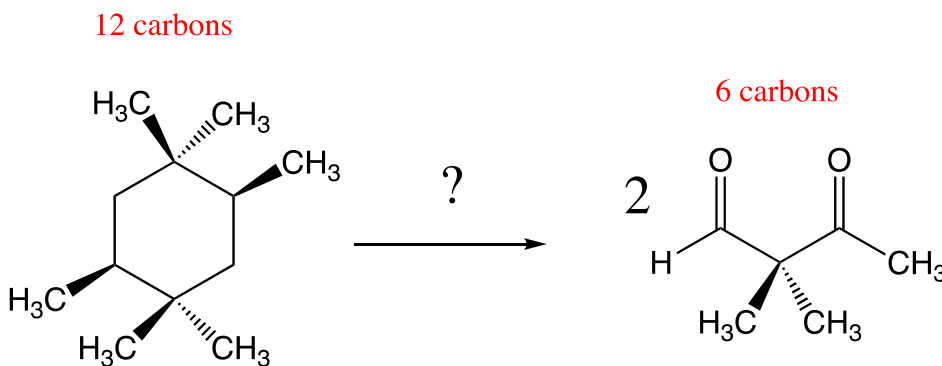
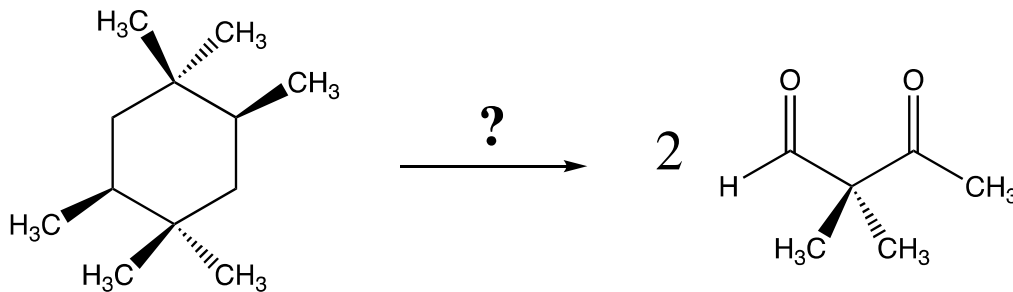
(16 pts)



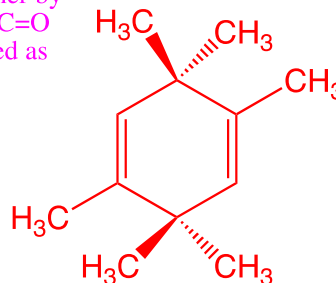
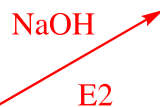
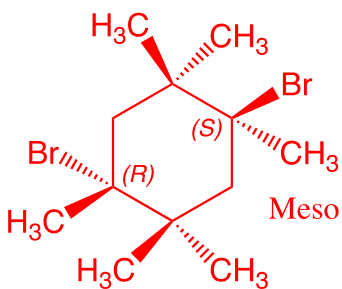
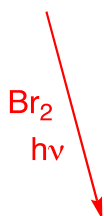
Recognize that the product has 10 carbons, while the starting materials have 3 and 7 carbons, respectively. Therefore, assume there is a new carbon-carbon bond made as shown. That means the two starting materials will be combined using an alkyne anion and primary haloalkane as that is the only C-C bond forming reaction we know so far. **Recognize** further that the C=C of the product most likely derives from the alkyne used in the C-C bond-forming step. Therefore, the last step must be the $\text{Na}^\ominus/\text{NH}_3$ reaction to give an *E* alkene as shown. That then defines the alkyne anion as being derived from the 3-carbon starting material, so the primary haloalkane must derive from the 7-carbon piece as shown. **Recognize** that the primary haloalkane is made in a single step from the 7-carbon alkene using the non-Markovnikov addition of HBr to the alkene in the presence of ROOR and $h\nu$ or heat. **Recognize** that the alkyne can be made from the 3-carbon alkene by traveling up I-35 using the reaction with Br_2 followed by strong base (1) 3 NaNH_2 then 2) $\text{HCl}/\text{H}_2\text{O}$ because it is a terminal alkyne product). Deprotonation of the terminal alkyne sets up the $\text{S}_{\text{N}}2$ reaction with the alkyne anion and primary haloalkane to give the 10-carbon alkyne structure that can lead to the reduction step.

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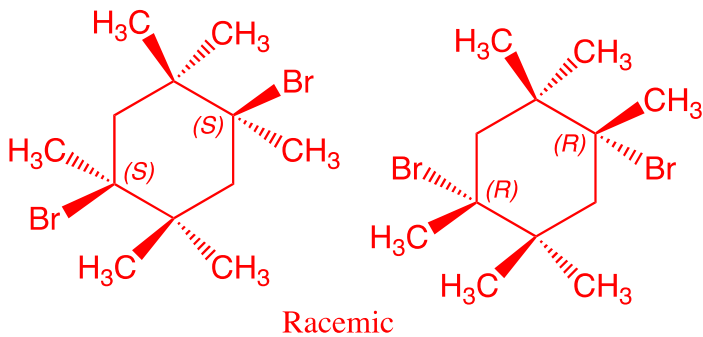
23. (10 pts)



Recognize that the product is 2 molecules of 6 carbons each and the starting material has 12 carbons. Recognize further the product is a diketone, which confirms the last step is the only C=C bond breaking reaction, ozonolysis. Put the pieces together by making new C=C to replace the C=O bonds to identify the diene needed as shown



- 1) O₃
- 2) (CH₃)₂S



Recognize that the required diene can be made by a double E2 reaction from exactly the haloalkane that comes from the alkane starting material. The hard part here is stereochemistry, as you get three stereoisomers, a racemic mixture of enantiomers and a meso compound.