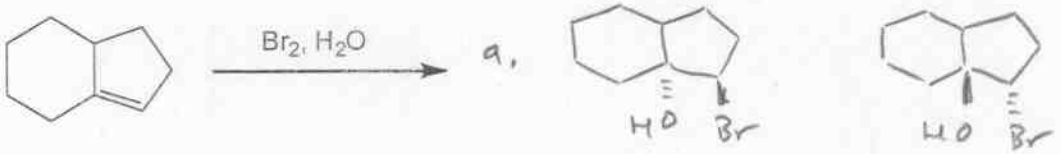
1. Consider the reaction of the alkene shown below.

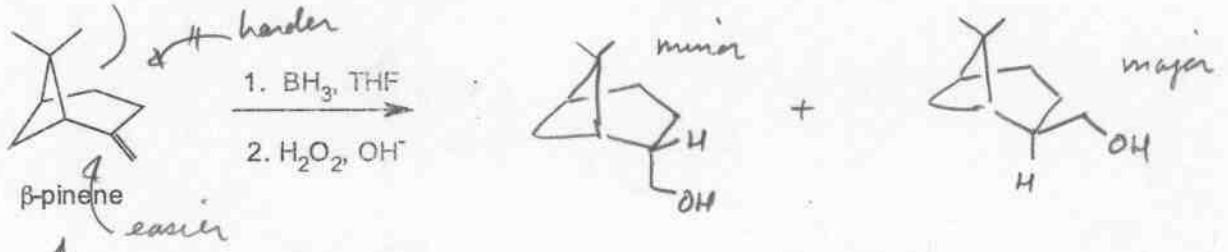
   a. Show *all* of the products formed in this reaction.
   b. Indicate whether the addition proceeds with *anti* or *syn* addition.
   c. Does the addition follow Markovnikov's rule? Explain (15 points)



b. anti

c. Yes. The more electronegative element ends up on the more substituted carbon

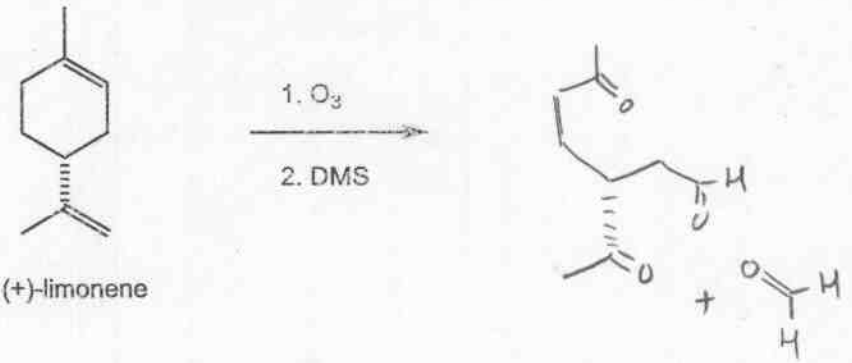
2. The reaction of β-pinene, shown below, yields two products (isomers) in unequal amounts. Show the structure of these two compounds and suggest which one is the major one produced. Also, indicate what the relationship of the isomers are – enantiomers, diastereomers, or constitutional isomers. (20 points)



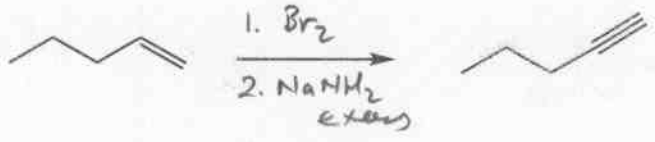
bottom approach of BH_3 is less hindered than top due to steric hindrance

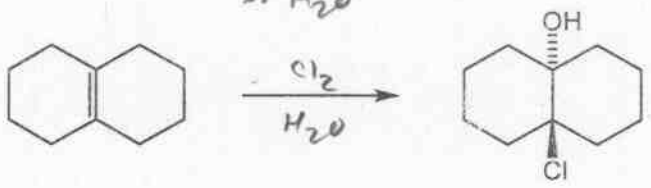
diastereomers

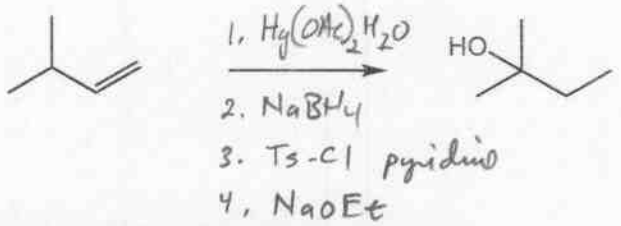
3. Show all of the products from the ozonolysis of (+)-limonene (found in orange and lemon peels). (10 points)



4. Fill in the *reagents* required to accomplish the following reactions. (15 points)

a 

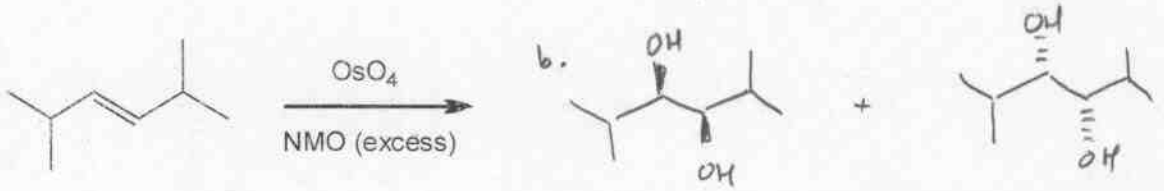
b 

c 

5. Consider the reaction of the alkene below.

a. Does the reaction proceed with *syn* or *anti* addition?
b. Show any and all products with the resulting stereochemistry using the correct notation (line, dash or wedge)
c. How many and what type of isomers are produced?
d. Are any *meso* compounds produced? (20 points)

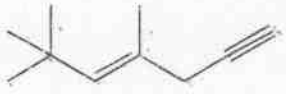
a. Syn

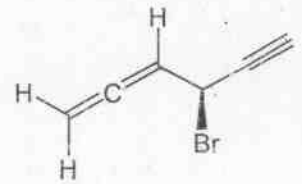


c. 2 isomers produced - enantiomers

d. No

6. Name the following compounds. Don't forget about stereochemistry. (10 points)

a 

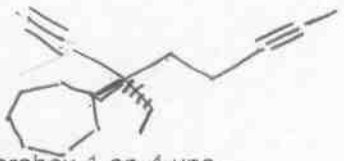
b 

(4S)-4-bromohexa-1,2-dien-5-yne

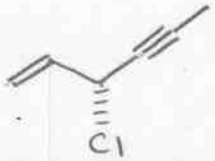
(E)-4,6,6-trimethylhept-4-en-1-yne

7. Draw the structures of the following compounds. (10 points)

a. (*S*)-3-cycloheptyl-3-ethylocta-1,6-diyne

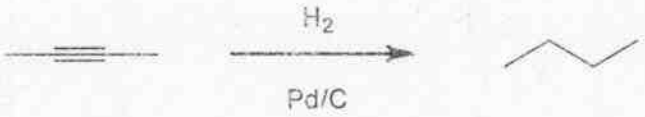


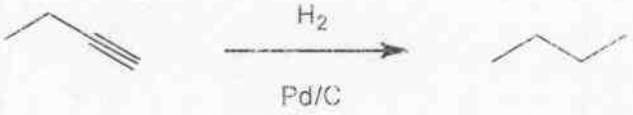
b. (*R*)-3-chlorohex-1-en-4-yne



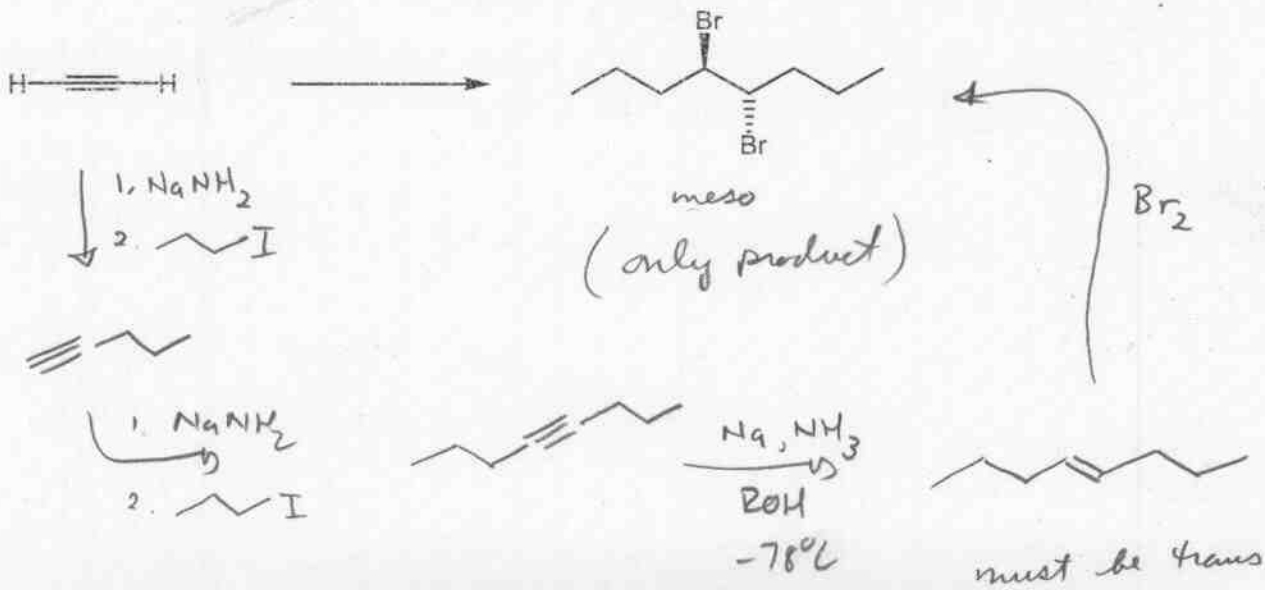
8. Hydrogenation of 2-butyne and 1-butyne are both exothermic, ΔH = -275 kJ/mol and -292 kJ/mol, *respectively*. Which alkyne is more stable and explain how the data indicate this?

(10 points)

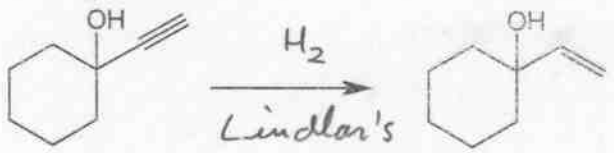
a 

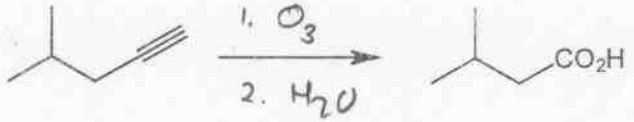
b 

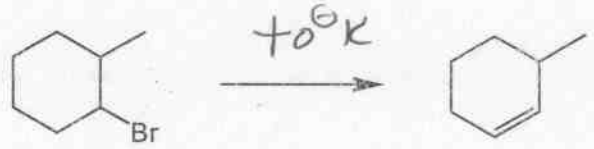
9. Show reagents and conditions to prepare the product shown below starting from acetylene. You can use any other reagents, but your synthesis must use acetylene (also, note the stereochemistry of the product). (10 points)



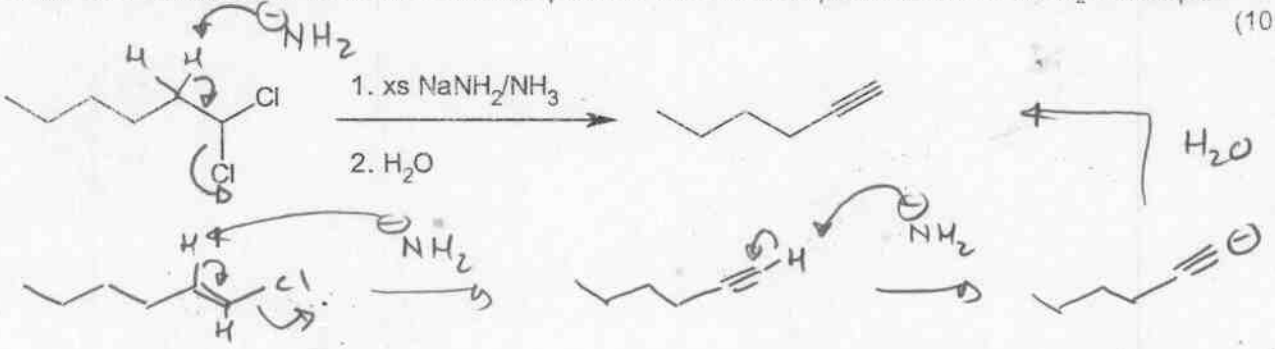
10. Fill in the *reagents* required to accomplish the following reactions. (15 points)

a 

b 

c 

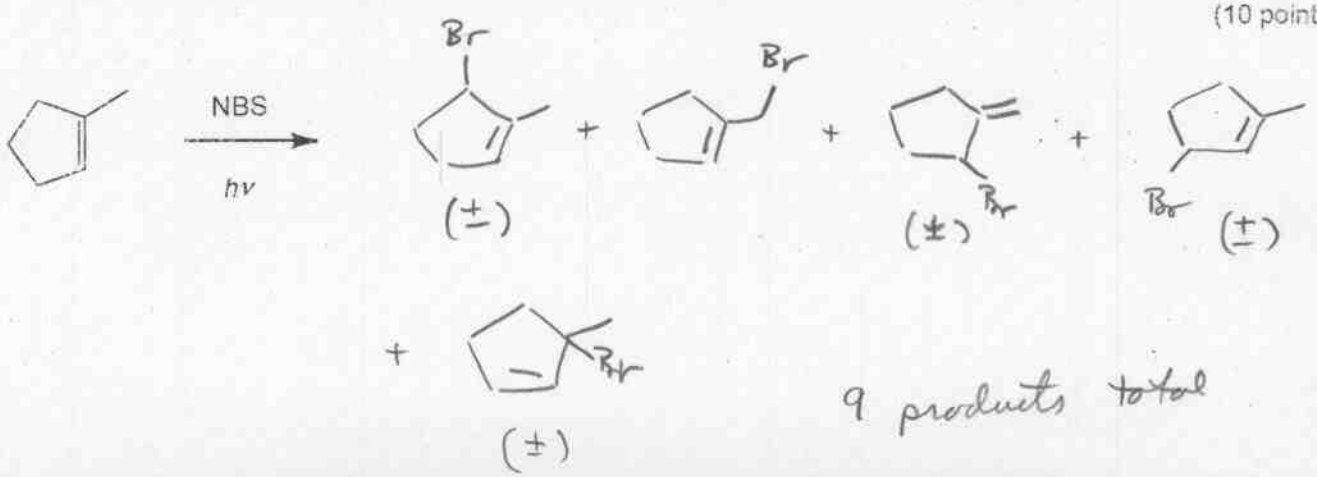
11. Show the mechanism for the formation of the product. Be sure to explain the role of the H_2O in step 2. (10 points)



(mostly trans)

Water is used to protonate the final acetylide ion

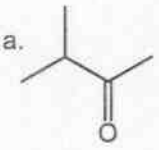
12. Show the product(s) from the reaction shown below. (Hint. there is more than one product!) (10 points)



9 products total

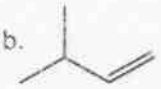
13. Show how to convert the alkyne below to each of the following compounds – show a separate list of reagents and conditions for each case. List the reagents and conditions below each compound (some of these may require more than one step!). You do not need to show any mechanisms or intermediates. (25 points)

a.



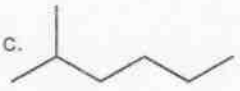
H_2SO_4
H_2SO_4
H_2O

b.



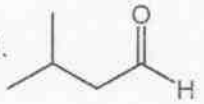
H_2
Lindlar's
or
Na, NH_3
ROH
$-78^{\circ}C$

c.



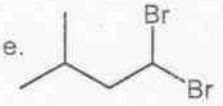
1. $NaNH_2$
2. 
3. H_2
Pd

d.



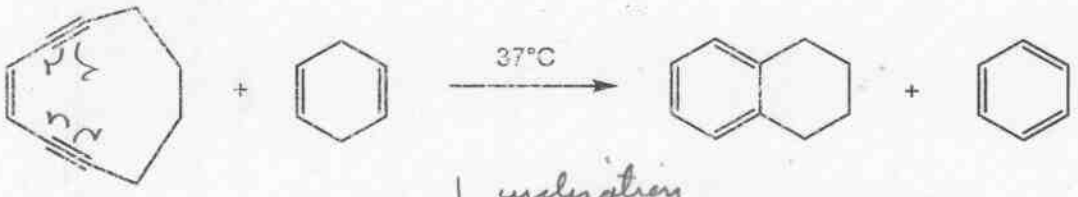
1. 9-BBN
2. H_2O_2
$\ominus_{OH}$

e.



1. H-Br, ROOR
2. HBr

14. EXTRA CREDIT – Challenge Problem. Show the mechanism of the Bergman cyclization of the "enediyne." The mechanism should account for the conversion of 1,4-cyclobutadiene to benzene. (20 EC points)



1 cyclization
2 separate H-abstractions