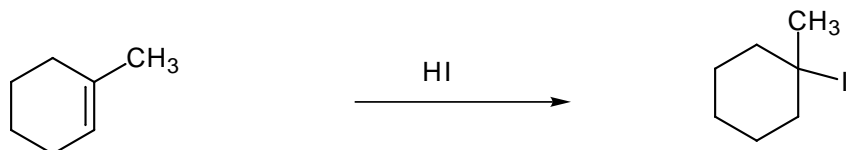
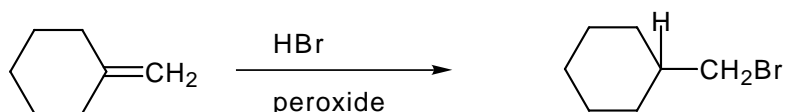


I. REACTIONS: Predict the major organic products of the following reactions.
INDICATE STEREOCHEMISTRY AS NEEDED. (4 points each)

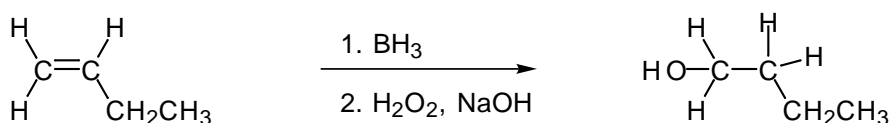
1.



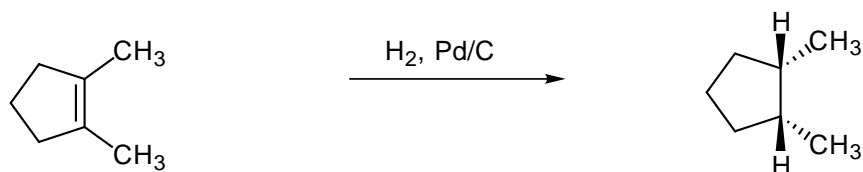
2.



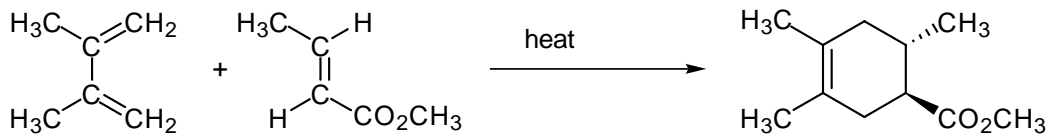
3.



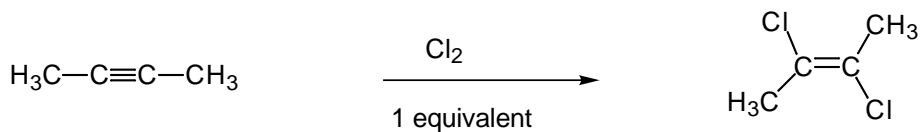
4.



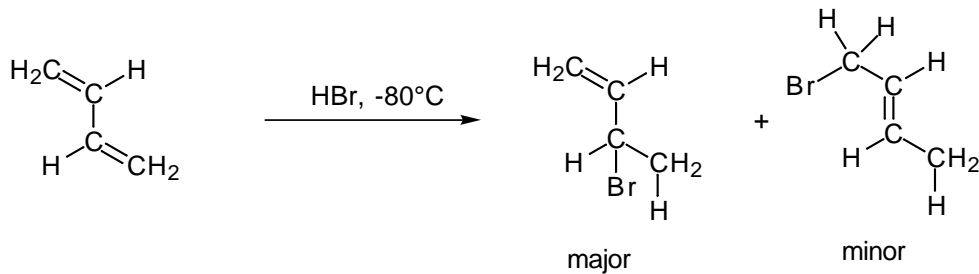
5.



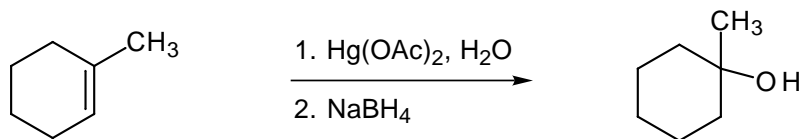
6.



7.



8.



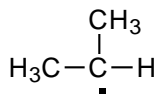
II. Multiple Choice: Place the letter in the blank and Circle the best answer (**only one**). (4 points each)

a 9. The rate limiting step for hydration of an alkene with water and acid is

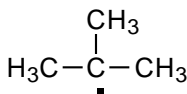
- protonation of the alkene by a strong acid
- addition of water to a carbocation to form the protonated alcohol
- loss of a proton from the protonated alcohol to form the alcohol.
- simultaneous addition of H^+ and HO^- to the alkene.

d 10. Which of the following free radicals is the most stable?

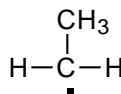
a.



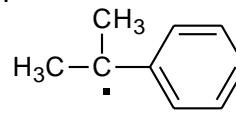
c.



c.



d.



b 11. Which of the following indicated hydrogens is the most acidic?

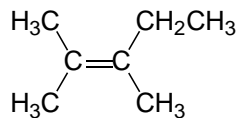
- $CH_3CH=CH_2$
- $CH_3C\equiv C-H$
- $CH_3CH_2CH_3$
- $H-CH_2CH_2OCH_3$

b 12. In the addition of HBr to 1,3-butadiene the 1,2 product predominates at $-80^\circ C$ while the 1,4 product predominates at $40^\circ C$. The 1,4 product is said to result from

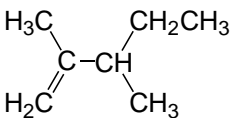
- kinetic control.
- thermodynamic control.
- a Diels Alder reaction.
- the s-cis diene.

a 13. Which of the following alkenes would have the lowest heat of hydrogenation?

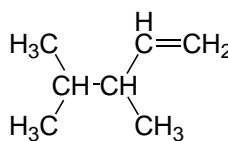
a.



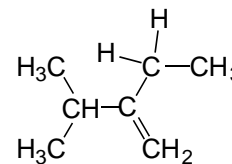
b.



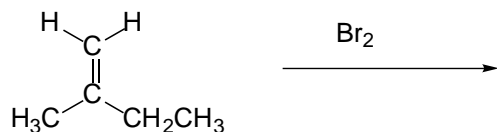
c.



d.



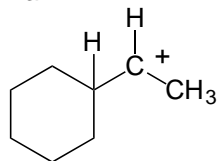
b 14. What is the stereochemical relationship of the products of the following reaction?



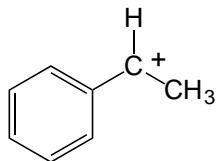
- diastereomers
- enantiomers
- identical (only one stereoisomer of the product is formed).
- cis-trans isomers
- conformational isomers

d 15. Which of the carbocations below is the most stable?

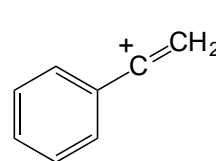
a.



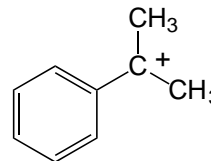
b.



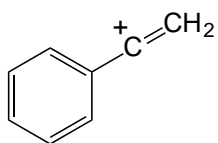
c.



d.



__c_16. What is the hybridization of the positively charged carbon in the carbocation below?



a. sp^3

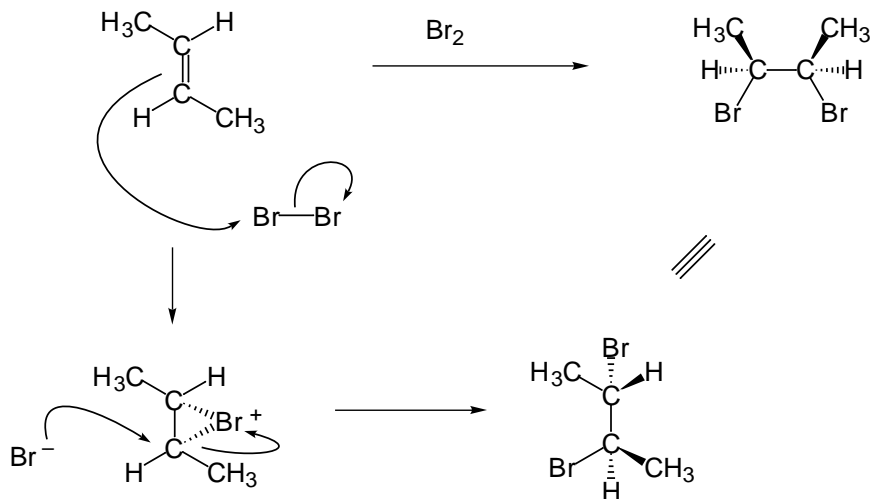
b. sp^2

c. sp

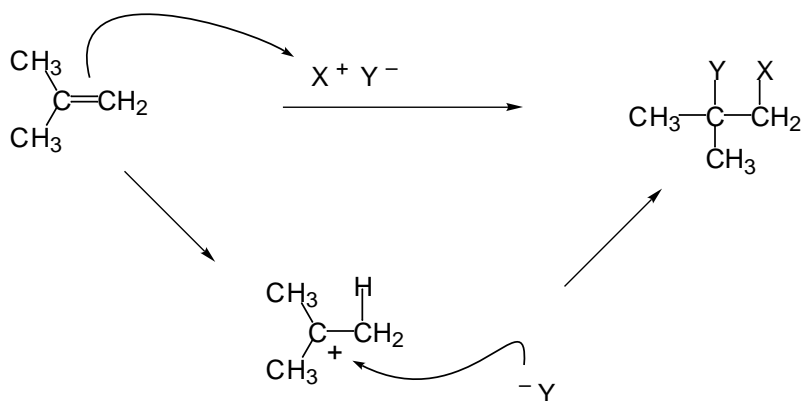
d. s

V. Mechanisms. Give a stepwise, detailed mechanism with arrows and intermediates for the following reactions. Be sure to account for stereochemistry as needed. (6 points each)

17.

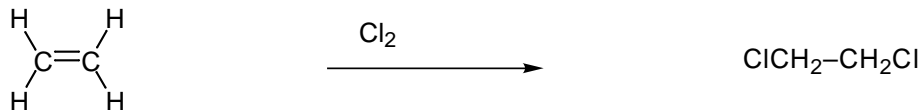


18.

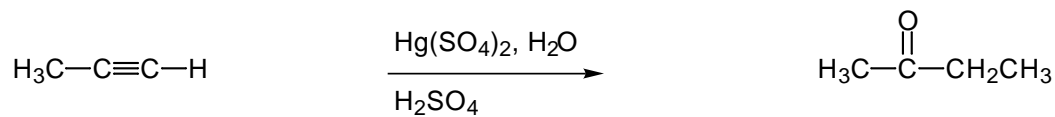


Syntheses: Give reagents to carry out the transformations below. (5 points each)

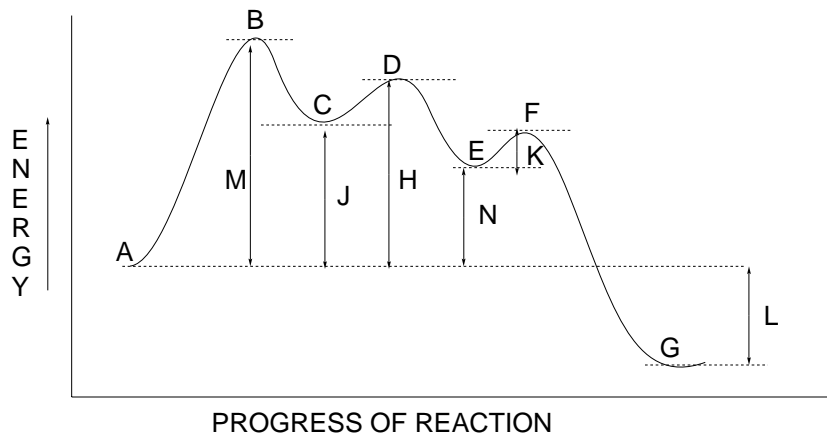
19.



20.

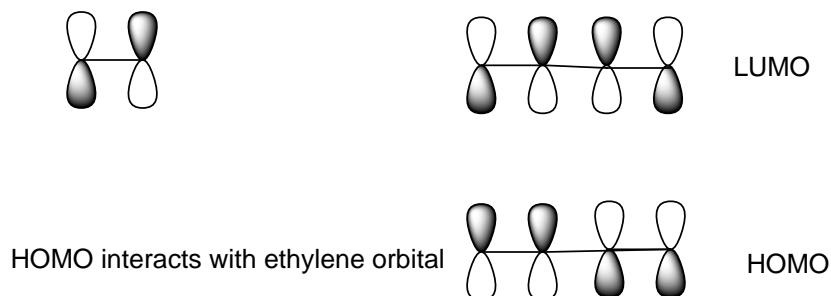


21. Consider the energy diagram below and answer the questions using the letters on the diagram. (10 points).



- What point(s) in the diagram represent transition states? B, D, F
- What point(s) in the diagram represent intermediates? C, E
- What is the energy of activation for the reaction? M
- What is the rate-limiting step in the reaction? A to C
- Is the reaction endergonic or exergonic? exergonic
- What is the free energy change of the reaction? L
- Does G or C form faster from E? G

22. Draw the HOMO (highest occupied molecular orbital) and the LUMO (lowest unoccupied molecular orbital) of 1,3-butadiene and label them. Circle the one which would interact favorably with the ethylene orbital below in a Diels-Alder reaction. (4 points)



PROBLEMS 5, 6,7, 20, 22 were not covered for the Exam on October 16, 2001