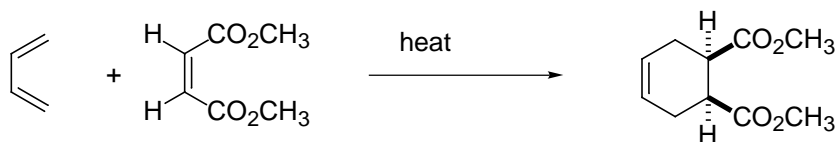
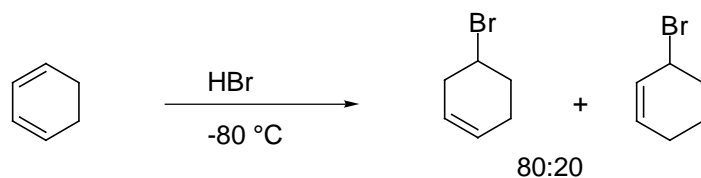


II. Reactions: Predict the major organic product of the following reactions. If more than one product is formed give both and indicate the **major** product. Indicate stereochemistry where necessary. (4 points each)

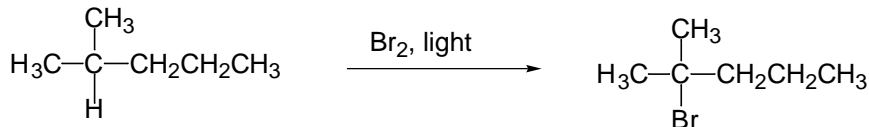
1.



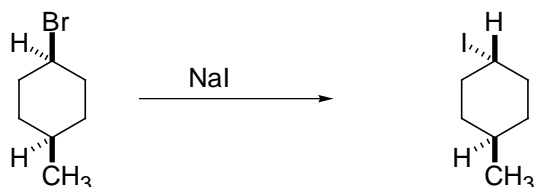
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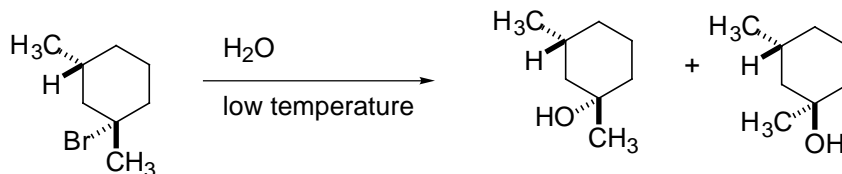
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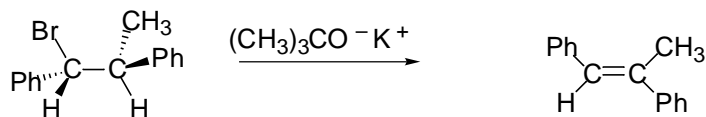
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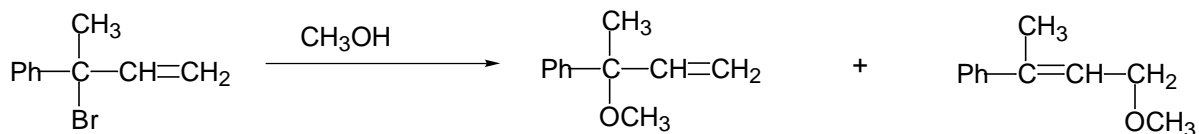
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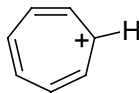
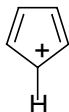
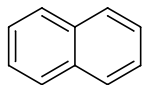
6.



7.



8. Indicate if the following compounds are aromatic, non-aromatic or anti-aromatic. (2 points each)



a. aromatic      b. anti-aromatic      c. aromatic      d. anti-aromatic      e. non-aromatic

9. List three criteria for aromaticity. (6 points)

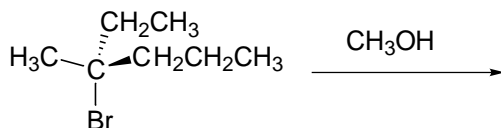
1. planar

2. 4n + 2 pi electrons

3. cyclic

II. Multiple Choice: Place the letter in the blank and Circle the best answer (**only one**). (3 points each)

A 10. In the following solvolysis reaction what is the relationship of the products formed?



- a. enantiomers                      c. structural isomers  
b. meso compound                  d. diastereomers

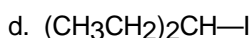
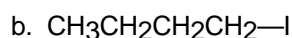
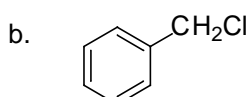
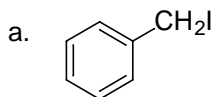
B 11. Which of the following reactions would proceed the fastest?

- a.  $\text{CH}_3\text{CH}_2\text{CH}_3 + \text{Br}_2 + \text{light} \rightarrow \text{CH}_3\text{CHBrCH}_3$   
b.  $\text{CH}_3\text{CH}_2\text{CH}_3 + \text{F}_2 + \text{light} \rightarrow \text{CH}_3\text{CHFCH}_3$   
c.  $\text{CH}_3\text{CH}_2\text{CH}_3 + \text{I}_2 + \text{light} \rightarrow \text{CH}_3\text{CHICH}_3$   
d.  $\text{CH}_3\text{CH}_2\text{CH}_3 + \text{Cl}_2 + \text{light} \rightarrow \text{CH}_3\text{CHClCH}_3$

D 12. Which of the following is the strongest nucleophile?

- a.  $\text{CH}_3\text{NH}^-$                       c.  $\text{CH}_3\text{O}^-$   
b.  $\text{Cl}^-$                               d.  $\text{CH}_3\text{Se}^-$

A 13. Which of the following alkyl halides would undergo the **fastest**  $\text{S}_{\text{N}}2$  reaction?



B 14. Which of the following are "concerted" reactions?

- a.  $\text{S}_{\text{N}}1$                               d. electrophilic addition  
b. Diels-Alder reaction      e.  $\text{S}_{\text{N}}1$  and E1

- c. E1
- \_\_A\_\_ 15. Reaction of a hydroxide ion ( $\text{HO}^-$ ) with a primary alkyl halide is most likely to result in:
- a.  $\text{S}_{\text{N}}2$  substitution                      c.  $\text{S}_{\text{N}}1$  substitution  
b. E2 elimination                              d. E1 elimination

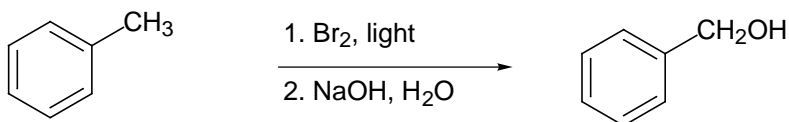
- \_\_B\_\_ 16. Which of the following statements is correct?
- a. Free radical bromination is more selective than chlorination because the transition state for bromination is more reactant-like.
- b. Free radical bromination is more selective than chlorination because the rate limiting step for bromination is more **endothermic** than for chlorination.
- c. Free radical bromination is more selective than chlorination because the rate limiting step for bromination is more **exothermic** than for chlorination.
- d. Free radical chlorination is more selective than bromination because the transition state for chlorination is more reactant-like.

- \_\_D\_\_ 17. Which of the following would be the rate limiting step in a free radical halogenation?
- a.  $\text{CH}_3\text{CH}_2\cdot + \text{Br}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{Br}\cdot$   
b.  $\text{Br}_2 \rightarrow 2 \text{Br}\cdot$   
c.  $2 \text{CH}_3\text{CH}_2\cdot \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$   
d.  $\text{CH}_3\text{CH}_3 + \text{Br}\cdot \rightarrow \text{CH}_3\text{CH}_2\cdot + \text{HBr}$

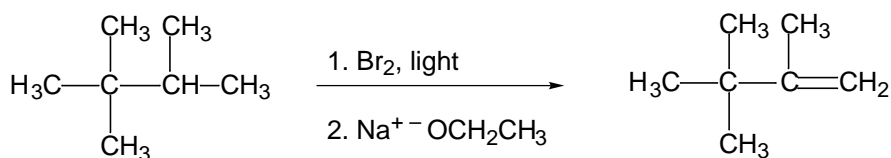
- \_\_F\_\_ 18. Ionization to give a carbocation and a leaving group is the rate determining step for
- a.  $\text{S}_{\text{N}}1$                       c. E1 and E2                      e.  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$   
b.  $\text{S}_{\text{N}}2$                       d. E1                                  f.  $\text{S}_{\text{N}}1$  and E1

Syntheses. Give reagents to show how to synthesize the compounds on the right from the compounds on the left. They may require more than one step. (4 pts each)

19.

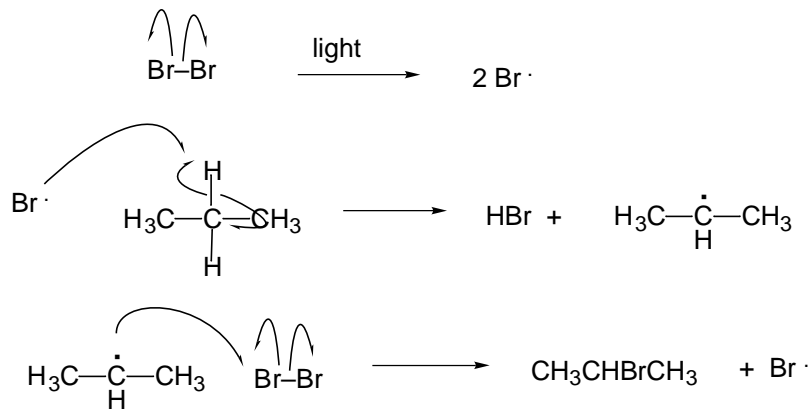
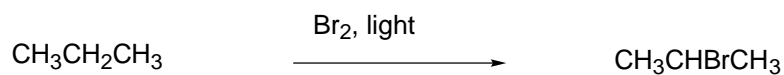


20.

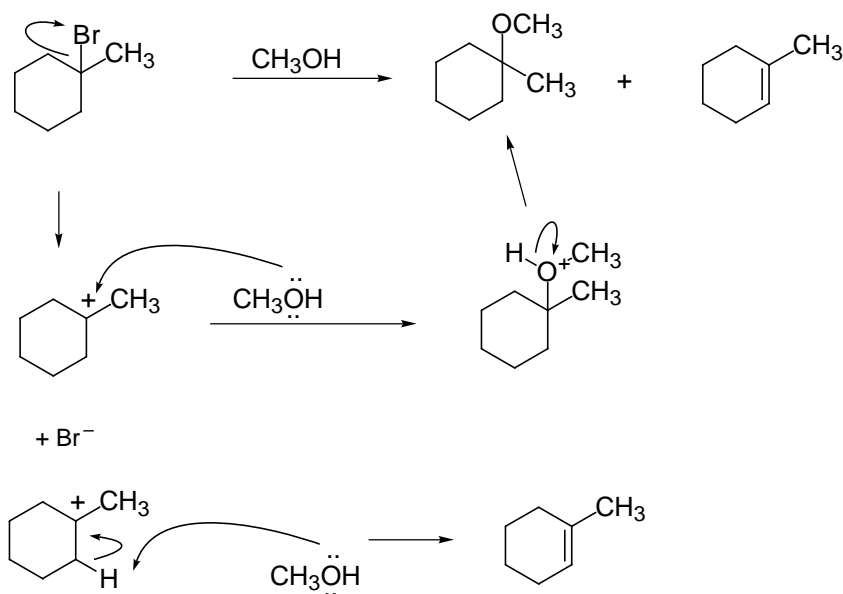


V. Mechanisms. Give a stepwise, detailed mechanism with arrows and intermediates for the following reactions. (5 points each)

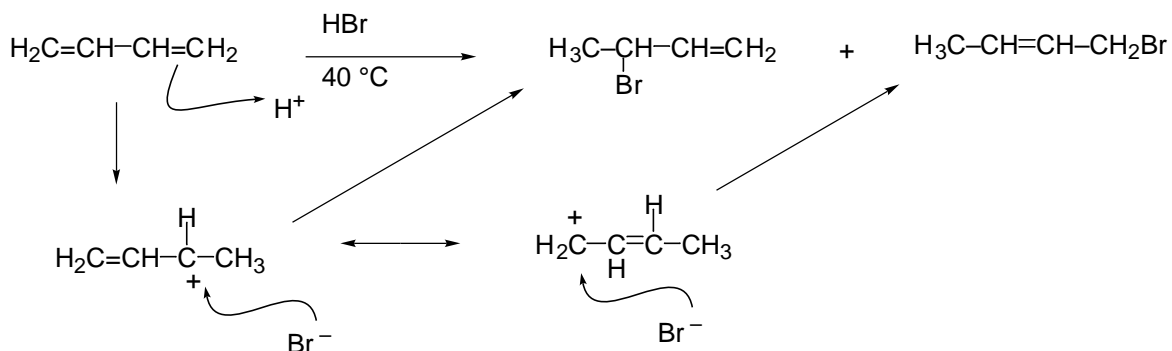
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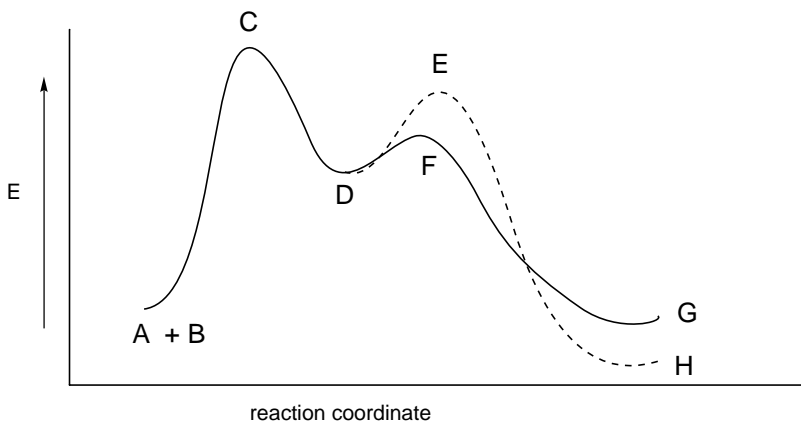
22.



23.



24. The energy diagram for the hypothetical reaction  $\text{A} + \text{B} \rightarrow \text{D} \rightarrow \text{G} + \text{H}$  is shown below. (6pts).



- What is the rate determining step? A + B goes to D
- What happens to the rate if the concentration of A is doubled? doubles
- What is the rate expression? rate =  $k[\text{A}][\text{B}]$
- If D is a charged species and A and B are neutral, what effect will a polar protic solvent have on the rate of reaction? increase
- What is the kinetically favored product? G
- What is the thermodynamically favored product? H