

Richter

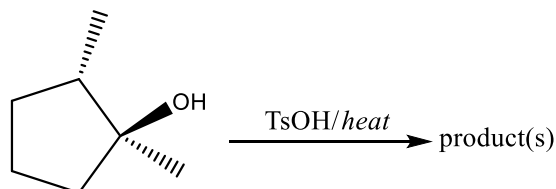
PRINT NAME \_\_\_\_\_.

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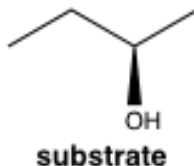
You are required to answer all questions. Please write legibly and draw clearly. Points will be deducted for illegible and unclear answers. Please answer in the space provided after each question. Use the reverse side if you need more space. There are a total of 100 points possible for this exam and the value of each question and/or section is shown in parenthesis beside that question/section. Note that some of the questions give you a choice. Do only the number of choices asked for. Extra answers will not be graded. **READ ALL QUESTIONS CAREFULLY AND APPORTION YOUR TIME APPROPRIATELY.**

**PART I: Structure, Reactivity, and Mechanism. (56 points total)**

1. Circle **all** statements **A-E** that are **TRUE** regarding the reaction below. (6)



- A. A carbocation rearrangement will take place during this reaction.  
 B. The reaction will display unimolecular kinetics.  
 C. The reaction will result in only substitution products.  
 D. The reaction will result in only elimination products.  
 E. The reaction will result in both elimination and substitution products.
2. Which of the following reagents would yield an optically active product if reacted with the substrate below? **Circle all correct answers. (6)**

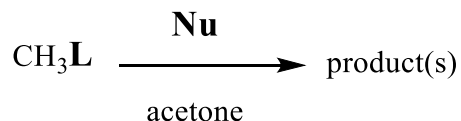
PBr<sub>3</sub>

TsCl/pyridine

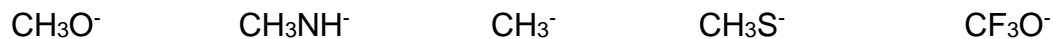
HBr

SOCl<sub>2</sub>/pyridineH<sub>2</sub>SO<sub>4</sub>/heatPOCl<sub>3</sub>/pyridine

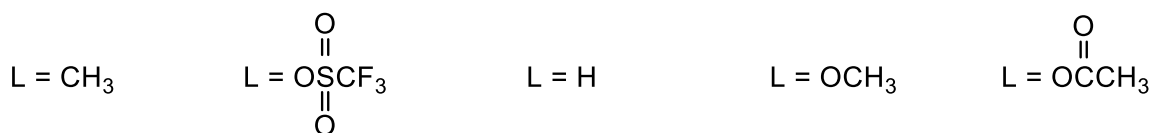
For questions 3-5, consider the reaction below.



3. Circle which nucleophile ("Nu") would lead to the fastest rate of reaction. (4)



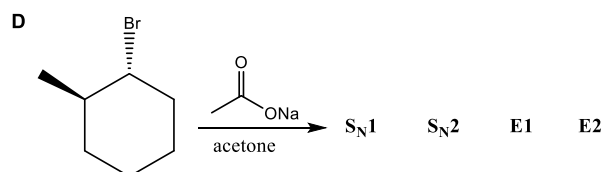
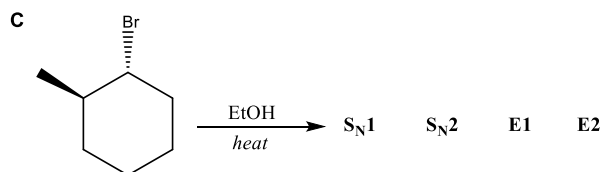
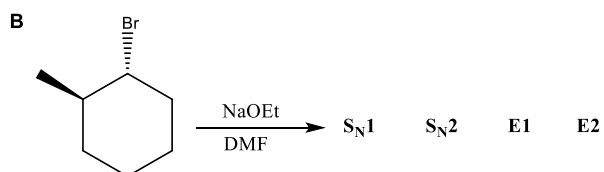
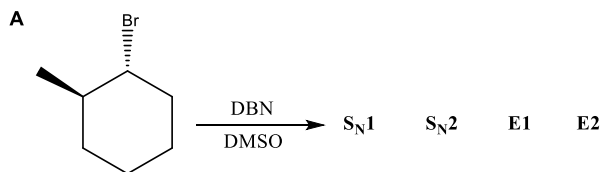
4. Circle which leaving group ("L") would lead to the fastest rate of reaction. (4)



5. True or false? Changing the substrate from  $\text{CH}_3\text{L}$  to  $\text{CH}_3\text{CH}_2\text{L}$  would lead to a decrease in the activation energy ( $E_a$ ) of the slow step of the reaction. (4)

Circle one:    T    F

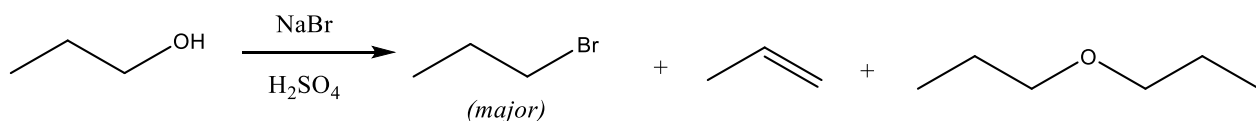
6. For each of the conditions below (A-D), circle the mechanism(s) that would be the most favorable. (10)



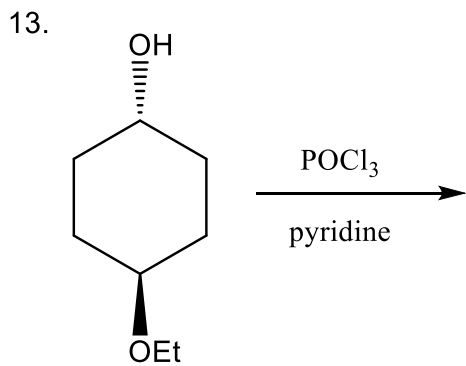
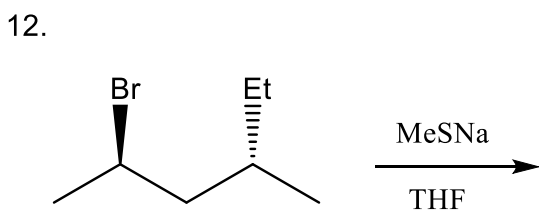
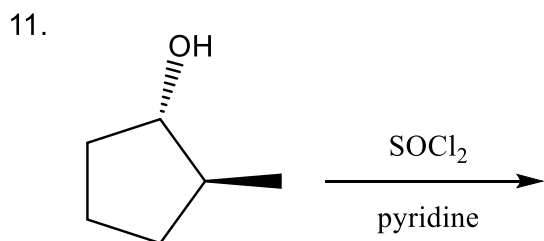
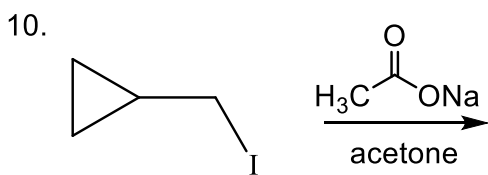
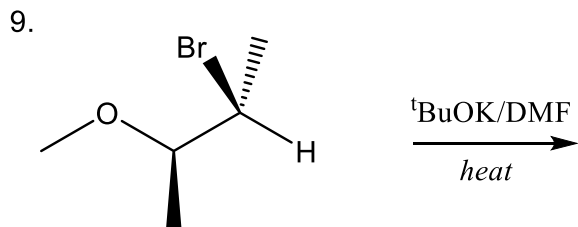
7. Which of the following statements is **TRUE**? *Circle all that apply.* (6)

- A. Nucleophilic strength and base strength always coincide (i.e. strong bases are always strong nucleophiles and vice versa).
- B. Methyl and primary alkyl halides can undergo  $S_N1$  substitution depending on the reaction conditions.
- C. Secondary halides always undergo  $S_N1$  substitution.
- D. Tertiary alkyl halides will not undergo  $S_N2$  substitution, regardless of the reaction conditions.
- E. Both  $S_N1$  and  $S_N2$  reaction rates will decrease if the concentration of the substrate (alkyl halide) is decreased.

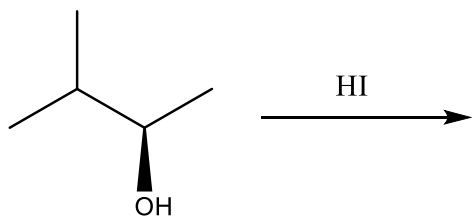
8. When propanol is treated with sulfuric acid in the presence of sodium bromide, three organic products are generated, as shown below. Draw a stepwise mechanism that accounts for the formation of the major product and each of the two minor products. (16)



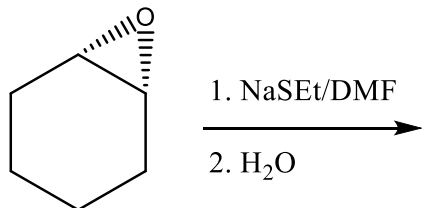
**PART II: Predict the Product(s).** For *each* of the reactions 9-15 below, draw the major organic product(s), including stereochemistry where appropriate. **(28 points total)**



14.



15.

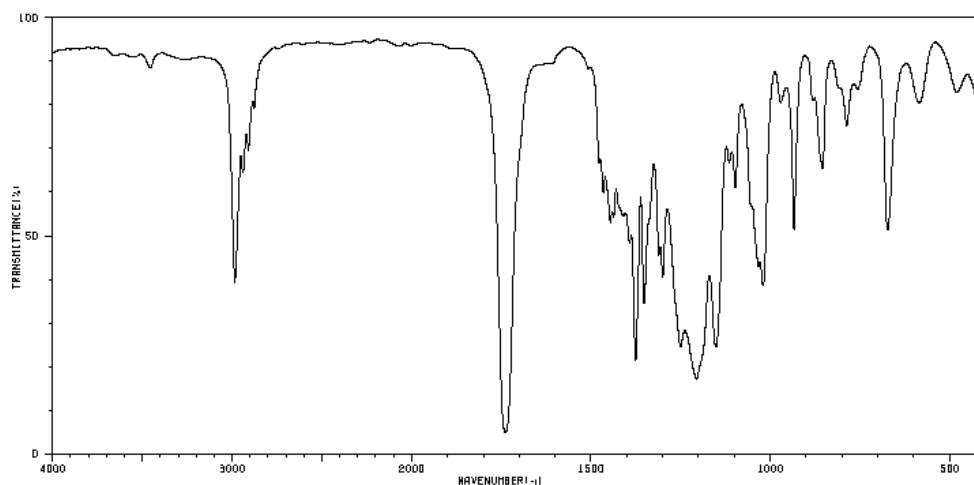


### Part III: Solve the Structure. (16 points total)

Formula of Unknown Compound: C<sub>5</sub>H<sub>9</sub>ClO<sub>2</sub>

16. Calculate the units of unsaturation for the formula above. (5)

17. Based on the IR spectrum below, suggest what functional group(s) may be present in the unknown compound. Label the band(s) on the IR spectrum that support your claim. (5)



18. Use the proton NMR spectrum below to propose the structure of the unknown compound. (6)

