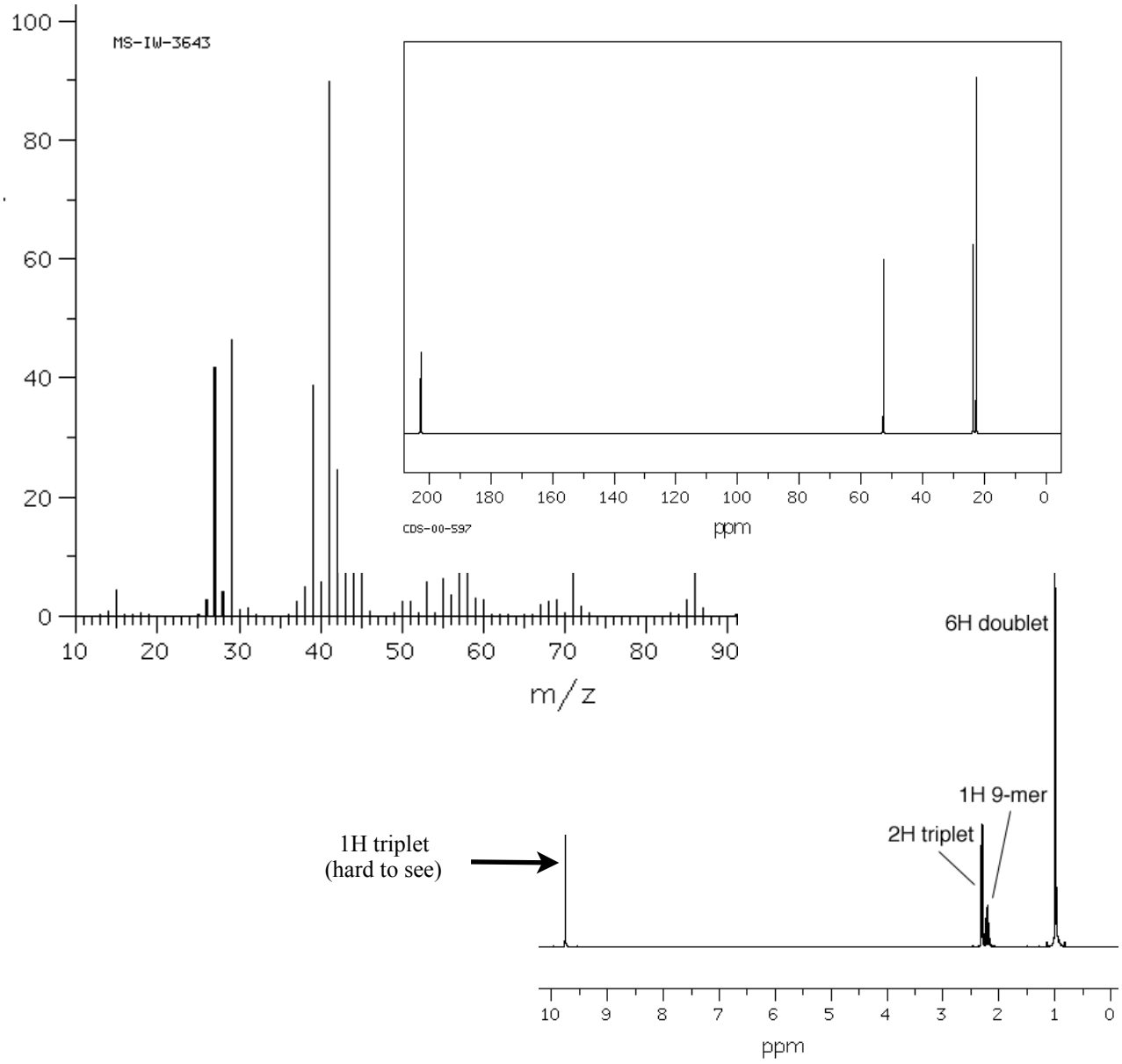
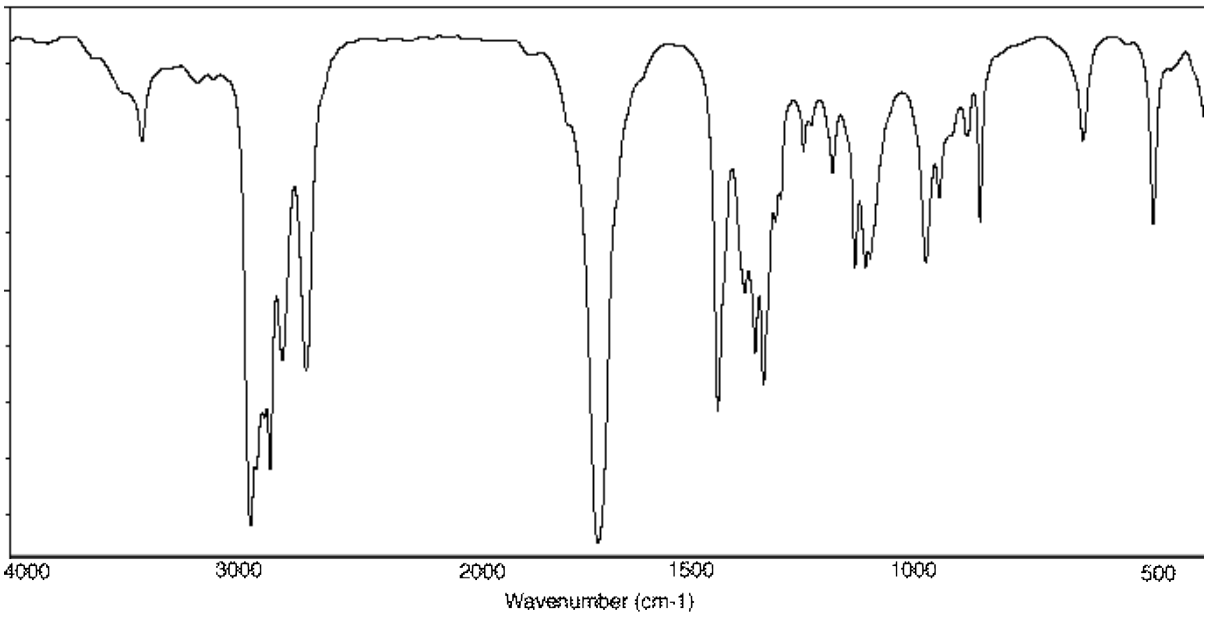
Organic Chemistry
CHM 224

Exam I Review Questions

This set of questions is a compilation of old exams and additional questions, and does not represent the typical length of an exam - this is WAY longer!

First three questions are based on the following four spectra.



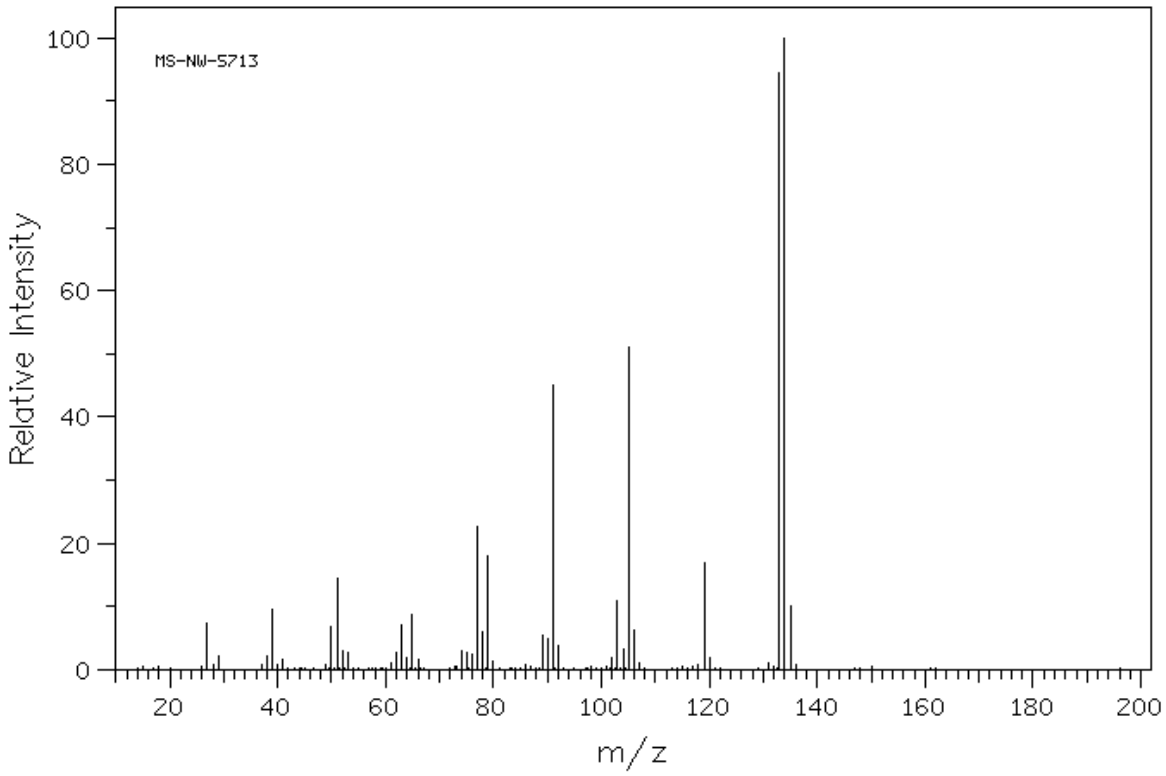


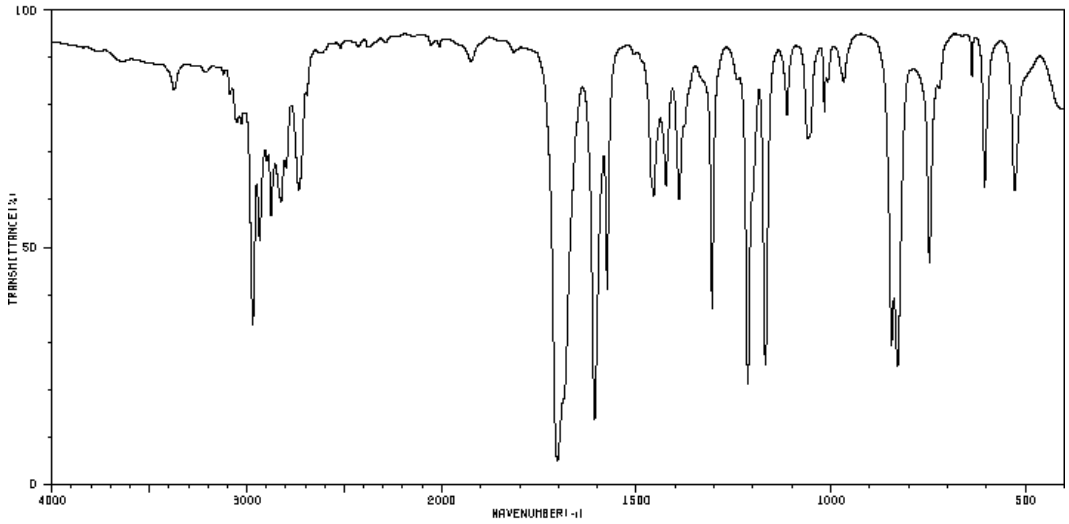
This compound contains C, H, and O atoms. Based on the spectral data, determine the most likely molecular formula for this compound.

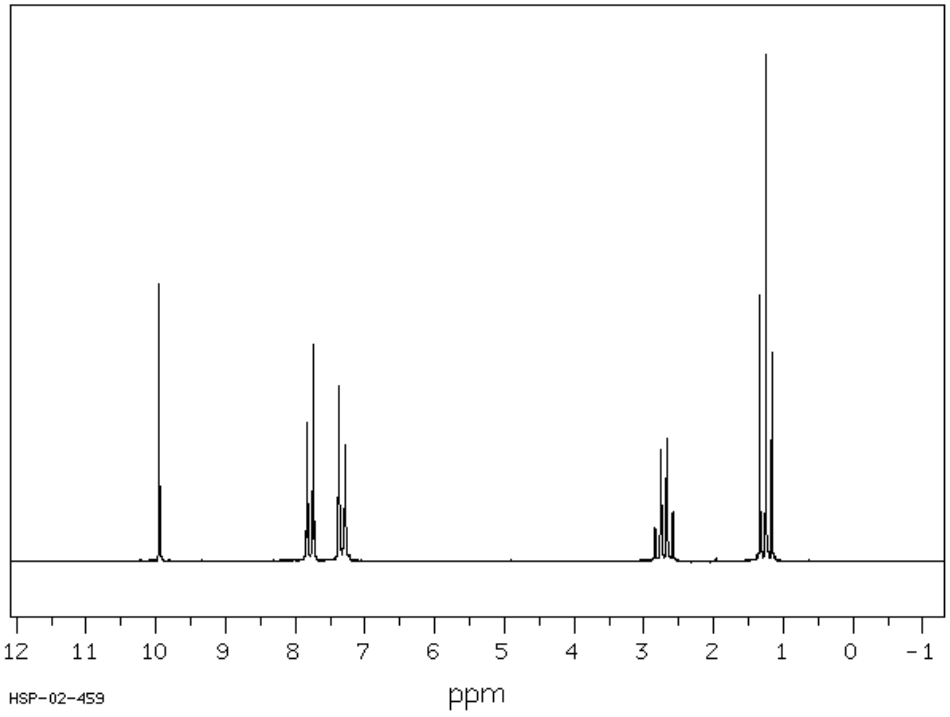
Analysis of the IR spectrum of this molecule indicates what key functional group is/are present?

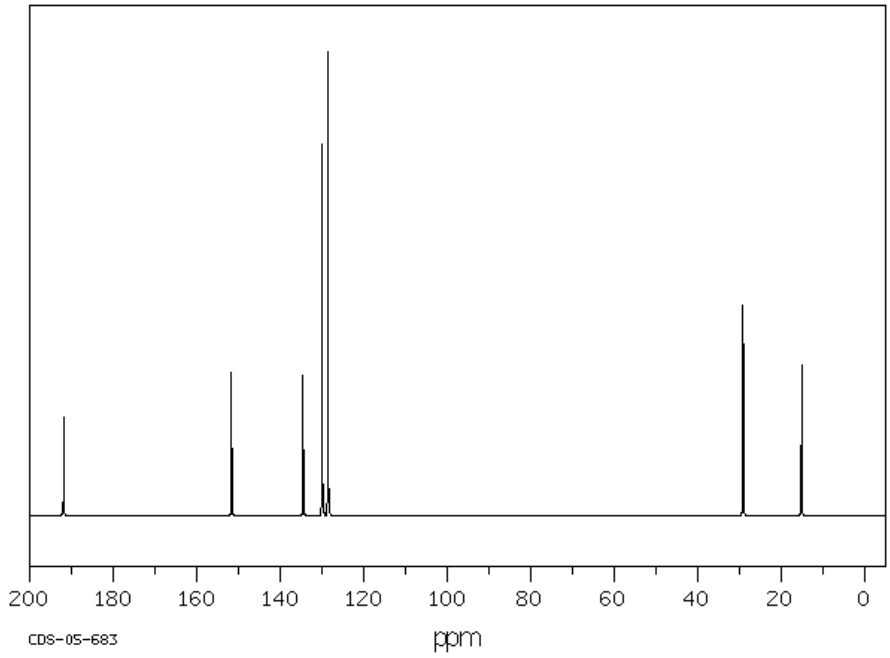
Propose a structure for this compound.

The next three questions are based on the following four spectra.






12 11 10 9 8 7 6 5 4 3 2 1 0 -1
HSP-02-459
ppm

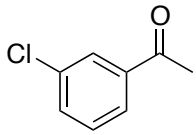

200 180 160 140 120 100 80 60 40 20 0
CDS-05-683
ppm

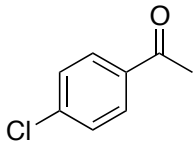
This molecule contains C, H and O - based on the spectral data, determine the most likely molecular formula for this compound.

Analysis of the IR spectrum of this molecule indicates what key functional group is present?

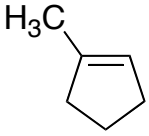
Propose a structure for this compound.

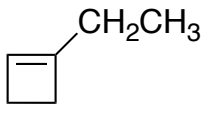
How could you tell the difference between the following two compounds using ^{13}C NMR only?



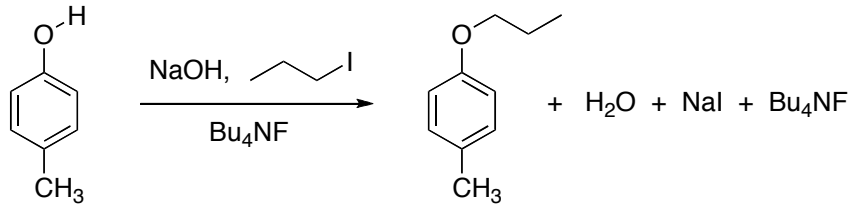


How could you tell the difference between the following two compounds using ^{1}H NMR only? Be specific!





The Williamson Ether synthesis you completed in the laboratory is shown below. Draw a stepwise arrow-pushing mechanism that accounts for the formation of the major organic product of the reaction. You may ignore the role of the tetrabutylammonium fluoride (Bu_4NF).

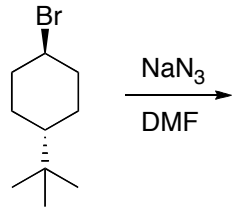


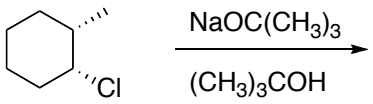
The substitution reaction shown in the above question follows an S_N1 or S_N2 mechanism?

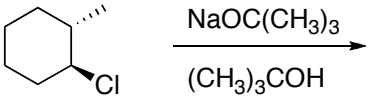
(this one is from the book!): (*S*)-2-Butanol slowly racemizes on standing in dilute sulfuric acid. Explain by drawing a mechanism that accounts for this racemization.

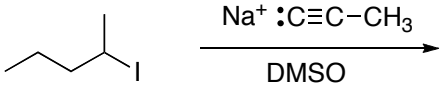
Assume each chemical below was made using either an S_N1 or S_N2 reaction. Identify the **BOND** that was most likely created in the substitution reaction that led to the formation of the products shown by either circling it or using an arrow that unambiguously points to it. For some of the chemicals below, there may more than one possible choice - identifying ONE (for each of the 4 below) is sufficient to receive full credit.

Predict the major product of each of the following reactions. Make sure to indicate stereochemistry when appropriate.:

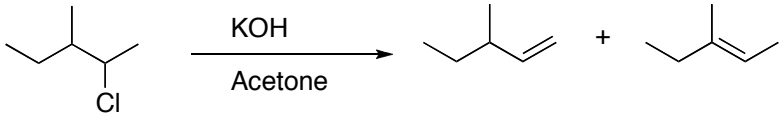




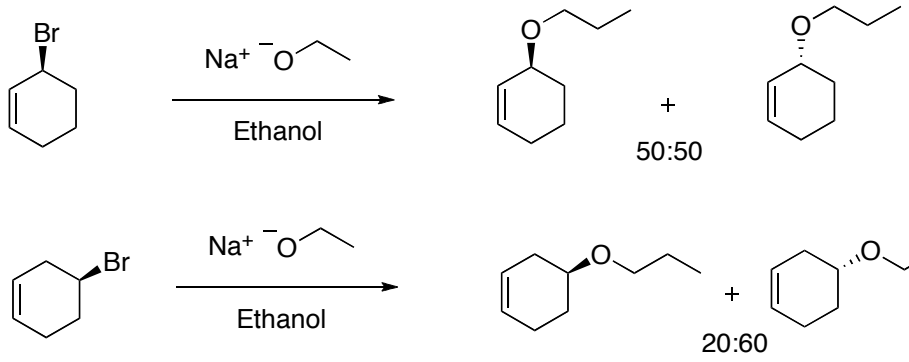




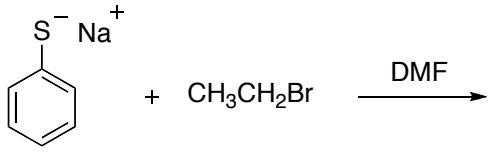
Write the complete stepwise mechanism the justifies the formation of both products. Show all electron flow with arrows and draw all reaction intermediates. Circle which of the two products is formed in higher yield.



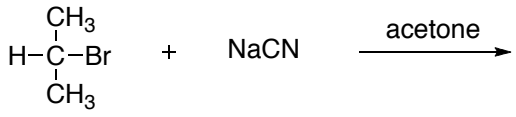
(S)-1-Bromo-2-cyclohexene reacts with sodium ethoxide in ethanol to produce a racemic mixture of substitution products, whereas (S)-1-bromo-3-cyclohexene produces a 20:60 mixture of substitution products (both reactions also produce minor amounts of elimination products)… Propose an explanation for why these two reactions do not both produce the same ratio of substitution products. Be as specific as you can to get all the points! (10 pts)



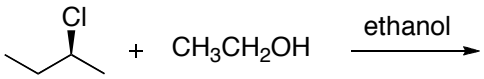
For the next set of three questions, draw the product(s) of the following reactions, and indicate if the reaction follows an S_N1 or S_N2 mechanism (circle one).



S_N2 or S_N1

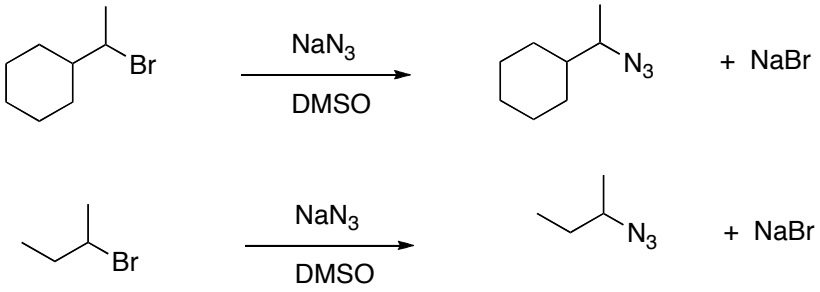


S_N2 or S_N1



S_N2 or S_N1

Consider the reactions below to answer the next four questions:



The alkyl bromide starting materials in these reactions are classified as:

3º b. 2º c. 1º d. 4º

The solvent in these reactions is:

protic b. aprotic

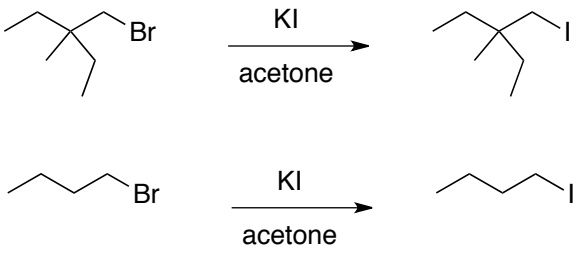
The nucleophile in these reactions is:

a. Na^+ b. the alkyl group c. Br^- d. N_3^-

Which reaction is should proceed at a faster rate (first or second one?)

a. S_N1 b. S_N2

Consider the pair of reactions below to answer the next four questions:



The alkyl bromide starting material in these reactions are classified as:

3º b. 2º c. 1º d. 4º

The solvent in these reactions is:

a. protic b. aprotic

The nucleophile in these reactions is:

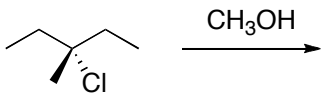
a. K^+ b. alkyl group c. Br^- d. I^-

Which reaction is faster (first or second one?)

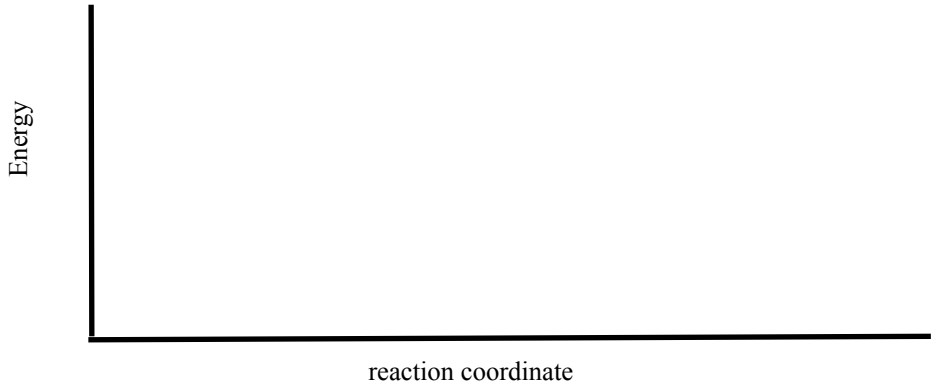
The mechanism for these reactions is:

a. S_N2 b. E2 c. S_N1 d. E1

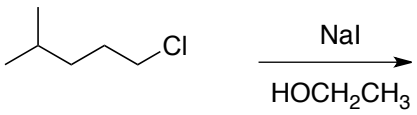
^1H NMR is highly useful in determining products of organic chemical reactions. One might question whether or not the following reaction proceeds through a substitution or elimination mechanism. However, studying the ^1H NMR spectrum of the product(s) reveals all signals appear between 2 and 0 ppm. Draw the major organic product(s) of this reaction.

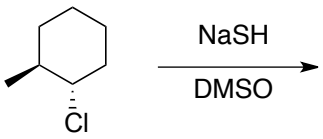


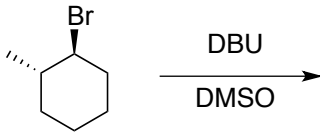
On the graph below, draw an energy diagram for an S_N1 substitution. Clearly label the electrophile/starting material (S.M.), the product (P) and any relevant intermediates (I) or transition states (TS).



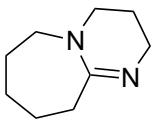
Draw the product(s) of the following reactions. If more than one product exists because of a mixture of possible mechanisms, circle the major product.

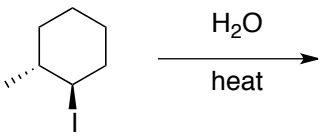


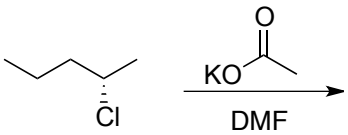


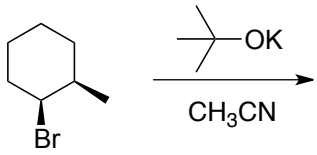


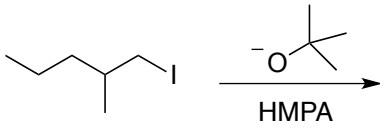
DBU =

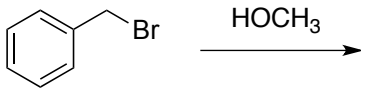












Select the mechanism(s) (S_N1, S_N2, E1, E2) [there may be more than one] that fit the description provided.

- This reaction mechanism is characterized by inversion of stereochemistry at a stereogenic reaction center and exhibits second-order kinetics.

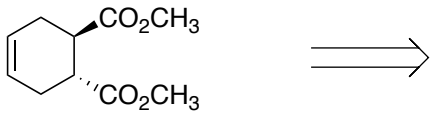
- This reaction mechanism is characterized by partial or complete racemization at a stereogenic reaction center and exhibits first-order kinetics.

- This reaction mechanism is characterized by a carbocation intermediate.

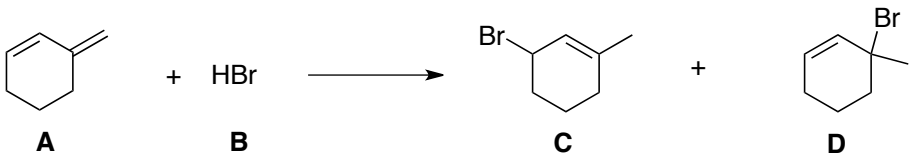
- This reaction mechanism is characterized by the requirement that a leaving group and a hydrogen on an adjacent carbon be anti-coplanar.

- This reaction mechanism is favored by 3° substrates, high temperatures, and a strong base.

The following molecule was prepared using a Diels Alder reaction. Write the structures of the starting diene and dienophile necessary. Pay special attention to the stereochemistry of the dienophile



Consider the reaction below to answer questions 1 - 5.



1. The nucleophile in the first step of this reaction is (**A** - **D**) _____.

2. The electrophile in the first step of this reaction is (**A** - **D**) _____.

3. The kinetically controlled product in this reaction is (**A** - **D**) _____.

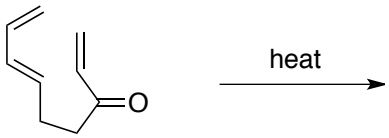
4. The product that results from 1,4-addition is (**A** - **D**) _____.

5. Draw a stepwise arrow-pushing mechanism that accounts for the formation of both products shown (**C** and **D**). Show all intermediate structures.

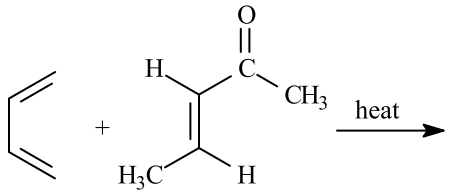
When an organic molecule is irradiated with ultraviolet radiation, the energy absorbed by the molecule corresponds to:

a. the amount necessary to increase molecular motions in functional groups
b. the amount necessary to excite electrons from one molecular orbital to another
c. the amount necessary to "flip" the spin of atomic nuclei
d. the amount necessary to strip a molecule of one electron to generate a radical cation

Draw the product of the following intramolecular Diels Alder reaction.



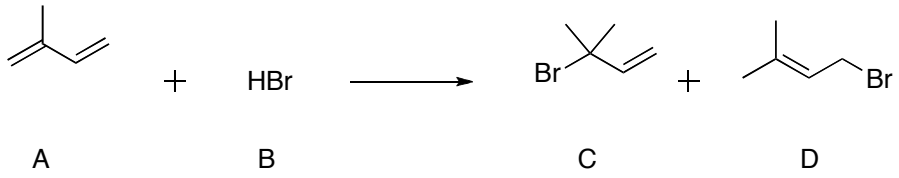
Write the structure(s) of the product(s) for the Diels-Alder reaction below (no mechanism is needed). *Be sure to indicate any relevant stereochemistry*.



Which of the following molecules is expected to have the longest wavelength for maximum absorbance in the UV spectrum?

a) ethylene
b) 1,3-butadiene
c) 1,3,5-hexatriene
d) 1,3,7,9-decatetraene

The following questions refer to the following chemical reaction:



The acid in the first step of this reaction mechanism is _____

The base in the first step of this reaction mechanism is _____

The kinetically controlled product of this reaction is _____

The product that has the lowest overall energy is _____

Starting from **A** and **B**, draw a **STEPWISE** arrow-pushing mechanism that accounts for the formation of **D**.