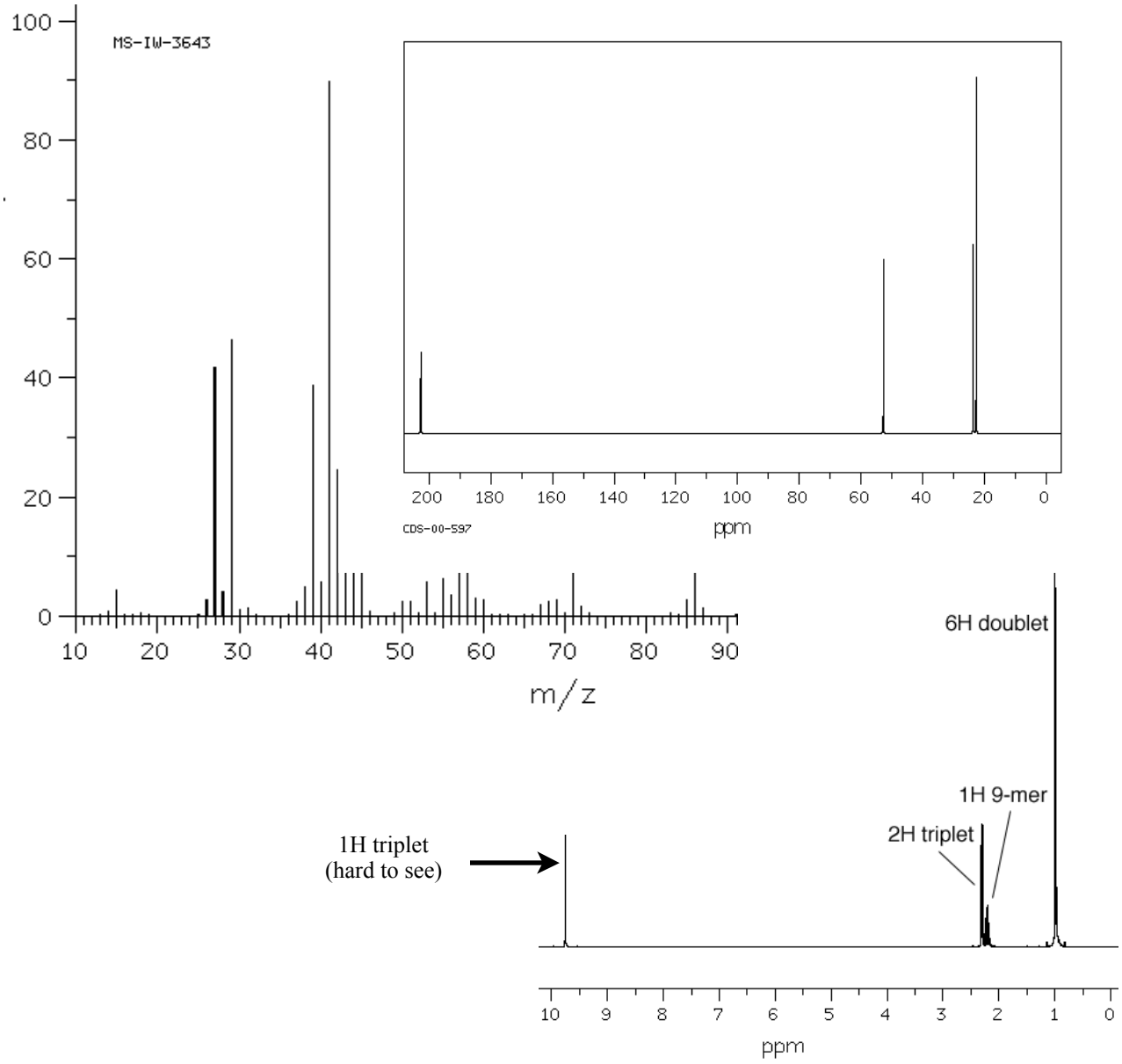
Organic Chemistry

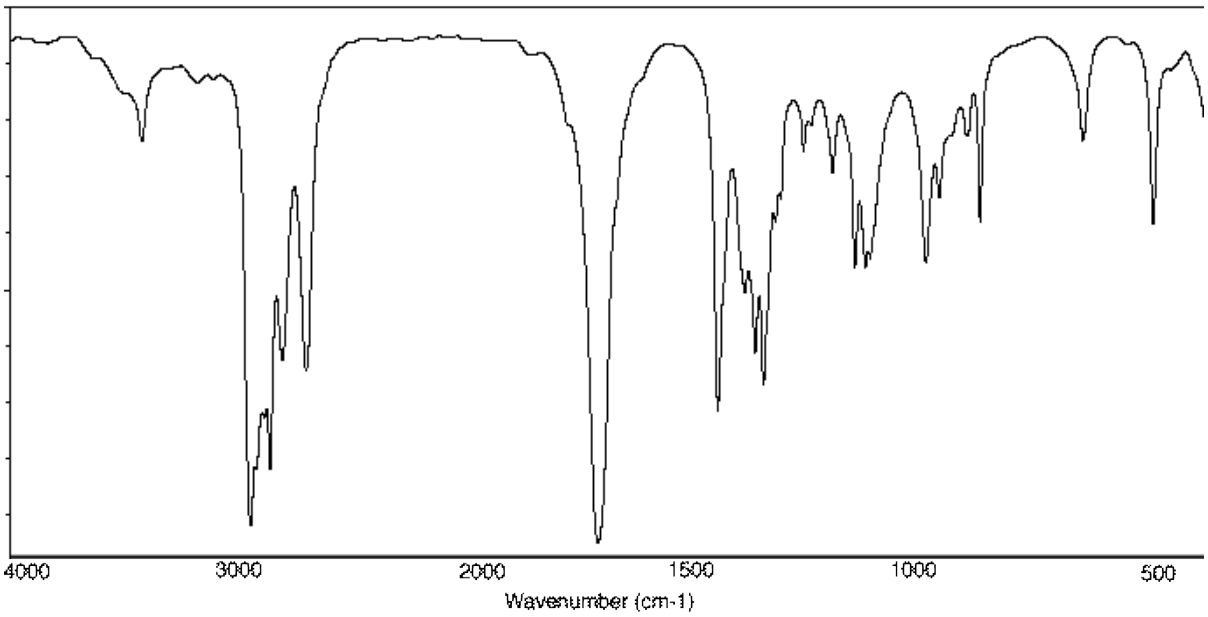
CHM 224

Exam I Questions

This set of questions is a compilation of old exams, and does not represent the typical length of an exam - there are more examples, therefore this is longer than a standard 1 hour exam.

First three questions are based on the following four spectra.



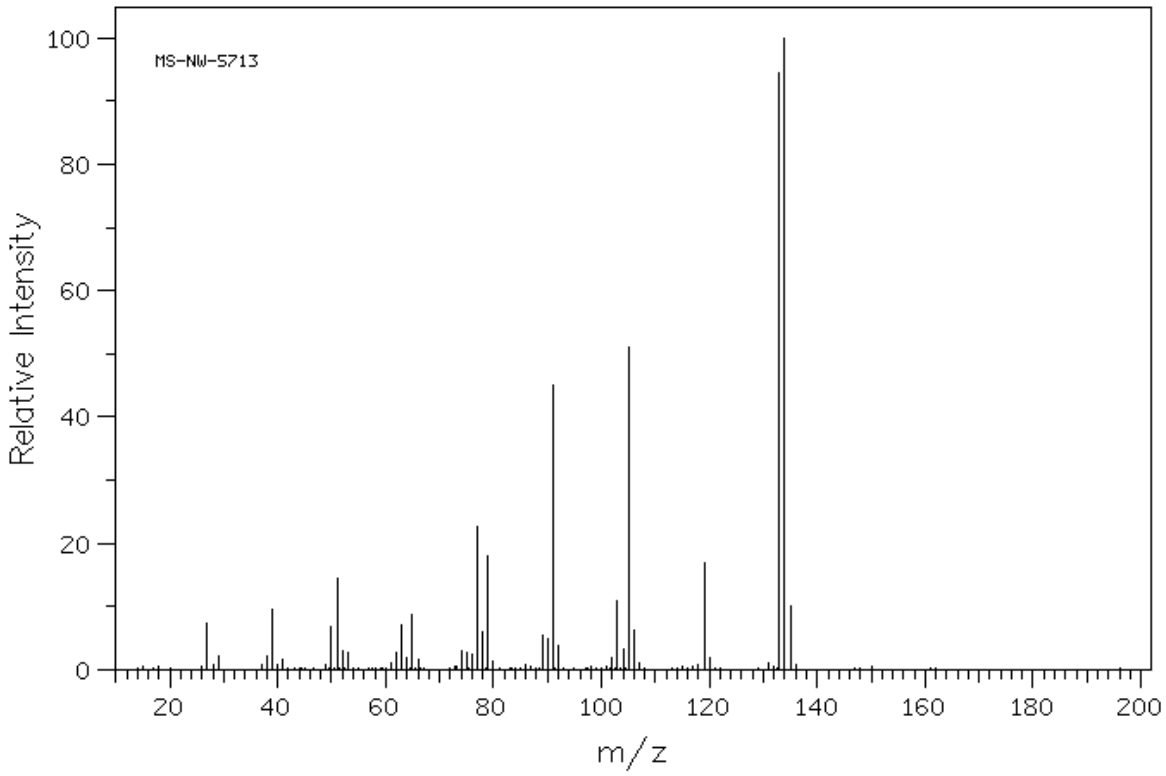


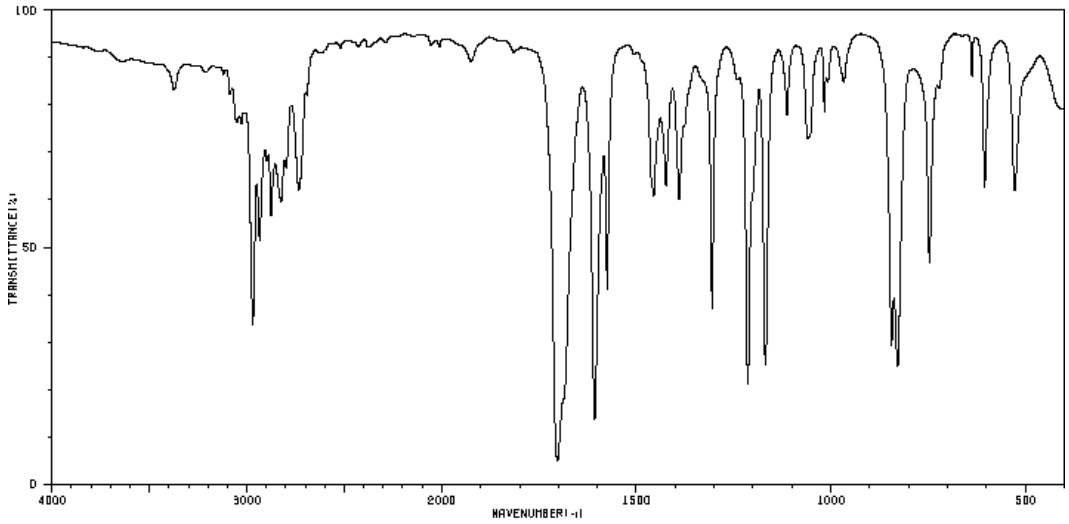
This compound contains C, H, and O atoms. Based on the spectral data, determine the most likely molecular formula for this compound.

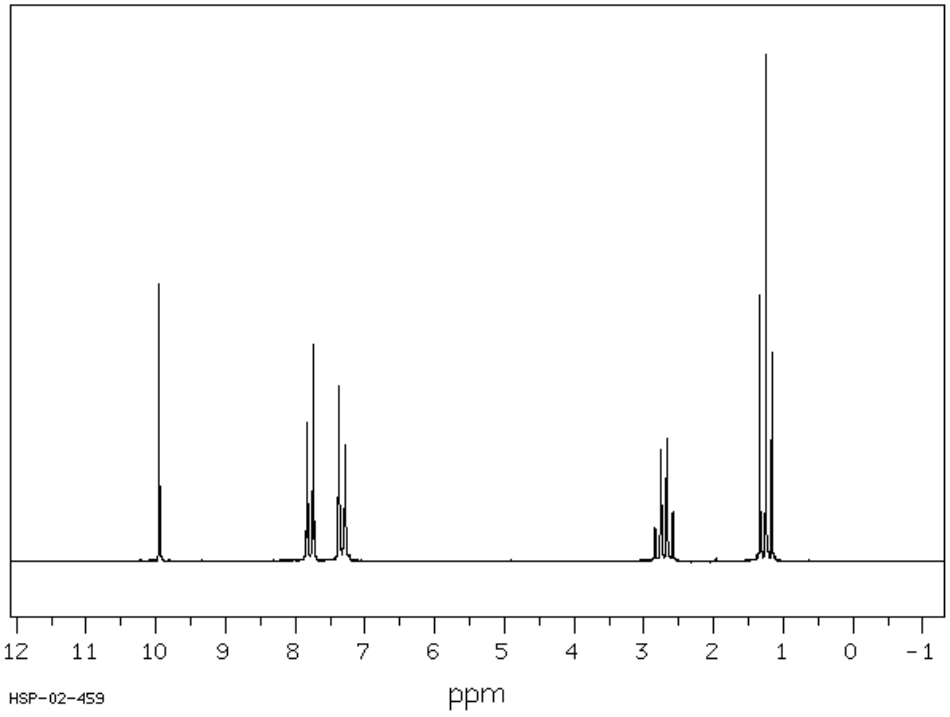
Analysis of the IR spectrum of this molecule indicates what key functional group is/are present?

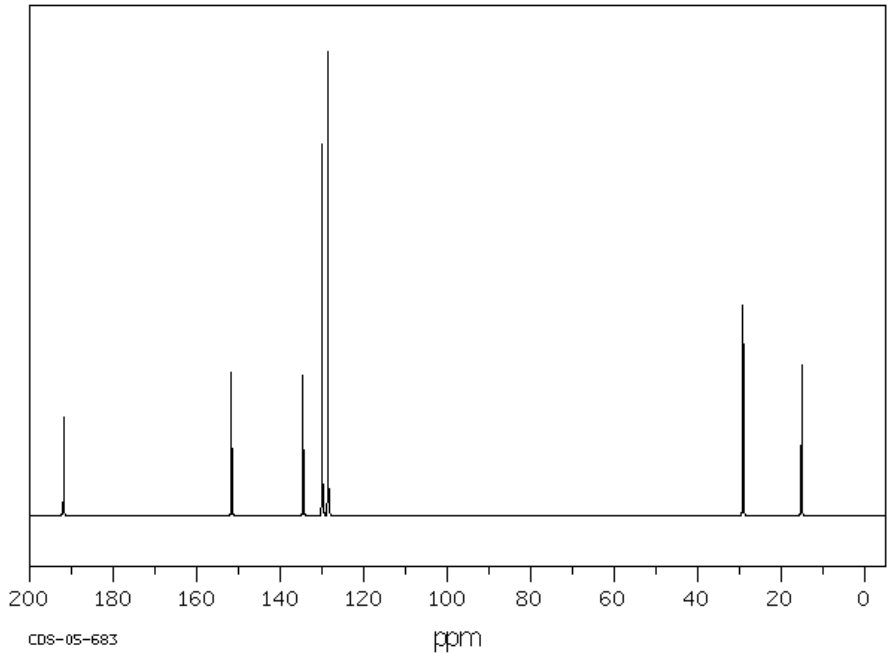
Propose a structure for this compound.

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

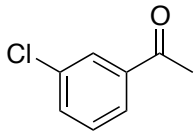

200 180 160 140 120 100 80 60 40 20 0
CDS-05-683
ppm

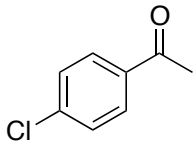
This molecule contains C, H and O - based on the spectral data, determine the most likely molecular formula for this compound.

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

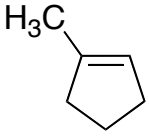
Propose a structure for this compound.

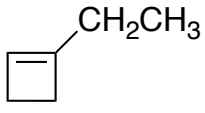
How could you tell the difference between the following two compounds using ^{13}C NMR only?



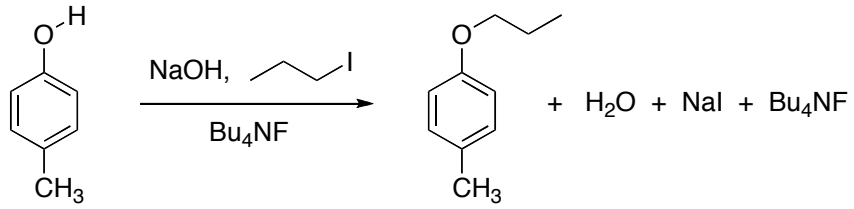


How could you tell the difference between the following two compounds using ^{1}H NMR only? Be specific!





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).

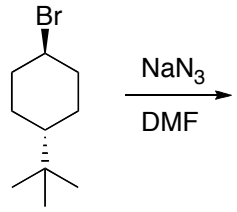


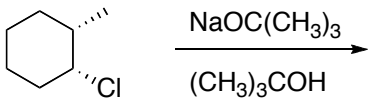
The substitution reaction shown in the above question follows an S_N1 or S_N2 mechanism?

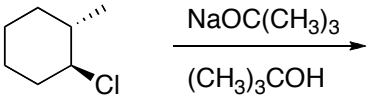
(this one is from the book!): (*S*)-2-Butanol slowly racemizes on standing in dilute sulfuric acid. Explain by drawing a mechanism that accounts for this racemization.

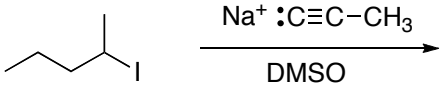
Assume each chemical below was made using either an S_N1 or S_N2 reaction. Identify the **BOND** that was most likely created in the substitution reaction that led to the formation of the products shown by either circling it or using an arrow that unambiguously points to it. For some of the chemicals 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.:

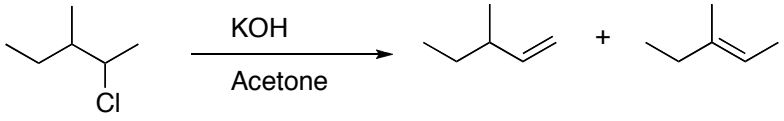




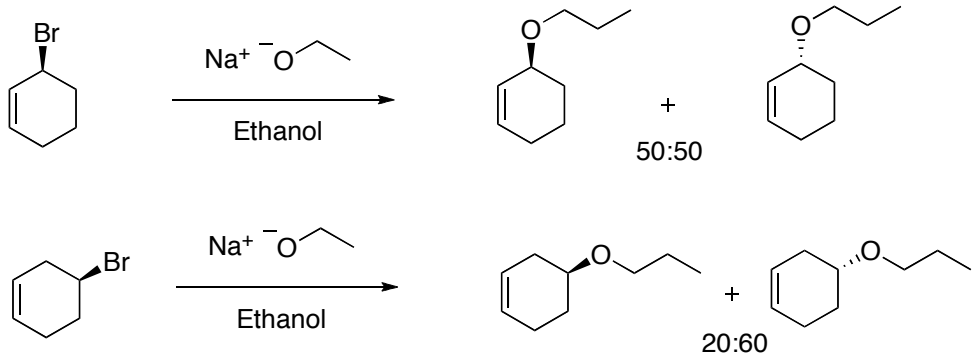




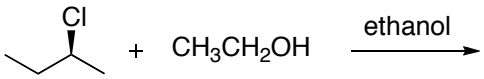
Write the complete stepwise mechanism the justifies the formation of both products. Show all electron flow with arrows and draw all reaction intermediates. Circle which of the two products is formed in higher yield.



(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)

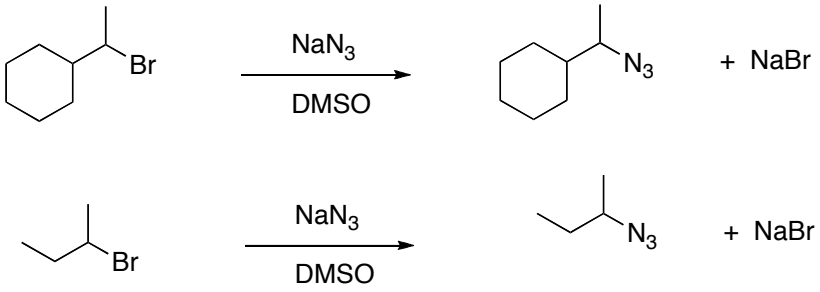


For the next set of three questions, draw the product(s) of the following reactions, and indicate if the reaction follows an S_N1 or S_N2 mechanism (circle one).



S_N2 or S_N1

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

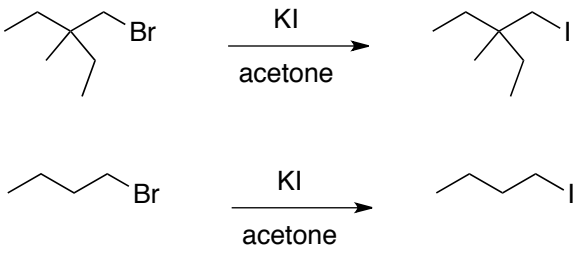
The nucleophile in these reactions is:

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:

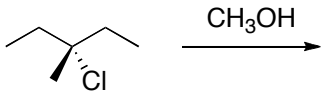
a. K^+ b. alkyl group c. Br^- d. I^-

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).