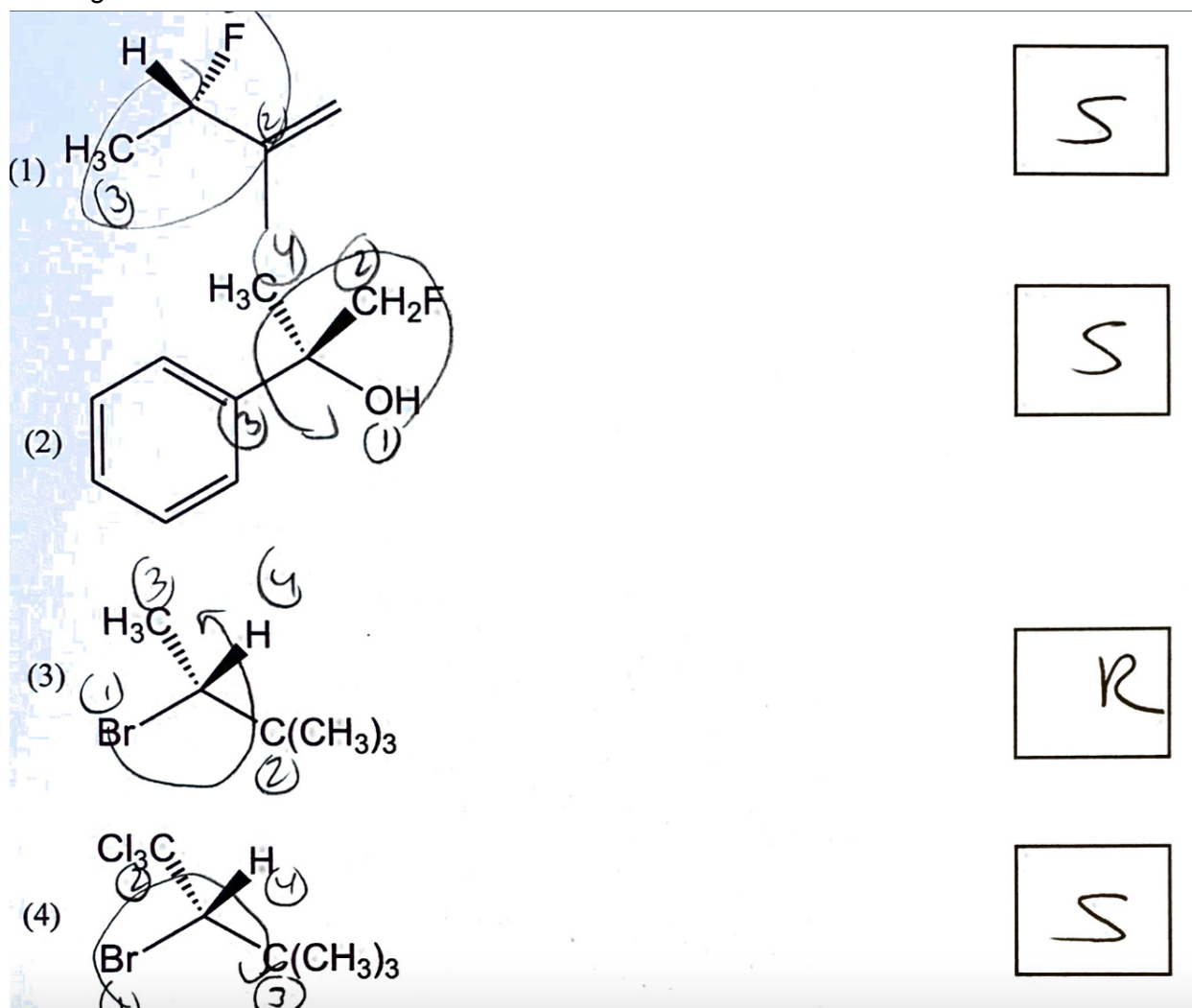
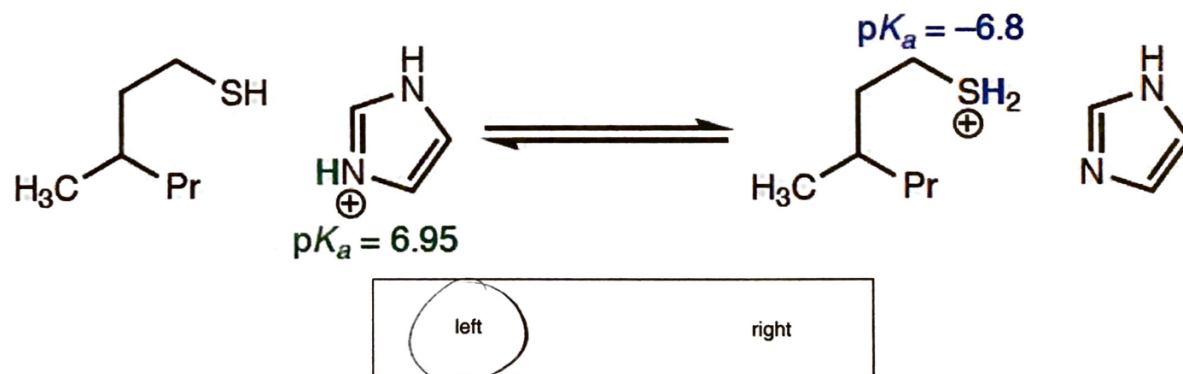


1. Assign R/S centers.



2.

Identify whether the acid-base equilibrium lies to the **left** or to the **right** in the reactions below. (2 pts each)



Lies to the left because equilibrium favors the side with higher pKa (weaker acid)!

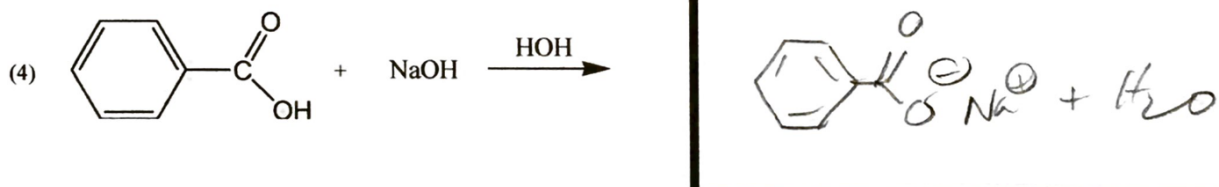
3. What is the index of hydrogen deficiency of a compound with a molecular formula of $C_9H_{11}NO$?

- (a) 3 (b) 4 (c) 5 (d) 6

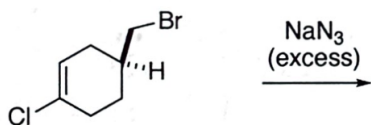
$$\frac{2(9) + 2 - 11 + 1}{2} = 5$$

C

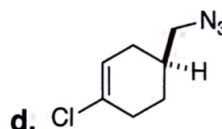
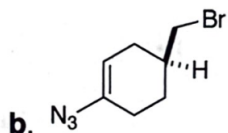
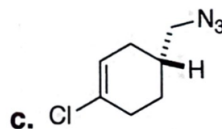
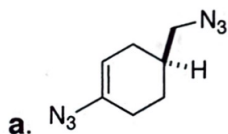
Complete the following acid-base reaction (write the products).



5. Azide anion is a very good nucleophile. Predict the major product from the following reaction?



D



Note there's no inversion of stereochemistry since the site of attack is NOT a stereocenter!

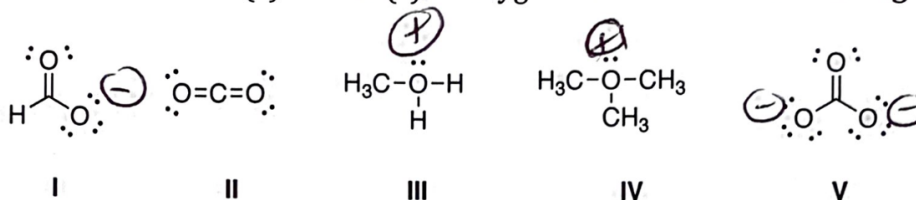
6.

Which of the following would react most quickly in an S_N1 reaction with acetic acid?

- a. methyl fluoride
- b. ethyl chloride
- c. isopropyl chloride
- d. tert-butyl bromide

D

7. Which structure(s) contain(s) an oxygen that bears a **formal charge of +1**?



(a) I and II

(b) III and IV

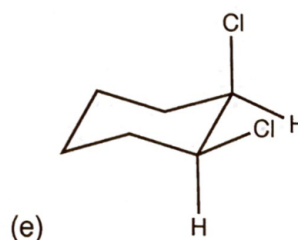
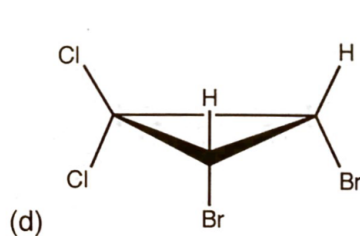
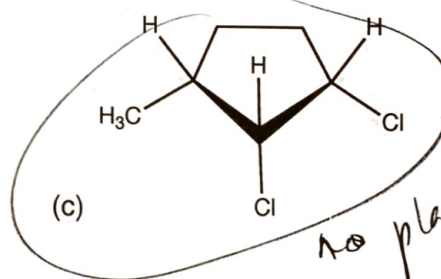
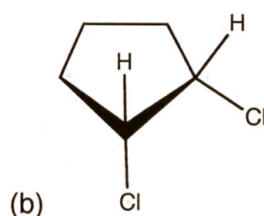
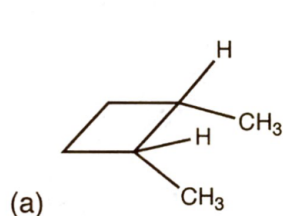
(c) V

(d) III

(e) I and V

B

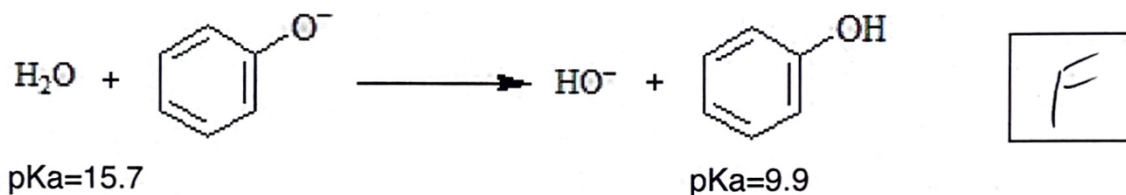
10. Which compound is **not** a meso compound?



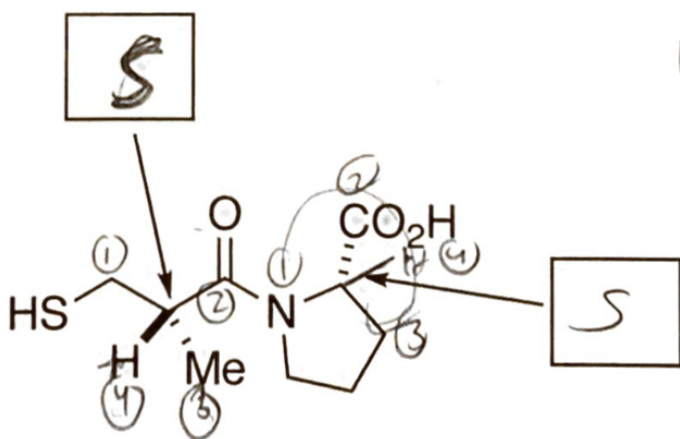
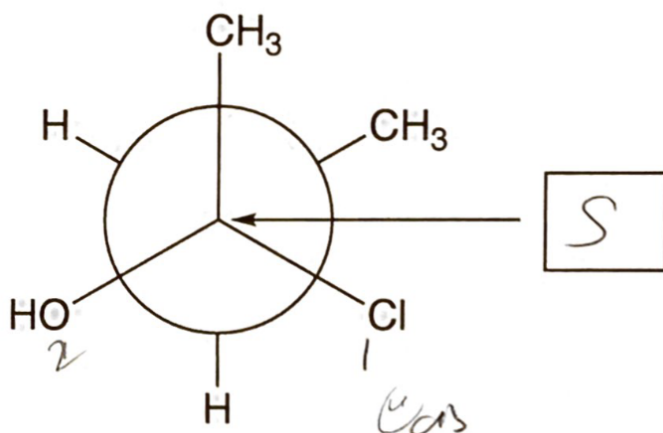
C

True or False:

12. The given reaction should be favorable based on the pKa values shown.

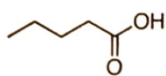


12. For each of the indicated chiral centers below, provide the correct R or S designation. (6 pts)



Remember that clockwise is R, counter-clockwise is S

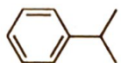
12. Match each compound to its IR spectrum. (12 pts)



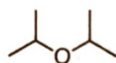
A



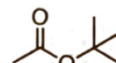
B



C



D

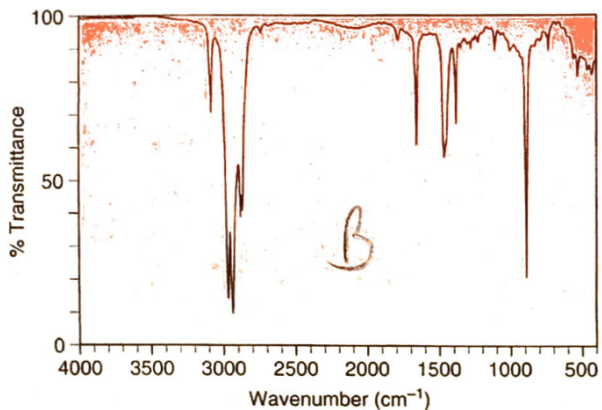


E

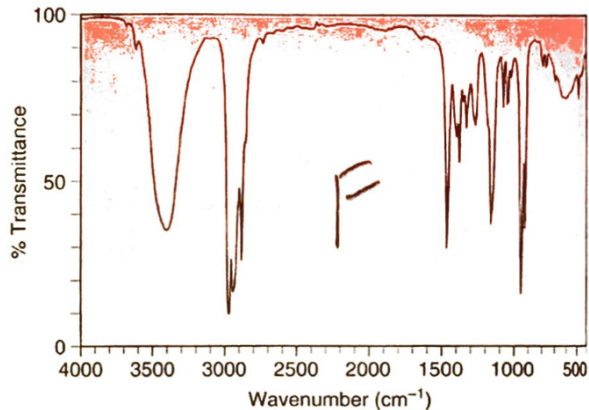


F

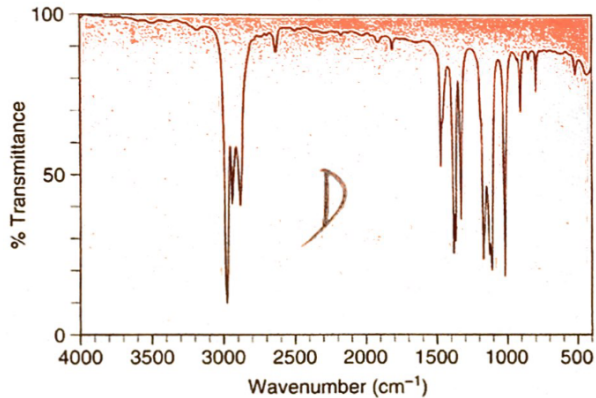
Spectrum [1]



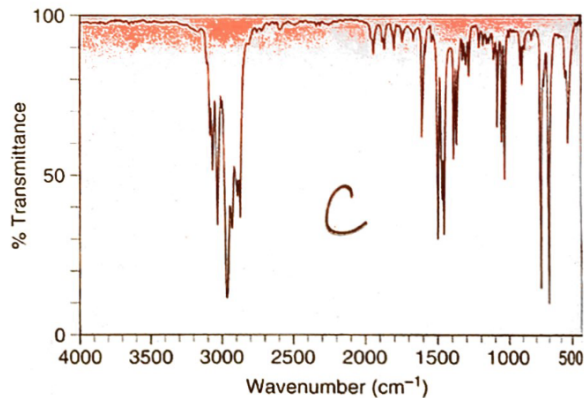
Spectrum [2]



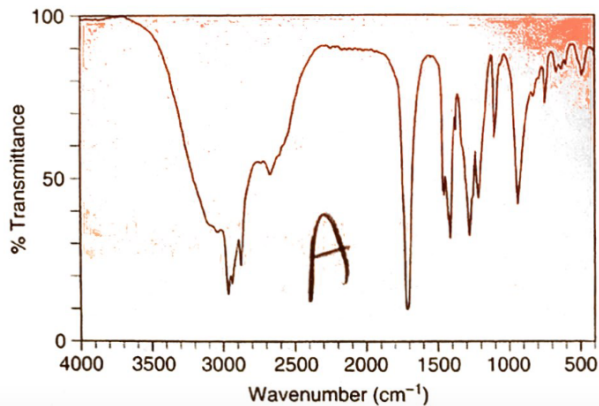
Spectrum [3]



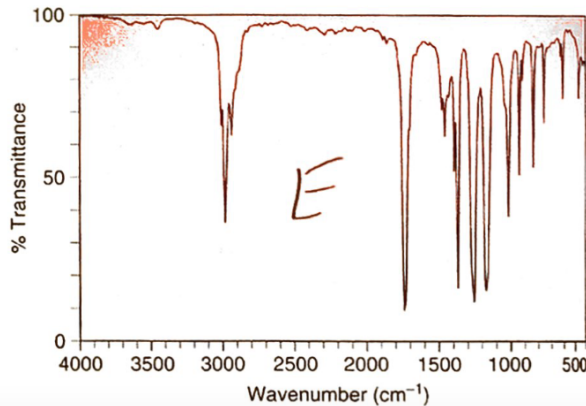
Spectrum [4]



Spectrum [5]



Spectrum [6]



14. For the problem shown below, answer the questions and draw the structure that corresponds to the following spectra.

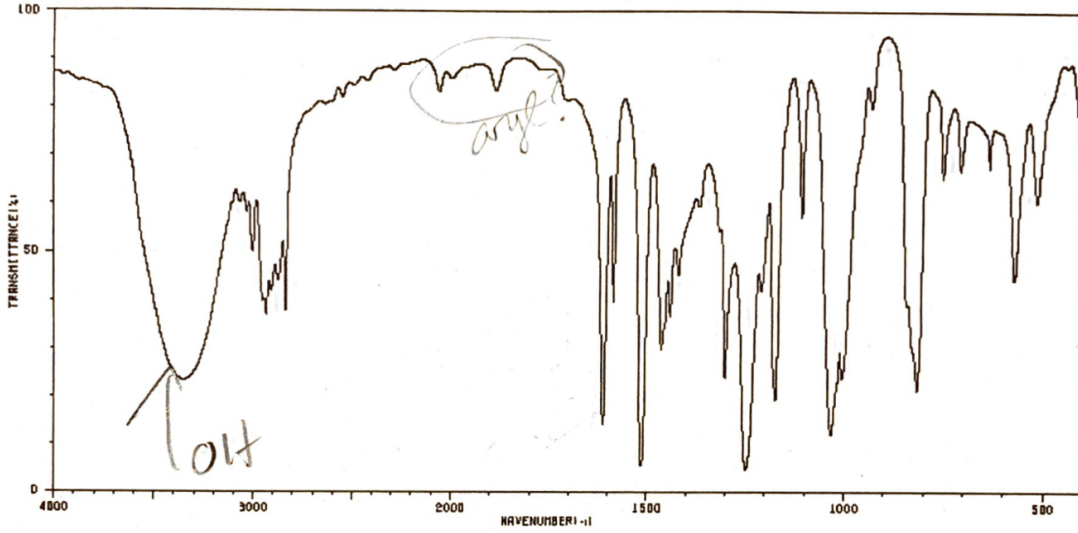
Empirical Formula: C_4H_5O

Mass Spec: $M^+ m/e = 138$

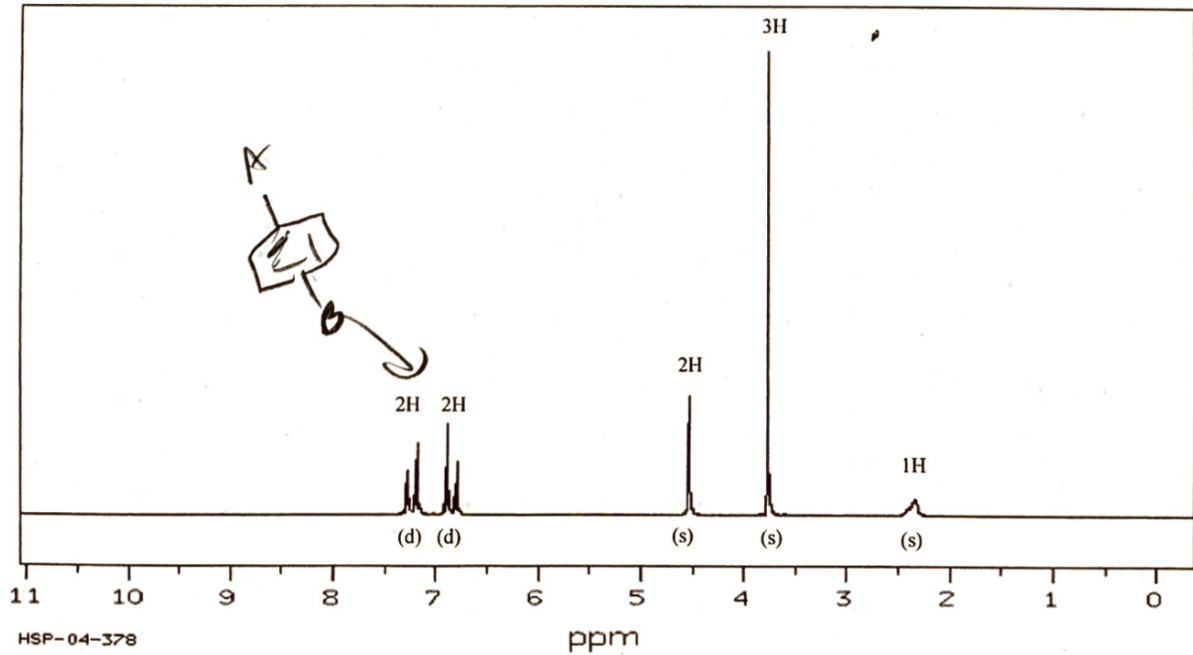
$$\begin{array}{l} 12(4) = 48 \\ \frac{2}{69} \\ \times \frac{2}{138} \end{array}$$

$$C_8H_{10}O_2 \quad \frac{2(8)+2-10}{2} = 4$$

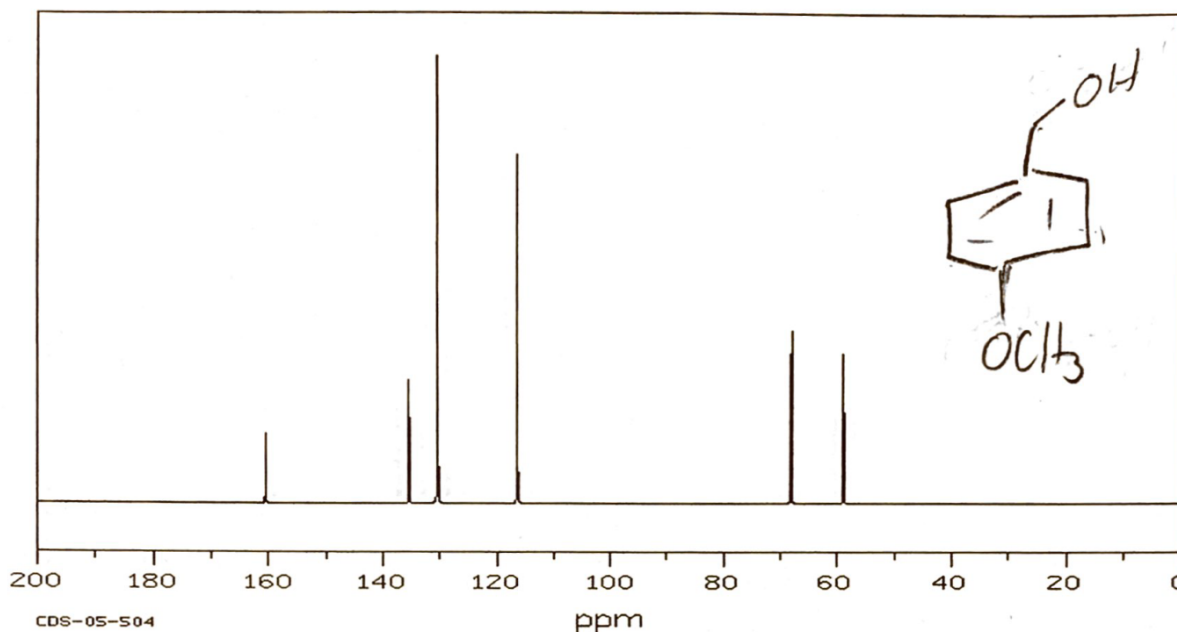
IR



1H NMR



¹³C NMR



Determination of the Molecular Formula (3pts)

- a) What the molecular weight of the unknown compound? 138
- b) What is the correct molecular formula of the unknown compounds? C₈H₁₀O₂
- c) How many degrees of unsaturation does this compound have? 4

Analysis of the IR spectrum (3 pts)

d) Which of the following bonds are present?

(circle all that are present) O-H C-O C=O

e) Based on the analysis of the IR, what type(s) of functional group(s) is/are present?

aryl (or phenyl), alcohol (or -OH)

Analysis of the ¹H NMR spectrum (5 pts)

f) How many different protons are there in the molecule? 5

g) Which of the following are present? (circle all that apply)

Et iPr tBu H on a heteroatom vinylic H (i.e. an alkene) aromatic H

h) How many aromatic hydrogens are there? 4

i) How many substituents are there on the aromatic ring? 2

Analysis of the ^{13}C NMR (4pts)

j) How many different carbons are there in the molecule? 6

k) How many types of aromatic carbons are there in the molecule? 4

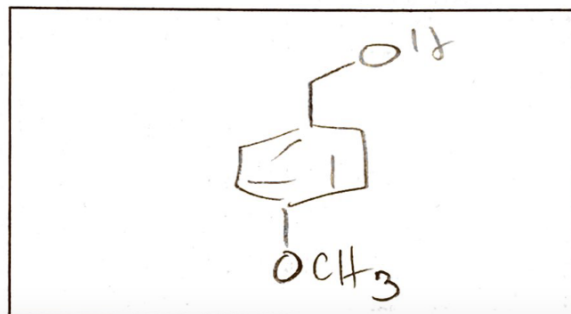
l) Is there a peak arising from a carbonyl in the ^{13}C NMR spectrum? (circle one) Yes No

m) How many types of sp^3 carbons are there? 2

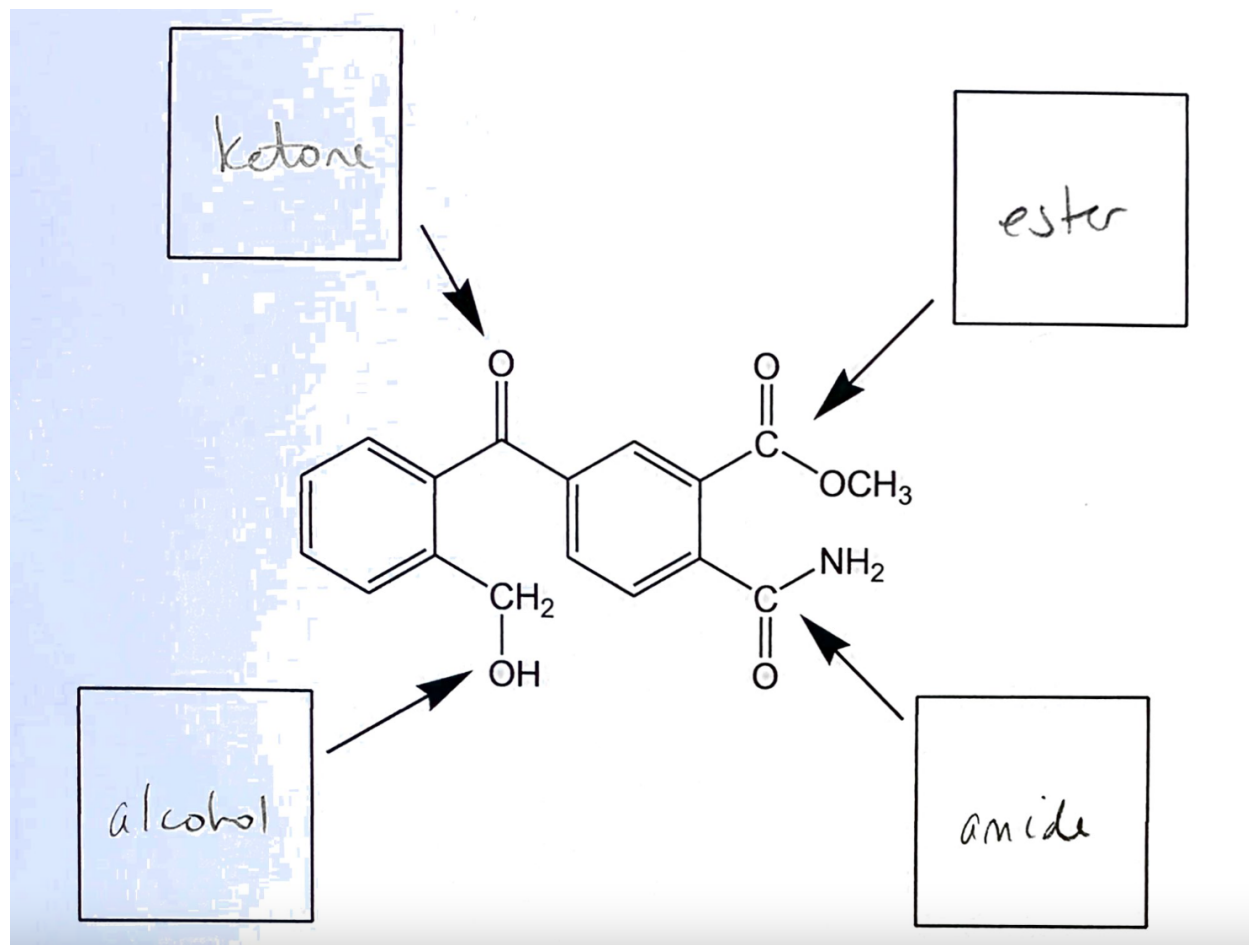
Putting it all together (5 pts)

n) Suggest a single structure for the molecule that is consistent with all of the data presented.

Note: Most of the credit for this problem comes from answering the questions above in the spaces provided.

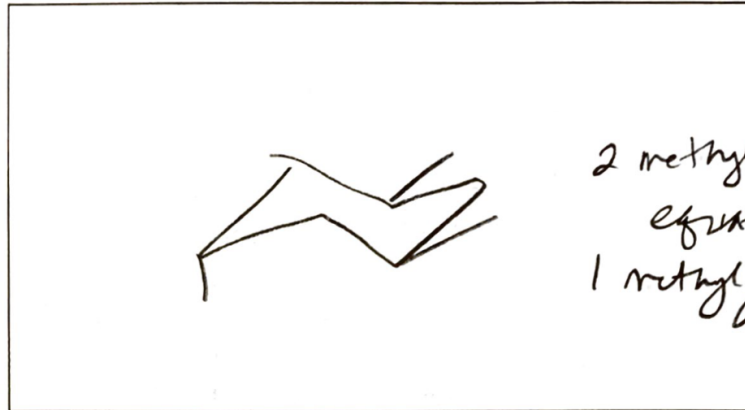
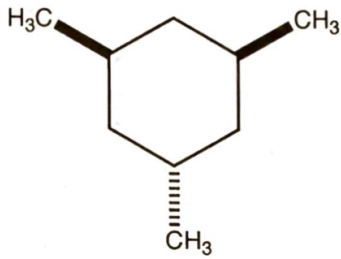


15.



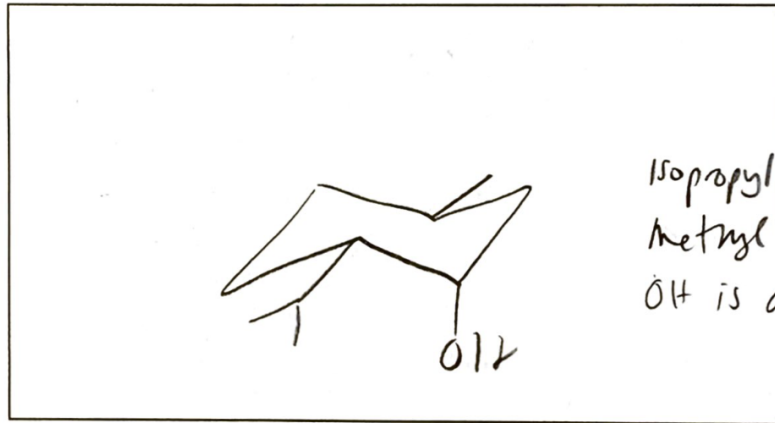
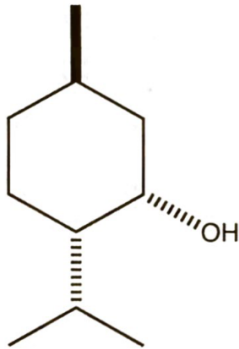
Note this is strictly for helping you on other problems (i.e. IR)! It's important you're familiar with some functional groups. :) You will not be tested about nomenclature only.

16. Draw the most stable chair conformation of the following compounds. (pts)



2 methyl are
equatorial
1 methyl is
axial

-2 for chair
flip

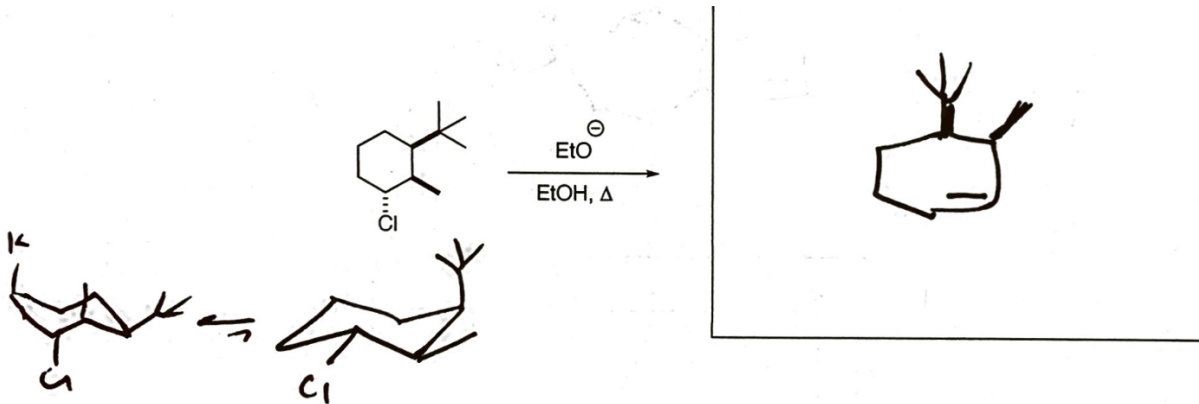


isopropyl is eq.
methyl is eq
OH is axial

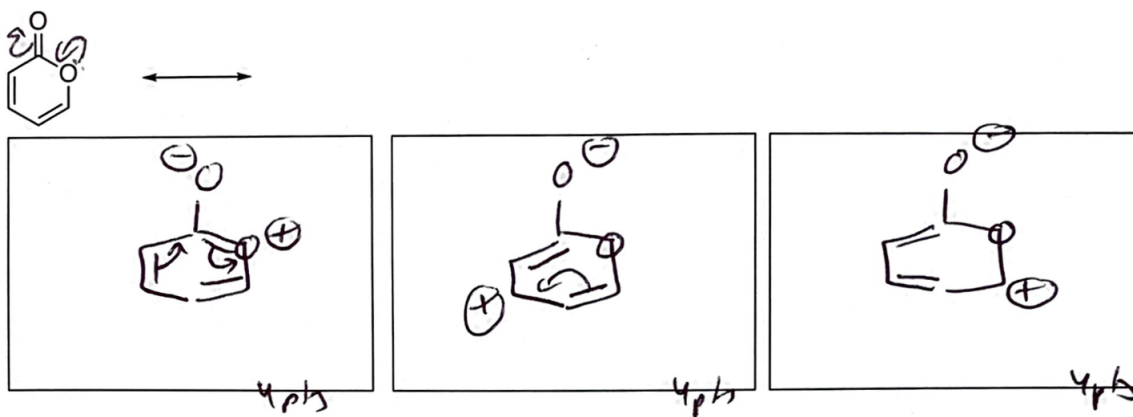
-2 for
chair flip



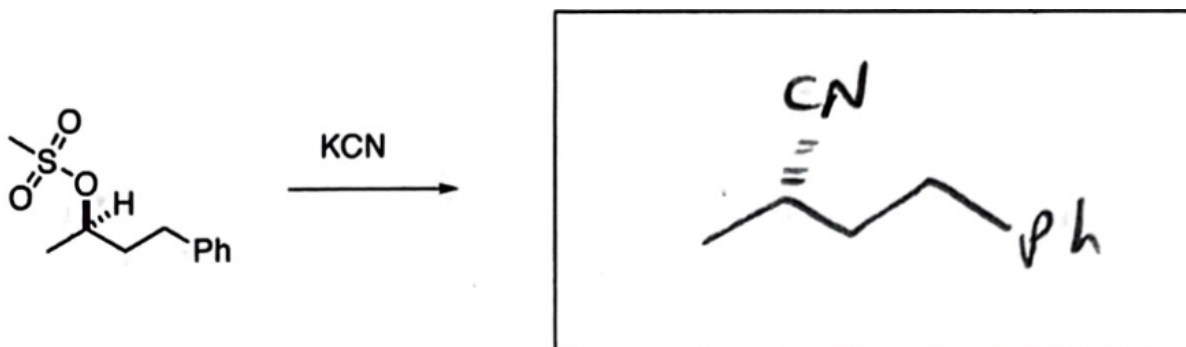
17.



18. Provide **three possible resonance contributors** for the following compound (12 pts total).



19.



It's an S_N2 reaction! The OM's group leaves. Technically you haven't learned about the mesylate leaving group, but it's similar to OTs. Note the inversion of stereochemistry!