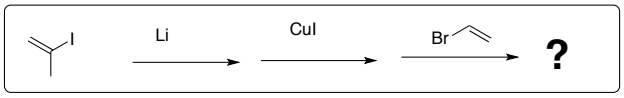
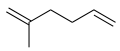
You are not allowed to post this exam on the internet!

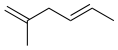
1. What is a major product of the reaction in the box?



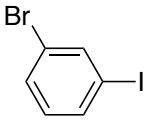
A) 

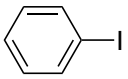
B) 

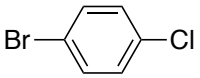
C) 

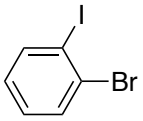
D) 

2. Which of the following compounds is expected to show two doublets AND two triplets in the ^{1}H NMR.

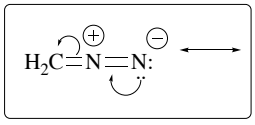
A) 

B) 

C) 

D) 

3. Which one of the following structures represents resonance contributor of molecule in the box in agreement with the shown curved arrows?



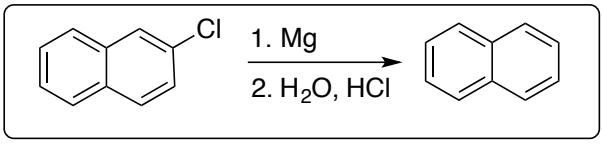
A) $H_2C{=}N{\equiv}N:$

B) $H_2\overset{\ominus}{\underset{\cdot\cdot}{C}}{-}N{\equiv}\overset{\oplus}{N}:$

C) $H_2\overset{\oplus}{C}{-}N{=}\underset{\cdot\cdot}{\overset{\ominus}{N}}:$

D) $H_2C{=}\underset{\cdot\cdot}{\overset{\ominus}{N}}{=}\overset{\oplus}{N}:$

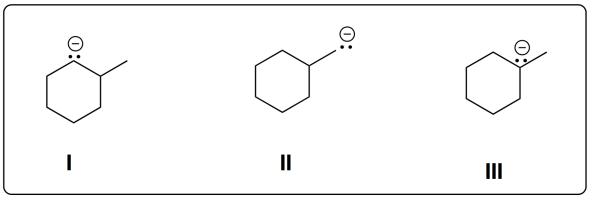
4. The following reaction sequence results in a chlorine-carbon bond being broken and a hydrogen-carbon bond being formed. From the point of view of an organic chemist how would you call such a reaction?



A) Oxidation B) Reduction

C) Elimination D) Addition

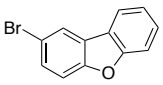
5. Arrange the carbanions shown in the box in order of decreasing stability. - List the most stable carbanion first.

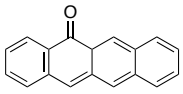


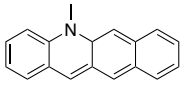
A) III > II > I B) I > II > III

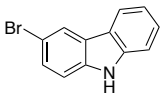
C) II > III > I D) II > I > III

6. Which of the following shows a set of molecular ion with m/z=245 and m/z=247 with equal intensity?

A) 

B) 

C) 

D) 

7. Which of the of the following correctly describes the charge distribution in methyl lithium?

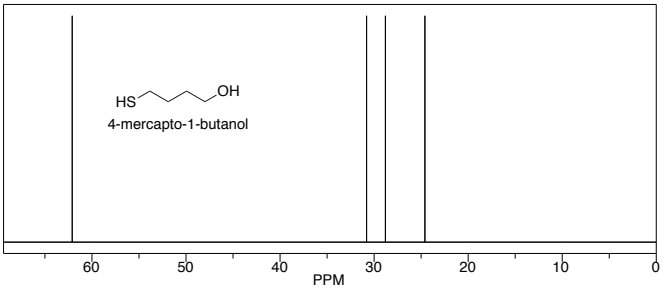
A) $\overset{\delta+}{Li}-\overset{\delta-}{CH_3}$

B) $\overset{\delta-}{Li}-\overset{\delta+}{CH_3}$

C) $\overset{\delta-}{Li}-\overset{\delta-}{CH_3}$

D) $\overset{\delta+}{Li}-\overset{\delta+}{CH_3}$

8. The structure of 4-mercapto-1-butanol is shown within its ^{13}C NMR spectrum.



What is the chemical shift of the carbon atom directly bond to the hydroxyl group? – Remember the carbon atom that is bond to the element with highest electronegativity will have the highest chemical shift.

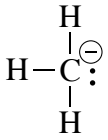
A) 62.1

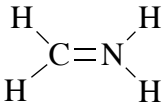
B) 30.8

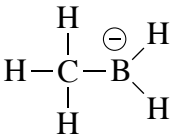
C) 28.8

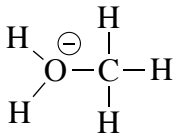
D) 24.6

9. Which one of the following molecules or polyatomic ions is a correct Lewis structure with correct formal charge?

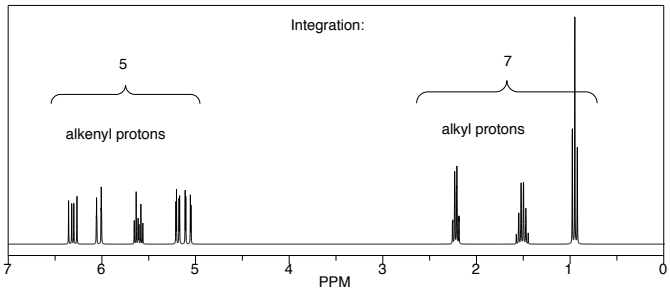
A) 

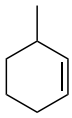
B) 

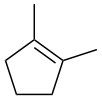
C) 

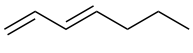
D) 

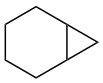
10. The chemical shifts in combination with the integration of the signals in ^{1}H NMR spectrum shown below indicate that there are 5 alkenyl protons and 7 alkyl protons in this compound. Solely based on this information what is the structure of this compound?



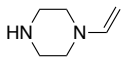
A) 

B) 

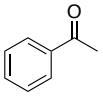
C) 

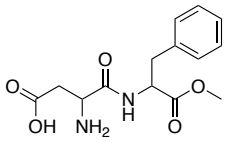
D) 

11. Which of the following has a index of hydrogen deficiency (= also called degree of unsaturation) of 0?

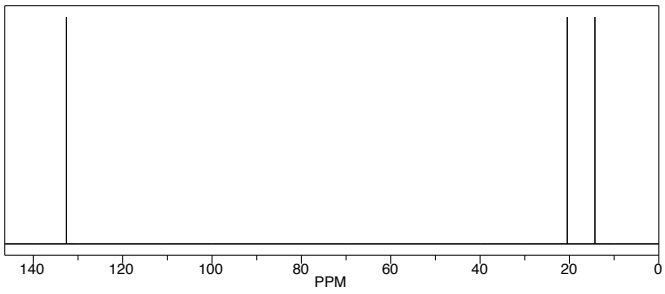
A) 

B) 

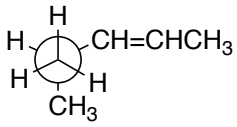
C) 

D) 

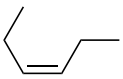
12. Identify the compound whose ^{13}C NMR spectrum shown below.



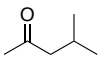
A) 

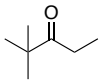
B) 

C) 

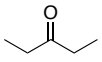
D) 

13. Which of the following compounds displays – besides other signals - a nonet (a signal that is split into nine lines) in the ^{1}H NMR?

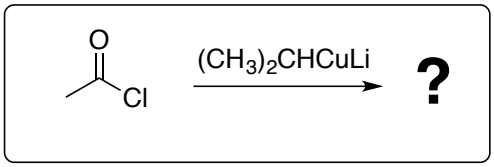
A) 

B) 

C) 

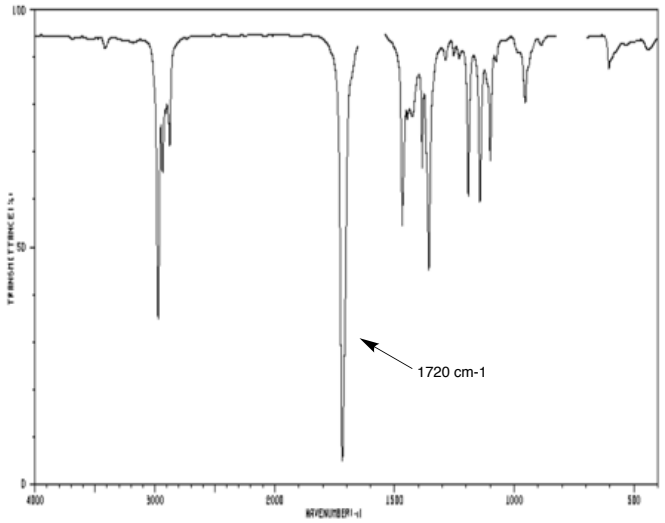
D) 

14. Use the spectrocopic data to determine the structure of the reaction in box.

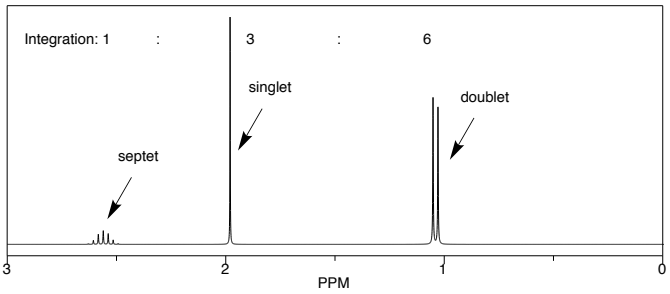


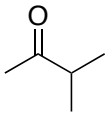
Spectroscopic data of the major product:

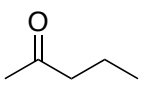
IR:

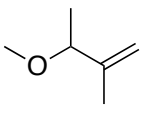


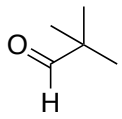
^{1}H NMR



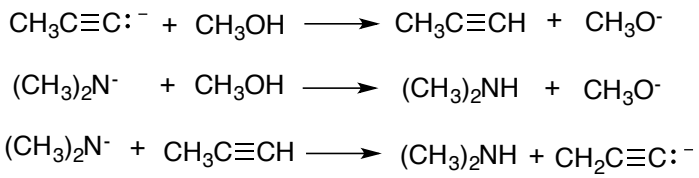
A) 

B) 

C) 

D) 

15. The following acid/base reactions proceed as written:



Solely based on the above equations, sort the acids according to decreasing acidity – list the most acidic species is first:

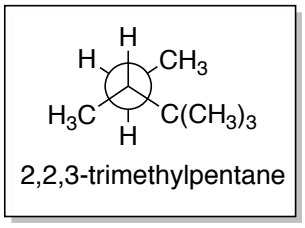
A) $(CH_3)_2NH > CH_3OH > CH_3C{\equiv}CH$

B) $CH_3OH > (CH_3)_2NH > CH_3C{\equiv}CH$

C) $CH_3OH > CH_3C{\equiv}CH > (CH_3)_2NH$

D) $CH_3C{\equiv}CH > CH_3OH > (CH_3)_2NH$

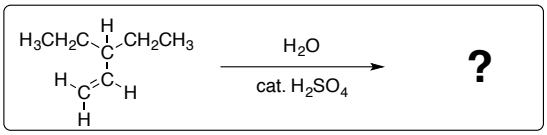
16. The Newman of 2,2,3-trimethylpentane is shown in the box. Predict the number of signals in ^{13}C NMR. – Please remember that NMR cannot distinguish between conformers.



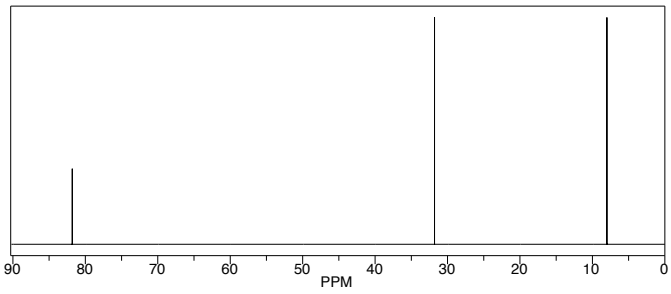
A) three signals B) four signals

C) six signals D) seven signals

17. According to the 13C NMR what is the major product of this reaction?



^{13}C NMR of the major product



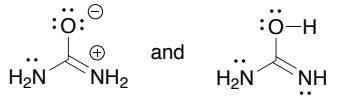
A) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2OH$

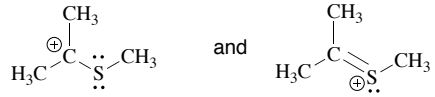
B) $CH_3\overset{\overset{OH}{|}}{C}HCH_2CH_2CH_2CH_3$

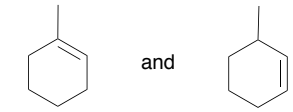
C) $CH_3CH_2\overset{\overset{OH}{|}}{C}HCH_2CH_3$ with CH_2CH_3 below

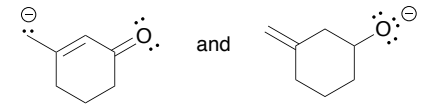
D) $CH_3\overset{\overset{OH}{|}}{C}HCH(CH_2CH_3)_2$

18. Which of the following pairs depicts resonance structures?

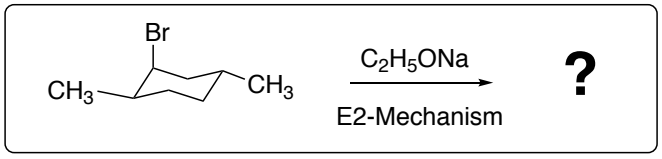
A) 

B) 

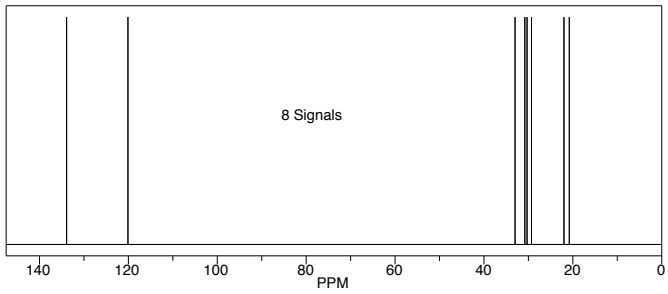
C) 

D) 

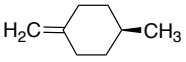
19. According to ^{13}C NMR spectrum, what is a major product of the reaction shown in the box?

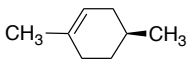


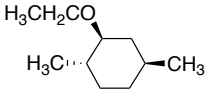
^{13}C NMR spectrum of the major product:



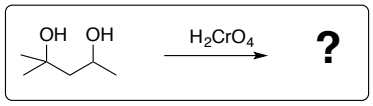
A) 

B) 

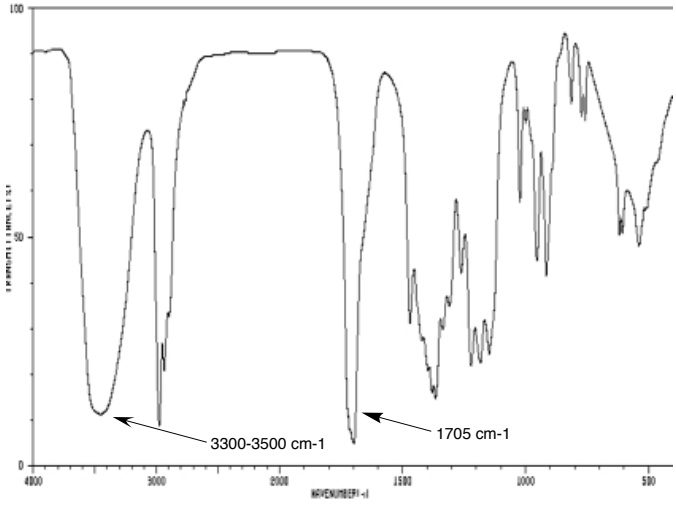
C) 

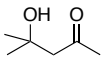
D) 

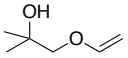
20. According to the IR spectrum which of the following is one of products of the reaction shown in the box?

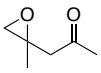


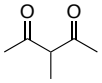
IR spectrum of this product:



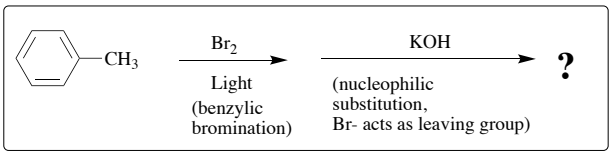
A) 

B) 

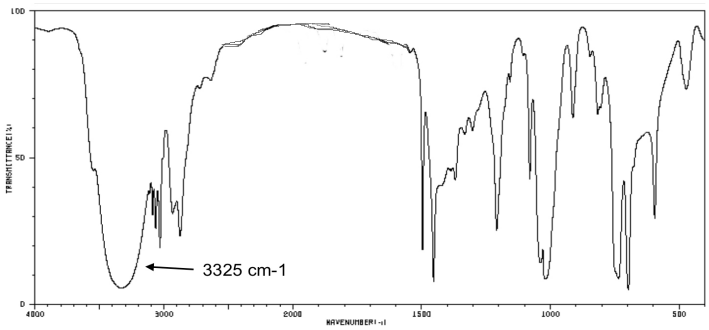
C) 

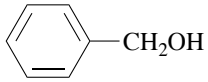
D) 

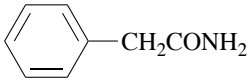
21. According to the IR spectrum what is the major product of the reaction sequence shown in the box?

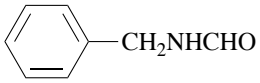


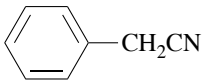
IR spectrum of the major product:



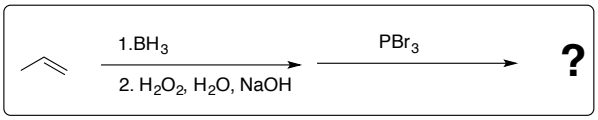
A) 

B) 

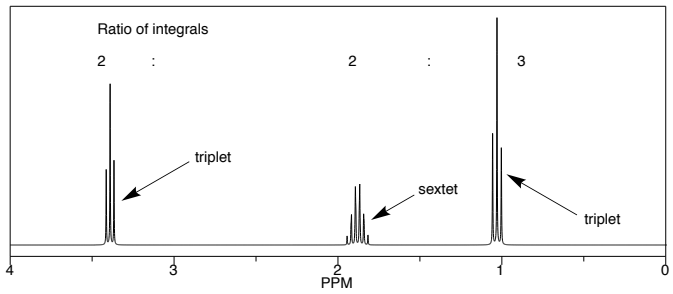
C) 

D) 

22. According to the ^{1}H NMR, what is the structure of the major product of the following sequence of reactions?



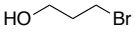
^{1}H NMR of the major product:



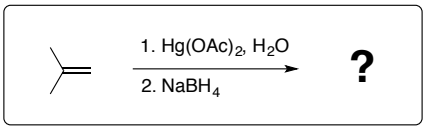
A) 

B) 

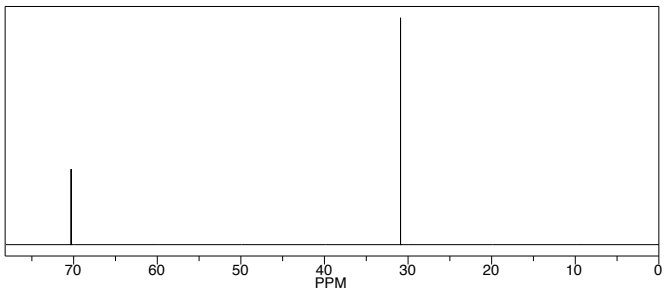
C) 

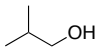
D) 

23. Which of the following is a major product of the reaction in the box? – An alternative way of performing this reaction is the use of H_2O, cat. H_2SO_4.

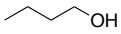


^{13}C NMR spectrum of the major product:



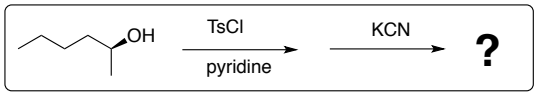
A) 

B) 

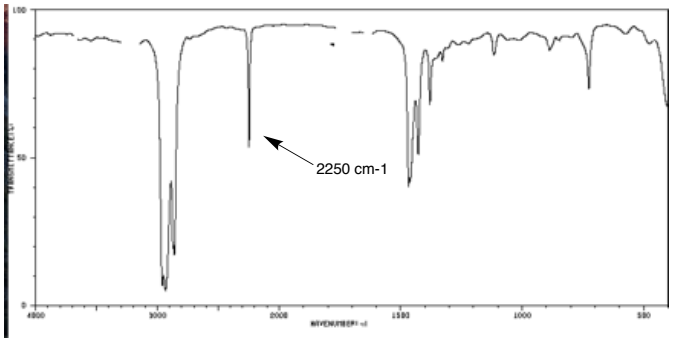
C) 

D) 

24. According to the IR spectrum, what functional group is present in the product of the following sequence of reactions:



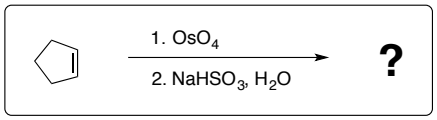
IR spectrum of the major product:



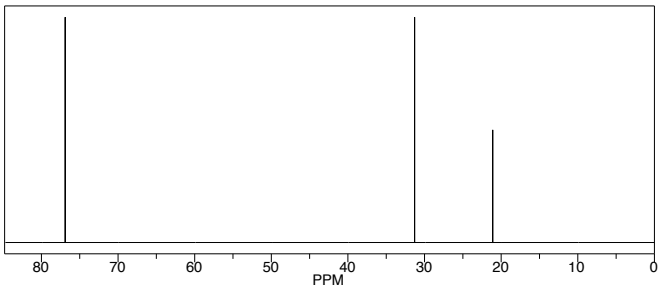
A) an amide B) a nitro group

C) an amine D) a nitrile/cyano group

25. What is a major product of the reaction in the box?



^{13}C NMR of the major product:



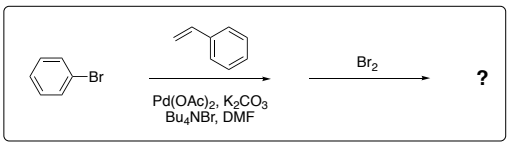
A)

B)

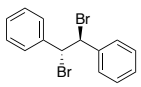
C)

D)

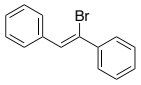
26. What is a major product of the reaction sequence shown in the box?



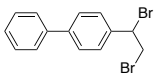
A)



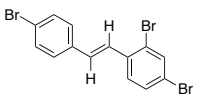
B)



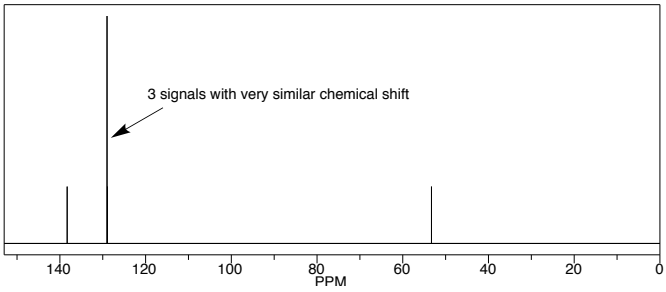
C)



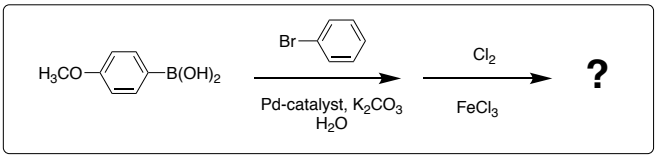
D)



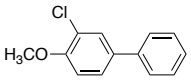
^{13}C NMR of the major product - five signals total



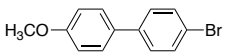
27. According to the mass spectrum, which of the following is a major product of the reaction shown in the box?



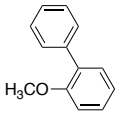
A)



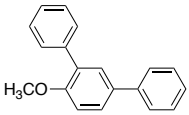
B)

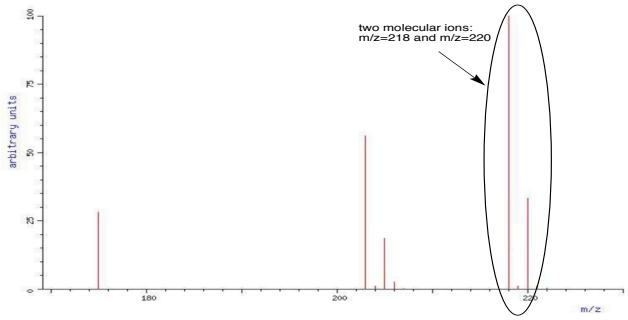


C)

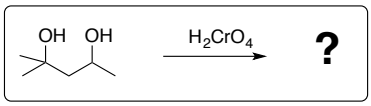


D)

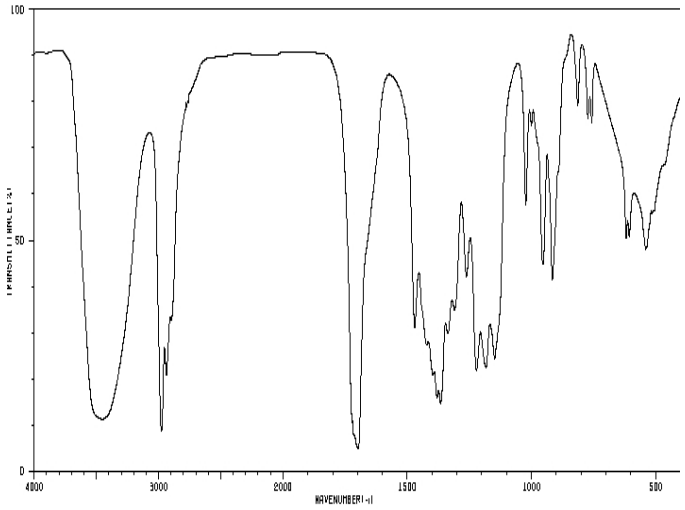




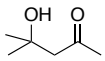
28. According to the IR spectrum which of the following is one of products of the reaction shown in the box?



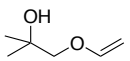
IR spectrum of the product:



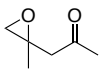
A)



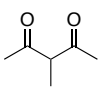
B)



C)



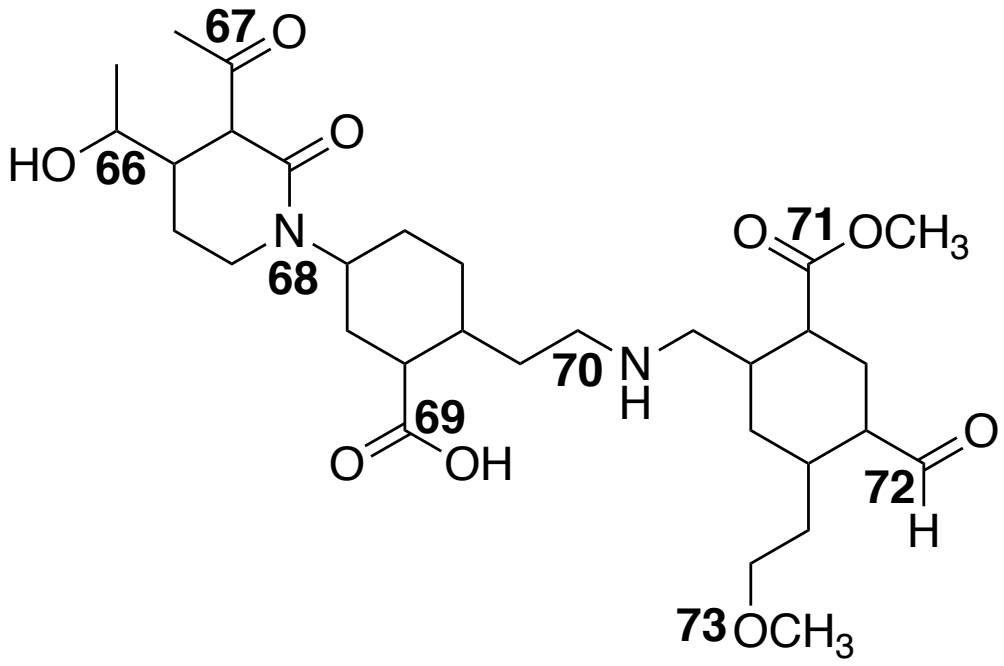
D)



Problems 28 and 29.

"write –in" - Please use the back of the Scantron form.

28. (16 pts) The functional groups in the drawing below are labeled using the numbers 66 to 73. Identify the functional groups indicated by numbers in the molecule shown, and write answer into lines 66 to 73 on the back of the Scantron form (2 pt for each functional group, 16 pts total). Choose from the following as answers: ketone, amine, arene, oxime, lactone, alcohol, ester, amide, alkene, ether, imine, thiol, enol, alkyne, carboxylic acid, nitro group, nitrile/cyano, acetal, hydrazone, acid anhydride, lactame, and aldehyde. – **Not all of these functional groups are present in this molecule**.



29. (2 pts) What is the structure of the molecule? - Please write your answer into line 74 on the back of the Scantron form.

Molecular formula: C_3H_7Cl