Chem 14C Exam 2 Sp2022 solutions and rubric

1. A hydrocarbon has an M^+ peak of *m/z* 136. It also has two double bonds and one ring in its structure. What is the molecular formula? **(8 pts total)**

$C_{10}H_{16}$

-1 if not a hydrocarbon

-2 if molar mass does not add up to 136

-2 if $C_{11}H_4$ (exceeds 2n+2), C_9H_{28}, etc…

-2 if molecular formula does not have 3 degrees of unsaturation

2. In as few words as possible, explain for the differences in observed IR absorptions in each of the following pairs of functional groups/molecules: (12 pts total)

a) an *sp* C-H stretch appears ~3300 cm^{-1}, while an sp^2 C-H stretch appears ~3100 cm^{-1}

the carbon of an *sp* C-H bond has more % s-character, which means it has a shorter bond length with H and therefore a stronger bond **(6 pts)**

student should mention either: % s-character
and/or bond length/strength (graded leniently)

b) C -O stretches appear around 1400 cm^{-1}, while a C-Cl stretch appears around 700 cm^{-1}

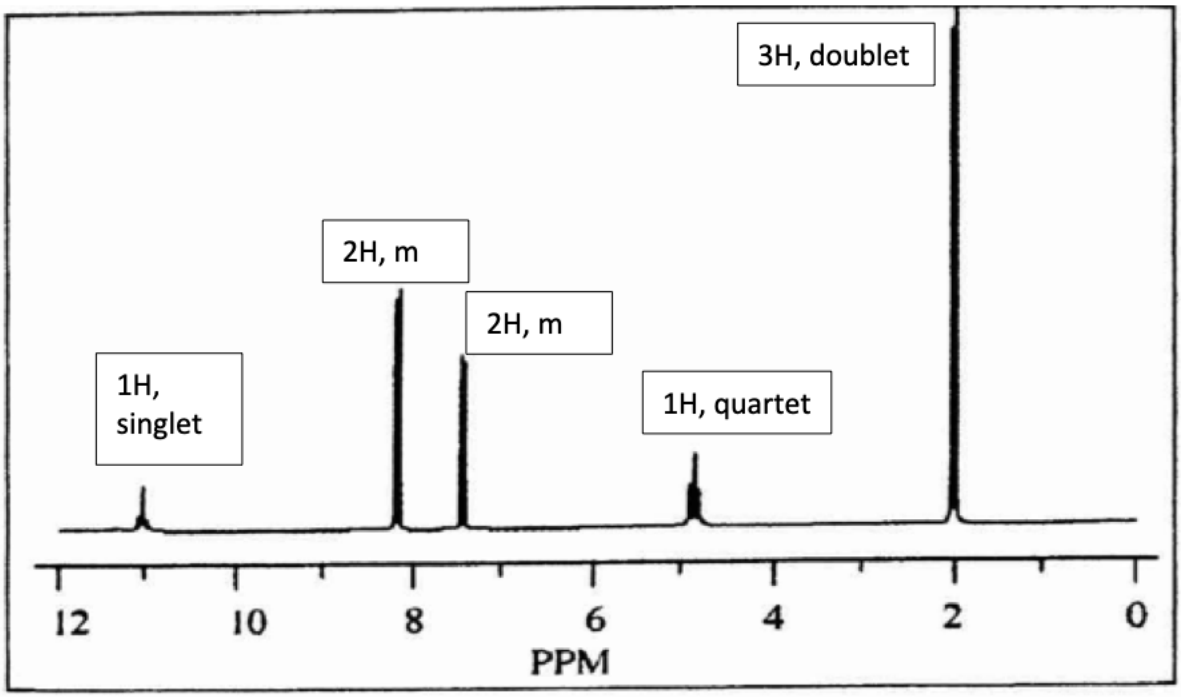
O has a smaller atomic mass than Cl **(6 pts)**

(2/6 if student says O has a larger atomic mass)
(3/6 if student uses dipole or bond strength argument)
(0/6 any other reason)

3. A compound has the following data:

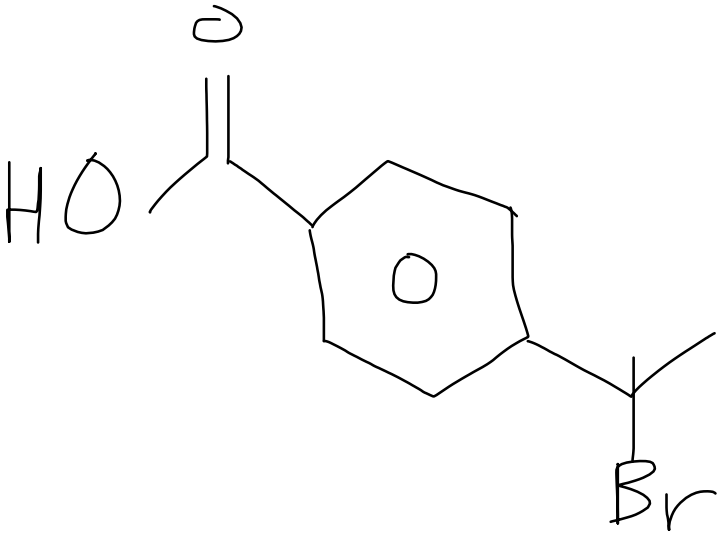
M^+ peak at *m/z* 228, *M + 2* peak at *m/z* 230 (~1:1 intensity)
IR: 3400 – 2500 cm^{-1} (intense, broad), 1710 cm^{-1} (intense, sharp)

^{13}C-NMR: there are seven signals



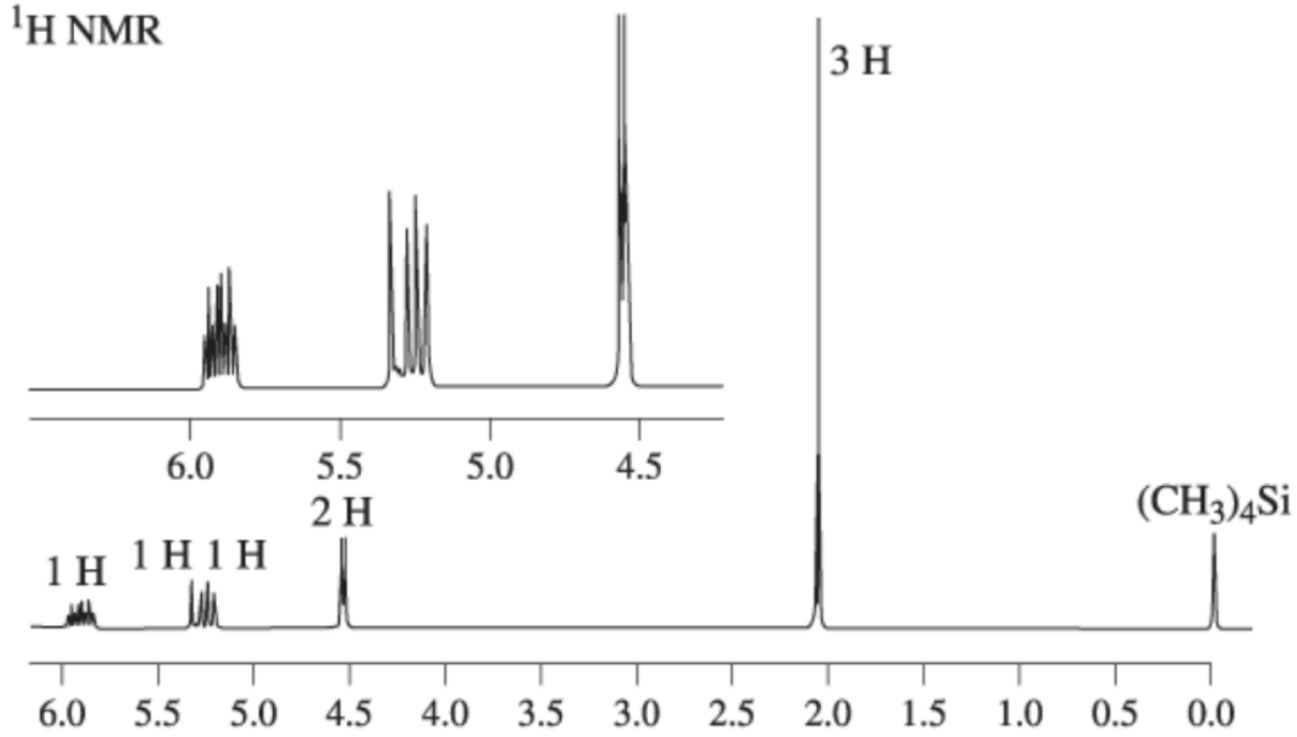
Deduce the structure. Use bond-line drawing as your final answer.

(17 pts total)



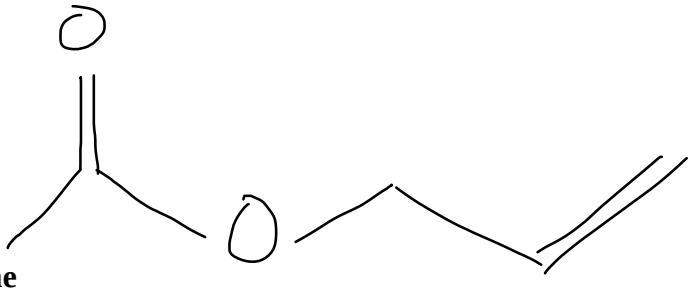
+4 -CO2H
+3 if aldehyde
+4 disubstituted benzene, para
+2 disubstituted benzene not para
+1 any other benzene
+4 bromine on secondary carbon
+2 if chlorine/sulfur/nitrogen, etc..
+2 if Br anywhere else
+2 methyl next to CH
+1 if not next to CH
+3 methyne (CH) next to methyl
+2 if not next to methyl
-3 pts if molar mass not 228

4. Deduce the structure of the compound with formula $C_5H_8O_2$ given the spectrum below.



The signal at 5.3 ppm is composed of two overlapping doublet of doublets.

Use bond-line drawing for your final answer. **(17 pts total)**



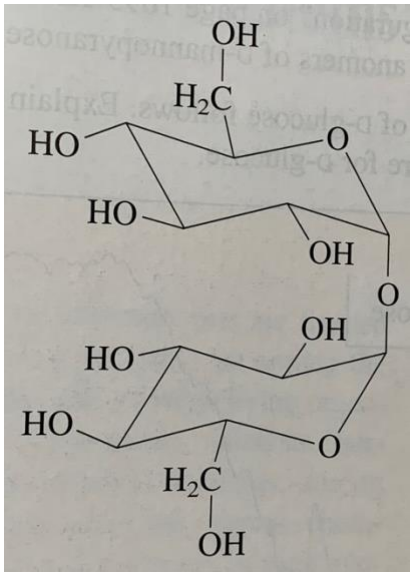
+4 ester
+4 alkene
+3 if there are not exactly 3 vinyl H's
+4 methyl
+3 if not next to carbonyl
+4 CH_2
+3 if not next to O

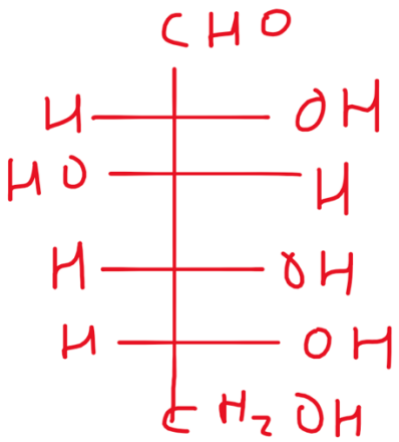
+1 total 2 degrees of unsaturation

-3 pts if not $C_5H_8O_2$

5. Answer the following questions about the compound shown below, which is used by insects and some fungi to store energy: (13 pts total)

a) Consider only the top monosaccharide chair conformation. Draw the Fischer projection of the *D*-hexose from which this chair conformation is derived.





(10 pts, -1 pt each error)
Errors include: OH wrong side, incorrect number of carbons, ketose instead of aldose, etc…

*****If not a D sugar, then -2 pts**

b) The disaccharide shown is (CIRCLE ONE): **(3 pts, all or nothing)**

reducing non-reducing cannot be determined