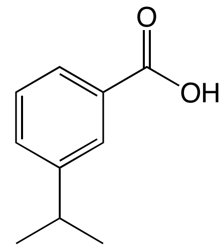
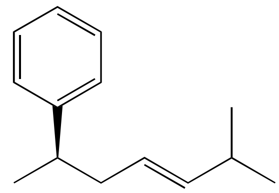
1. Provide an unambiguous name (IUPAC or common) for each of the following molecules. (12 pts)

a)



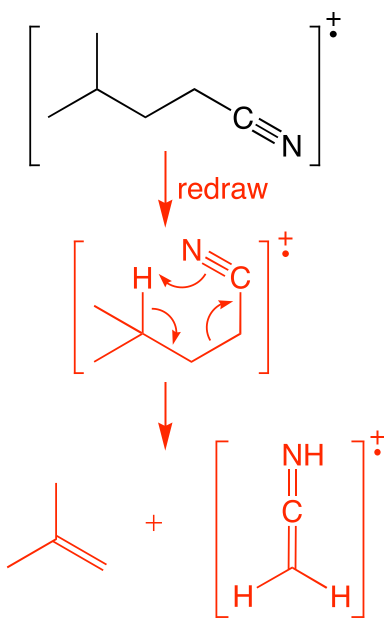
3-isopropylbenzoic acid

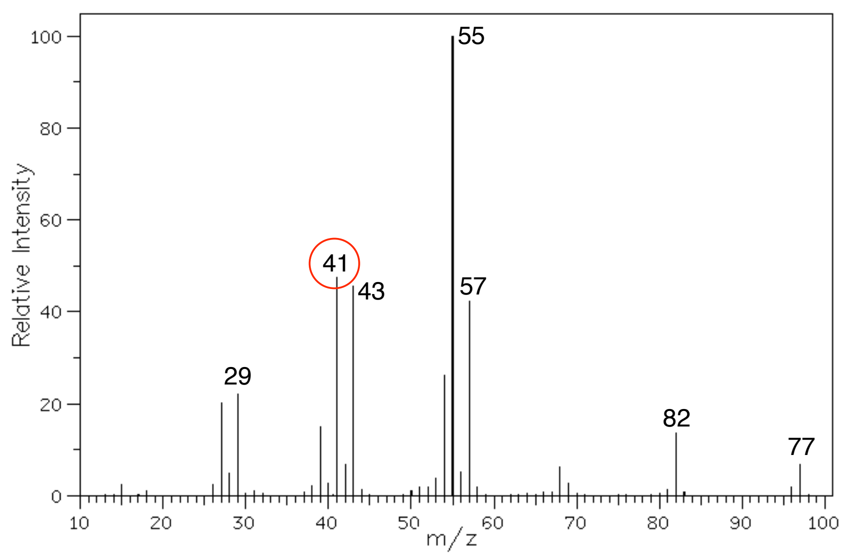
b)



(*R*,*E*)-2-methyl-6-phenyl-3-heptene

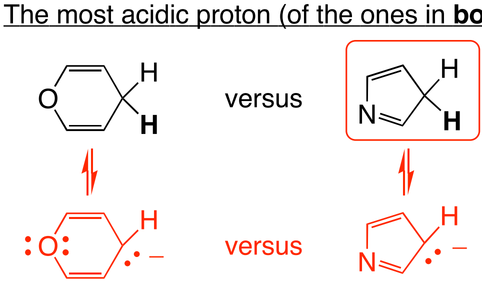
2. The following nitrile undergoes a McLafferty-like fragmentation to yield one of the peaks in the mass spec. shown below. Provide a mechanism for this rearrangement, show both fragments, and circle the number above the peak that is represented by this fragmentation. (9 pts)





3. Circle the compound that best fits the description provided and provide an explanation for your choice using both pictures and words. (12 pts).

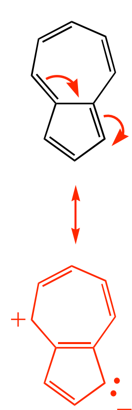
The most acidic proton (of the ones in **bold**)



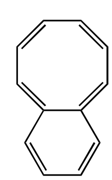
Conj. base has 6 pi e's so it is aromatic, which means it's very stable and likely to be formed.

The conj. base has 8 pi e's, so it would be anti-aromatic. Therefore, the acid is not likely to want to give up its proton to form the conj. base.

The most polar molecule

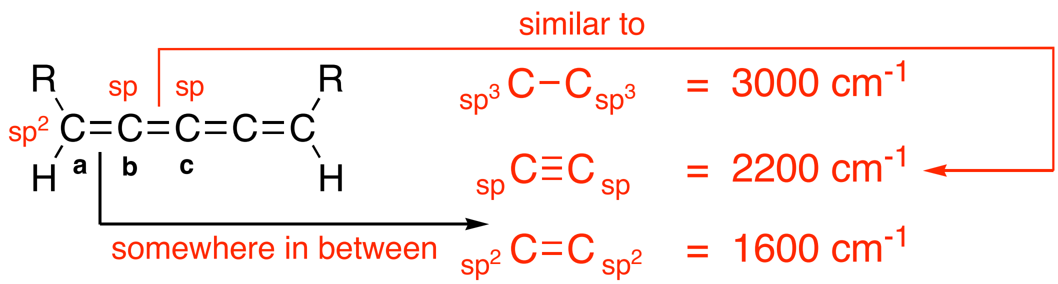


versus



One resonance possibility makes both rings aromatic and thus will be a major contributor. Since there are charges in the structure, a dipole will be present making the molecule polar. The other structure cannot achieve the same situation.

4. The following structure is known as a cumulene. Using your knowledge of IR stretching values for other functional groups, predict the IR stretching values (in cm^{-1}) for the two bonds indicated below. If your predictions are not identical provide a reason for their differences in the box provided. (10 pts)



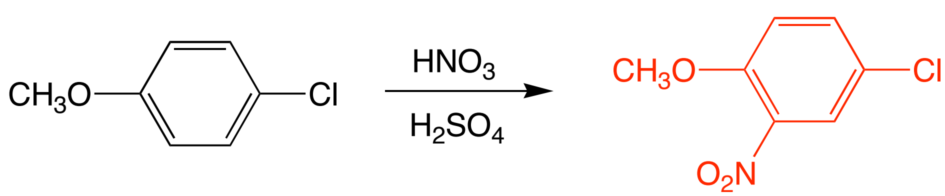
$C_a{=}C_b$ = **1900** cm^{-1} $\qquad$ $C_b{=}C_c$ = **2100** cm^{-1}

Explanation

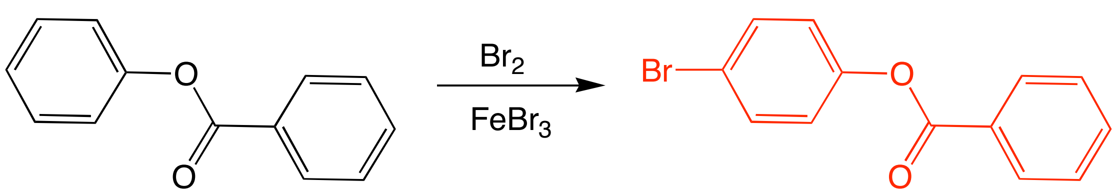
C_a is sp^2 hybridized, while C_b and C_c are sp hybridized. Since sp hybridized carbons form shorter bonds than sp^2 orbitals, the double bond with TWO sp hybridized carbons would be shorter than the double bond with the sp^2 and sp hybridized carbons. The shorter the bond, the faster the vibration. The faster the vibration, the higher the wavenumber of the vibrational stretch.

5. Predict the *major* organic product of each of the following reactions. You may draw other products for partial credit, however if you do, you must *circle* the major product for full credit. (18 pts)

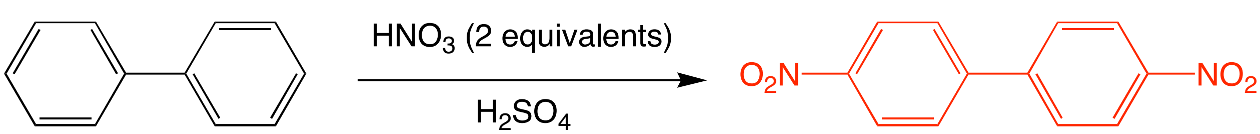
a)



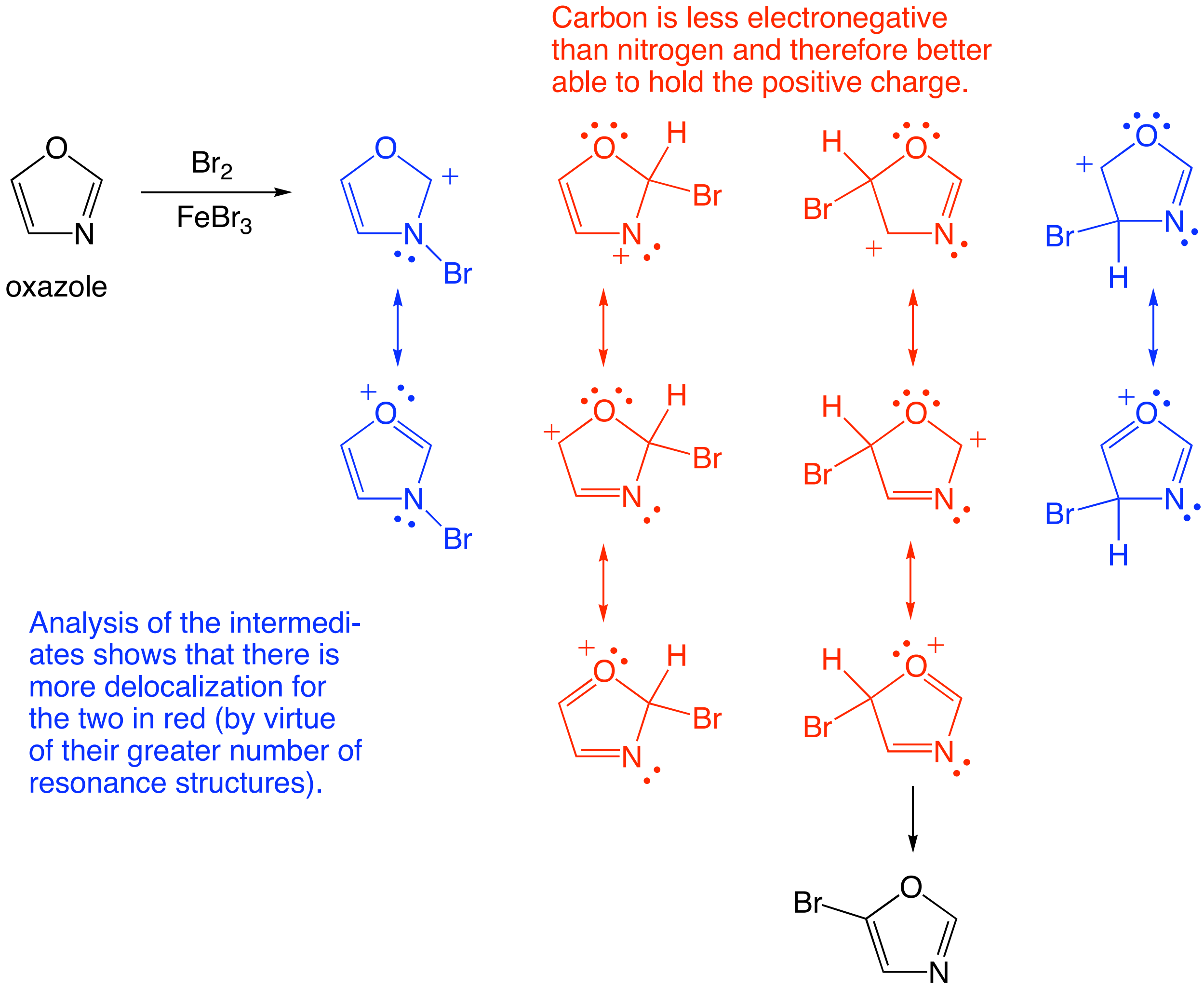
b)



c)

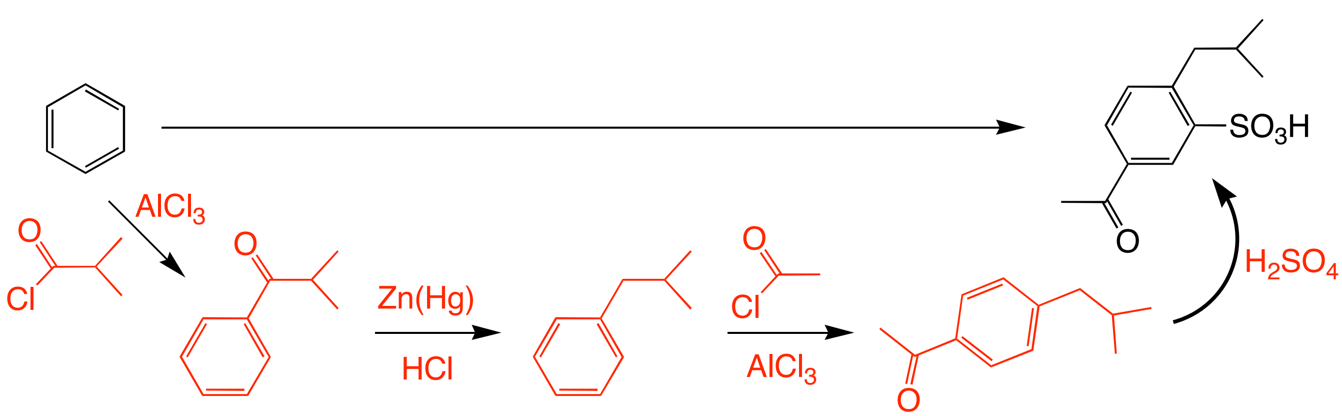


6. Use resonance theory (by drawing the resonance structures of all the possible intermediates leading to products) to predict the major product of the following hypothetical electrophilic aromatic substitution reaction. Circle the major product and provide an explanation for your decision. (14 pts)

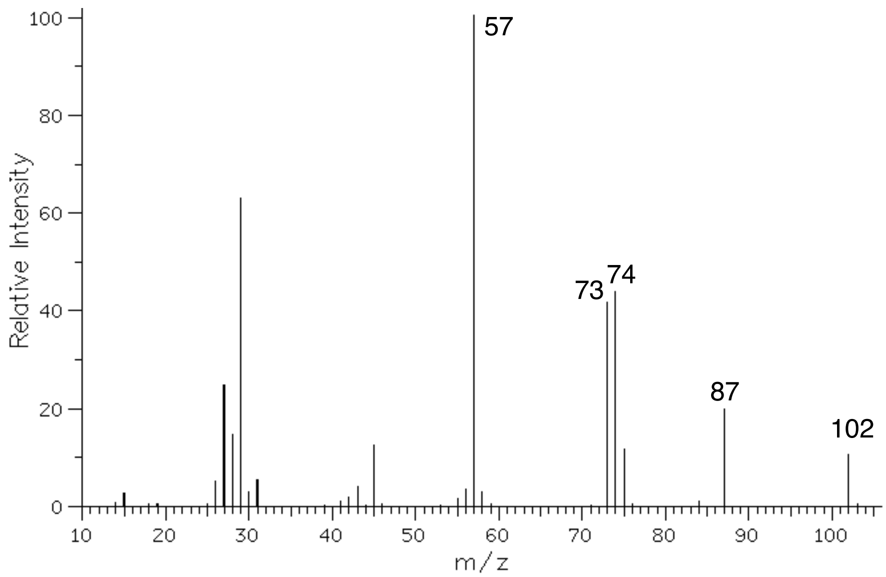


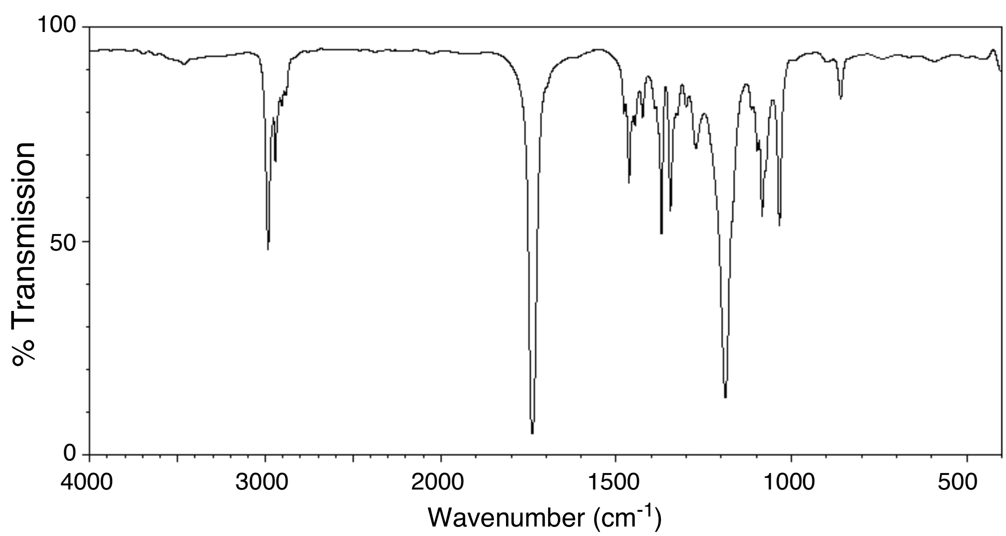
favored product

7. Propose a synthesis for the following transformation. Provide the products of each step for full credit. (10 pts)

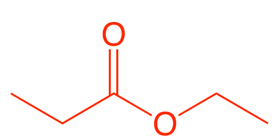


8. Determine the structure represented by the spectra provided. The molecular formula of the unknown compound was determined to be $\mathbf{C_5H_{10}O_2}$. For full credit, you must assign significant peaks in each of the spectra. (15 pts)





The IR shows a C=O stretch at approx 1700 cm^{-1}. There are no OH stretches. A C-O stretch is seen at approx 1200 cm^{-1}.



Loss of methyl [M-15] is seen for the beta-cleavage near the ether. Peaks in the MS are seen for both alpha-cleavages and for the McLafferty Rearrangement of the ester. The McLafferty is the key piece of data for arrivinbg at the structure above.