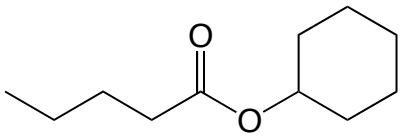
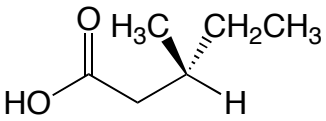
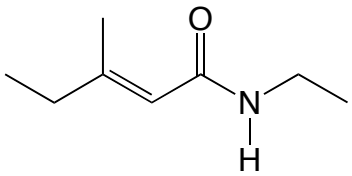
1. Provide an unambiguous name (IUPAC or common) for each of the following molecules. (15 points)



cyclohexyl pentanoate

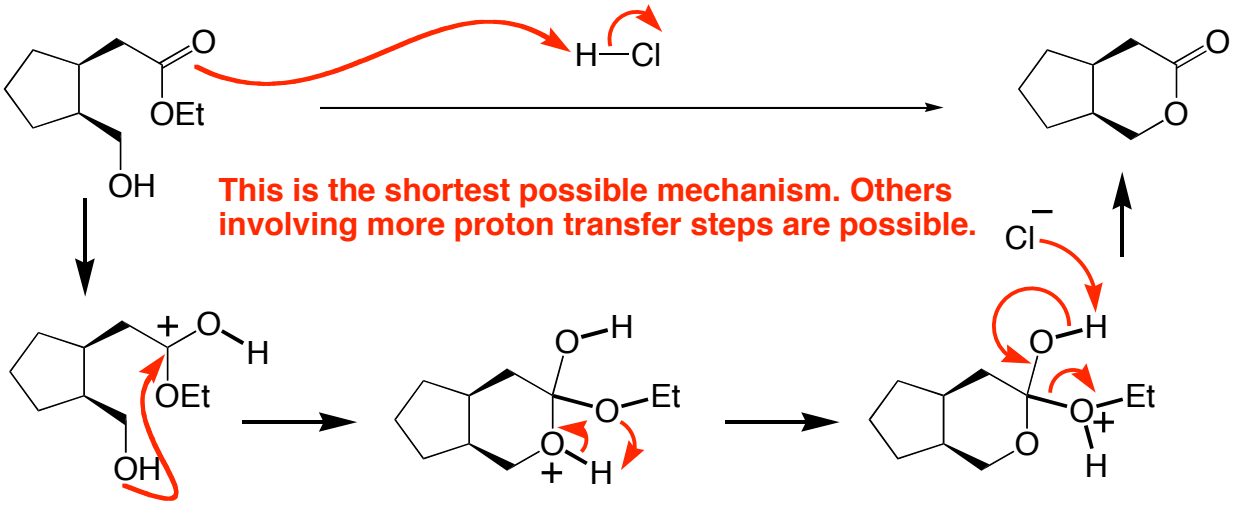


(*R*)-3-methylpentanoic acid



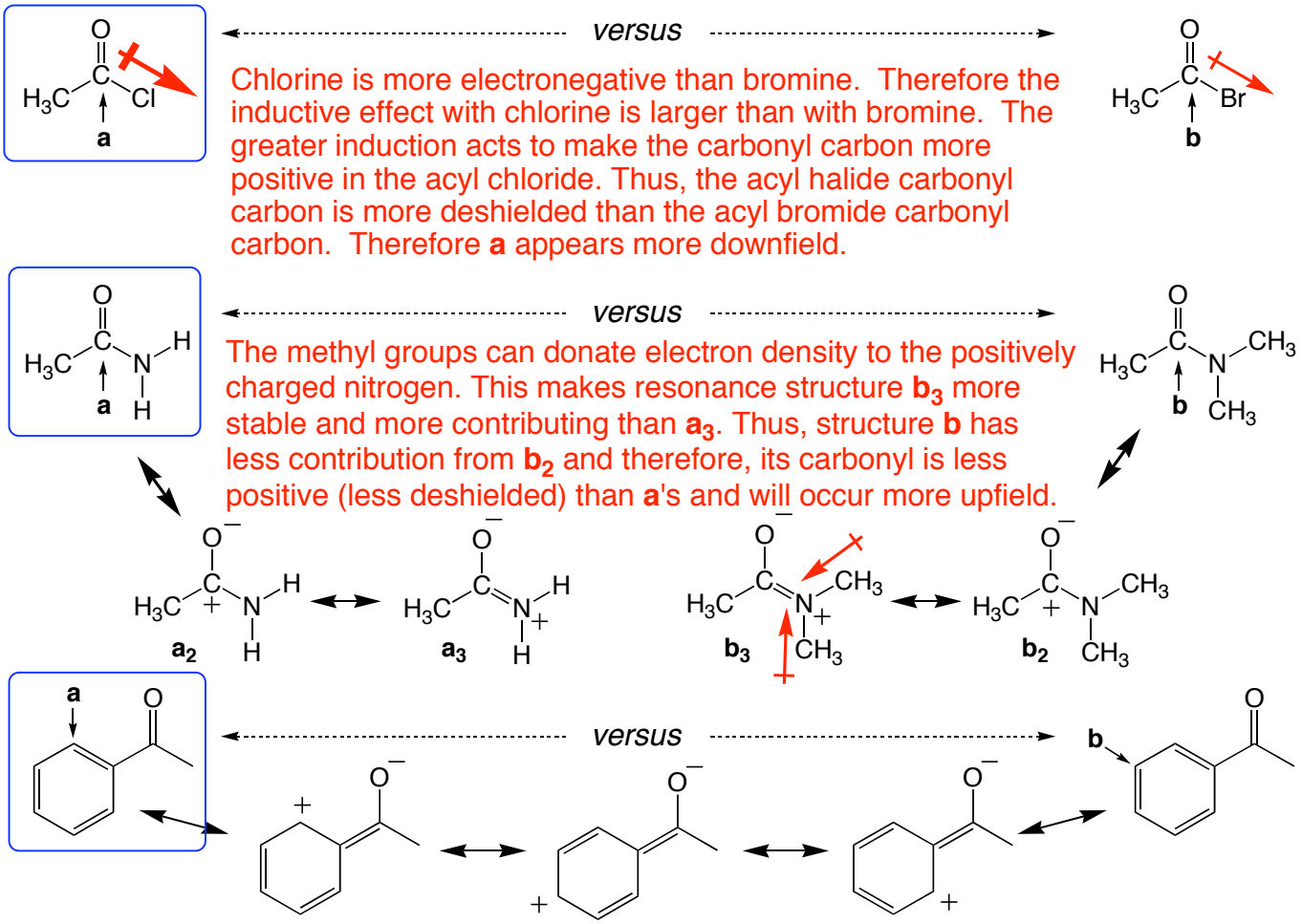
(*E*)-*N*-ethyl-3-methylpent-2-enamide

2. Provide a mechanism for the following reaction. You must show the products of each step and all formal charges for full credit. (12 points)



This is the shortest possible mechanism. Others involving more proton transfer steps are possible.

3. For each pair of compounds, decide which of the indicated carbons (**a** versus **b**) would resonate further downfield in a ^{13}C NMR spectrum (**circle** the one that would show up more downfield). Provide an explanation for your choice that uses both pictures and words. (15 points)

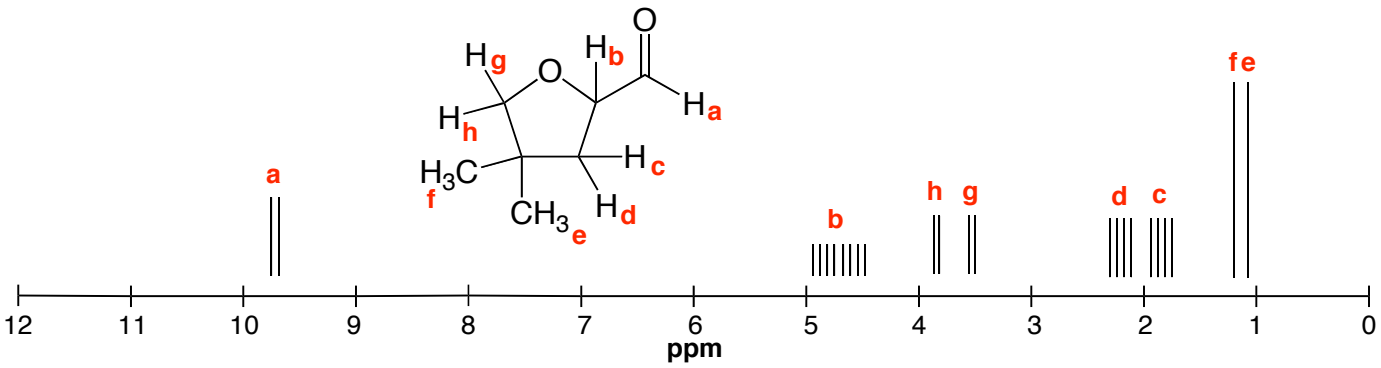


Chlorine is more electronegative than bromine. Therefore the inductive effect with chlorine is larger than with bromine. The greater induction acts to make the carbonyl carbon more positive in the acyl chloride. Thus, the acyl halide carbonyl carbon is more deshielded than the acyl bromide carbonyl carbon. Therefore **a** appears more downfield.

The methyl groups can donate electron density to the positively charged nitrogen. This makes resonance structure $\mathbf{b_3}$ more stable and more contributing than $\mathbf{a_3}$. Thus, structure **b** has less contribution from $\mathbf{b_2}$ and therefore, its carbonyl is less positive (less deshielded) than **a**'s and will occur more upfield.

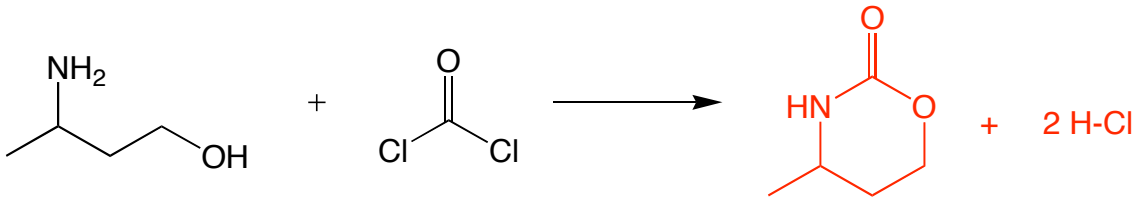
Resonance shows that carbon **a** has more positive character than **b**, making **a** more deshielded and thus resonating more downfield than **b**.

4. Predict the ^{1}H NMR spectrum of the following molecule, taking care to approximate chemical shift values and to show splitting patterns (do not show integration). For full credit, you must assign your peaks (label w/ letters) *and* consider the relative heights in all peaks that show splitting. (12 points)

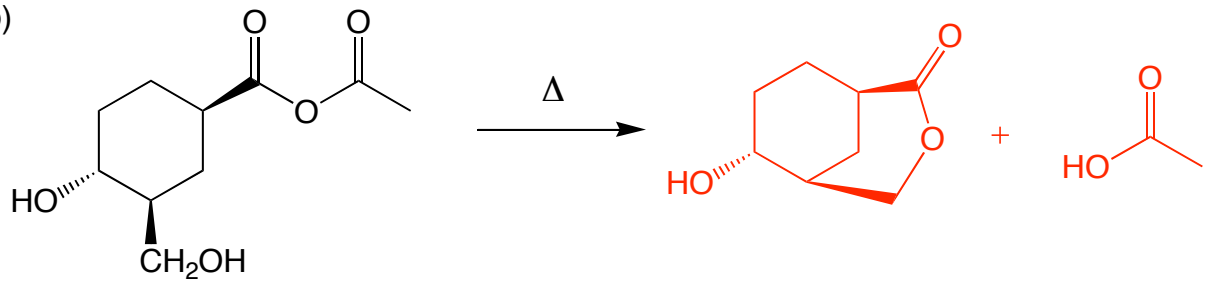


5. Predict the *major* organic product of each of the following reactions. You may draw other products for partial credit, however if you do, you must *circle* the major product for full credit. (18 pts)

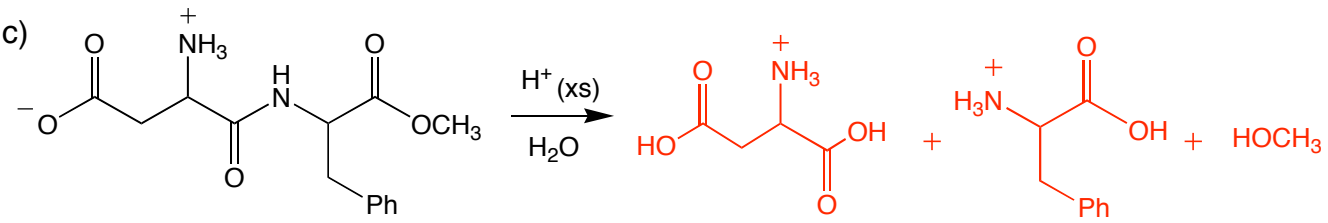
a)



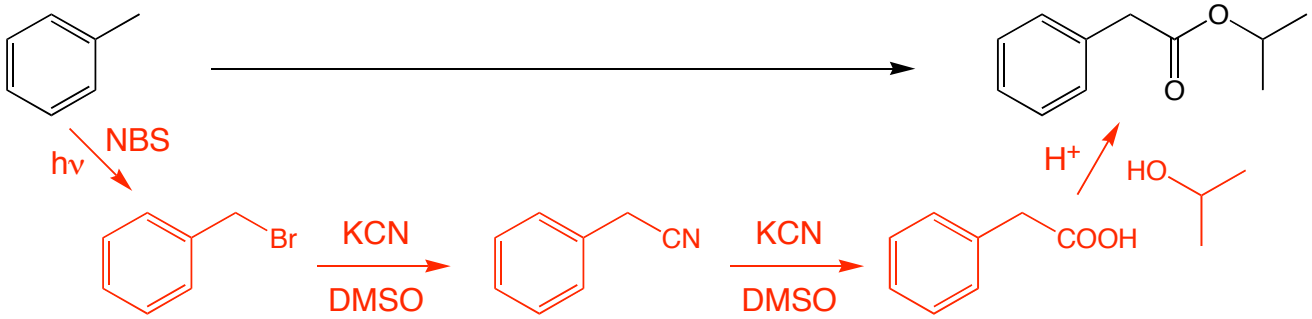
b)



c)



6. Propose a synthesis for the following transformation. Provide the products of each step for full credit. (13 pts)



7. A compound with the molecular formula $C_7H_{14}O_2$ gives the following spectra. Provide a structure for this compound. For full credit, you must assign peaks in each of the 3 spectra! *Circle your answer.* (14 points)