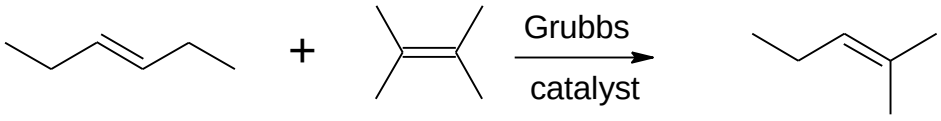
1.) Which is more reactive: an organolithium or organomagnesium reagent? **Explain.** (12 pts)

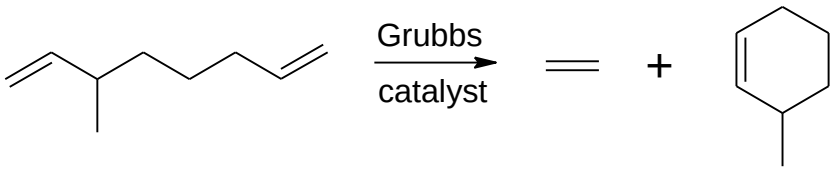
Organolithium. Since Li is **less electronegative** than Mg, its bond to C is ***more polar***, making the C= more nucleophilic = more reactive

2.) Show **all** possible new products formed from the metathesis of the following compounds. If only one compound is listed, assume that it is in excess. (20 pts, 10 pts ea)

a.)



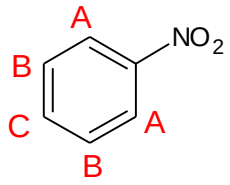
b.)



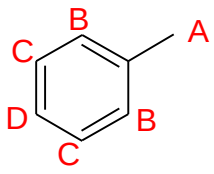
3.) Can Grignard reagents be used in aqueous solvent? Why or why not? (10 pts)

NO. Grignard reagents are **highly nucleophilic** due to the carbanion and will prematurely react with any partially positive H.

4.) Consider the following structures of (a) nitrobenzene and (b) toluene. Explain why the ^{1}H NMR spectrum on a 300 MHz instrument for (a) shows three separate signals (a doublet, a triplet, and a doublet of doublets), while (b) shows only two (a singlet and a rough "multiplet"). (20 pts)



(a) nitrobenzene

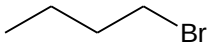


(b) toluene

Each should show **three** distinct signals for their benzene H's as they are unequivalent to one another. However, since the $-CH_3$ group is only **slightly electronegative** (C = 2.5), its deshielding pull is too weak to separate each signal on this NMR. The $-NO_2$ group is **highly electronegative** (N = 3.0, O = 3.5) so will show each H individually with large separation.

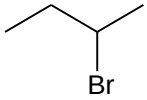
5.) Consider the free-radical monohalogenation of butane with Br_2 and light (hν). (18 pts)

a.) Give the structure of the *most probable* product.



(6 H's versus 4 H's)

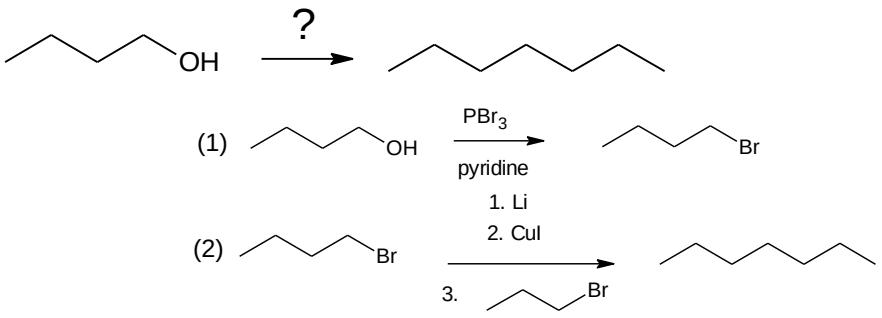
b.) Give the structure of the *most stable* product.



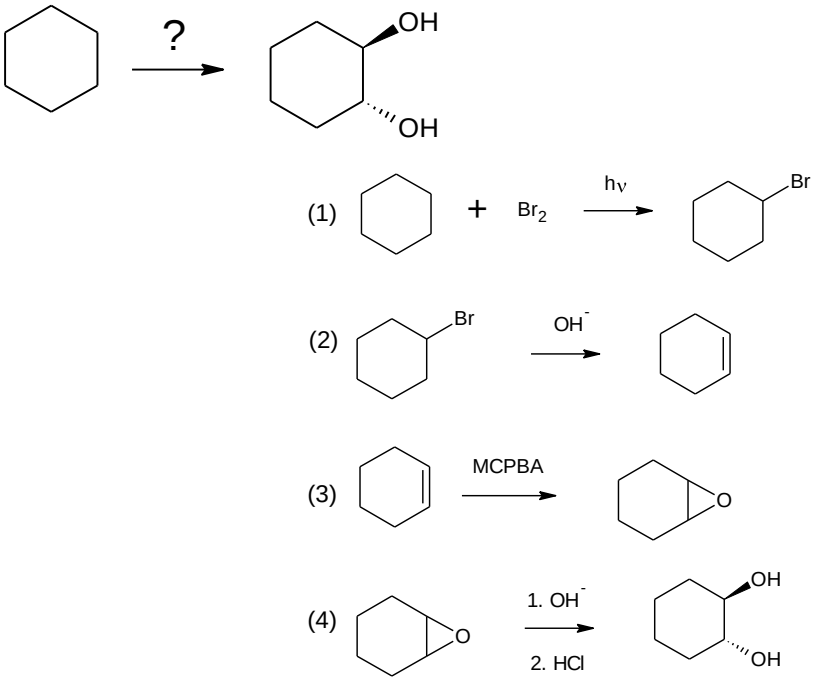
(2^o C versus 1^o C)

6.) Design multistep syntheses to convert the following reactants into the indicated products. Include all reagents and reaction conditions necessary. Show each step individually. (50 pts, 25 pts ea)

a.)



b.)

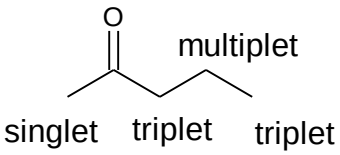


PAGE 2: _____

7.) From the provided ^{1}H and ^{13}C NMR spectra on the following pages and the molecular formulas given here for each, determine the **most likely structure**. Include (1) degrees of unsaturation, (2) labels for the multiplicity of each signal (singlet, doublet, multiplet, etc.), in the ^{1}H NMR spectra, and (3) labels for each H and C in the structure to their corresponding signals in the ^{1}H and ^{13}C spectra, respectively. (70 pts, 35 pts ea)

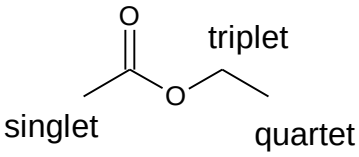
a.) Page 4: $C_5H_{10}O$

DOU= $\frac{(2\times5+2)-2}{2}$ =1, pi bond → aldehyde or ketone

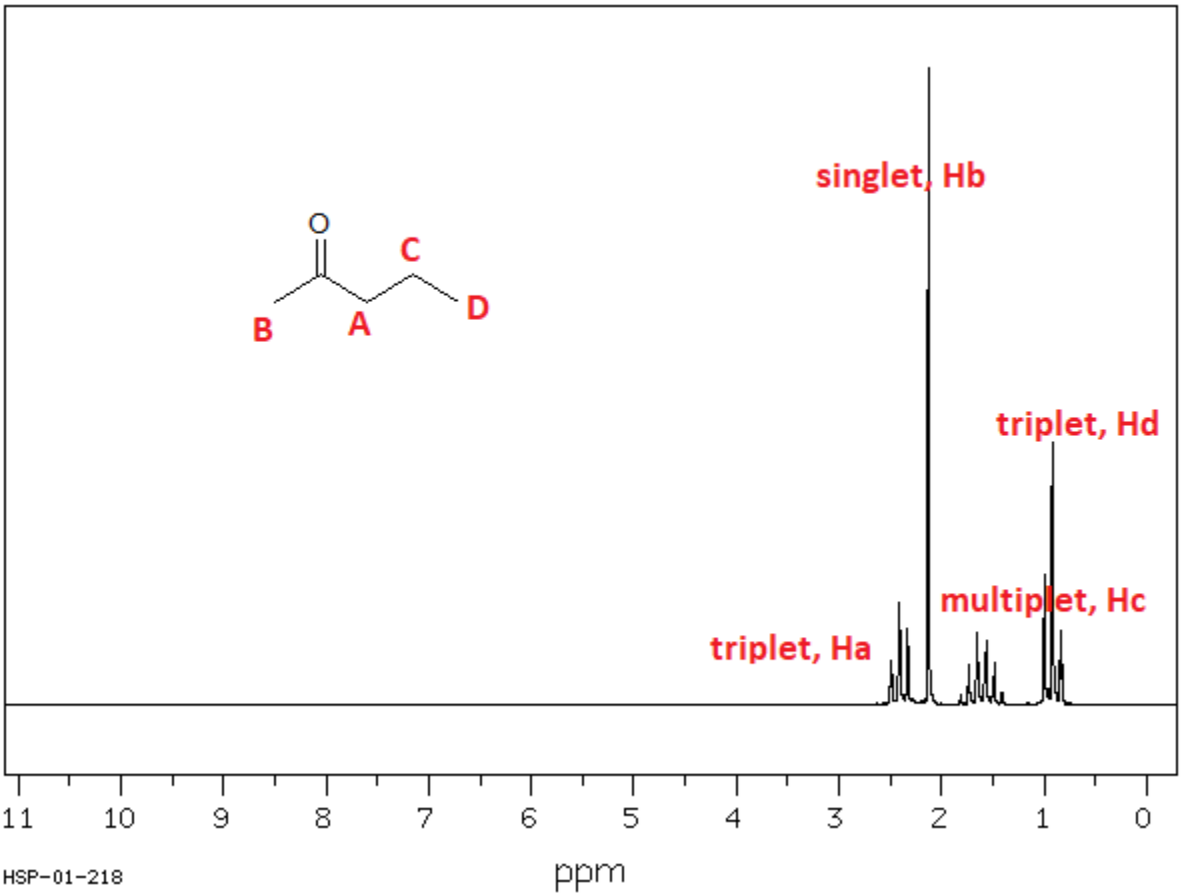


b.) Page 5: $C_4H_8O_2$

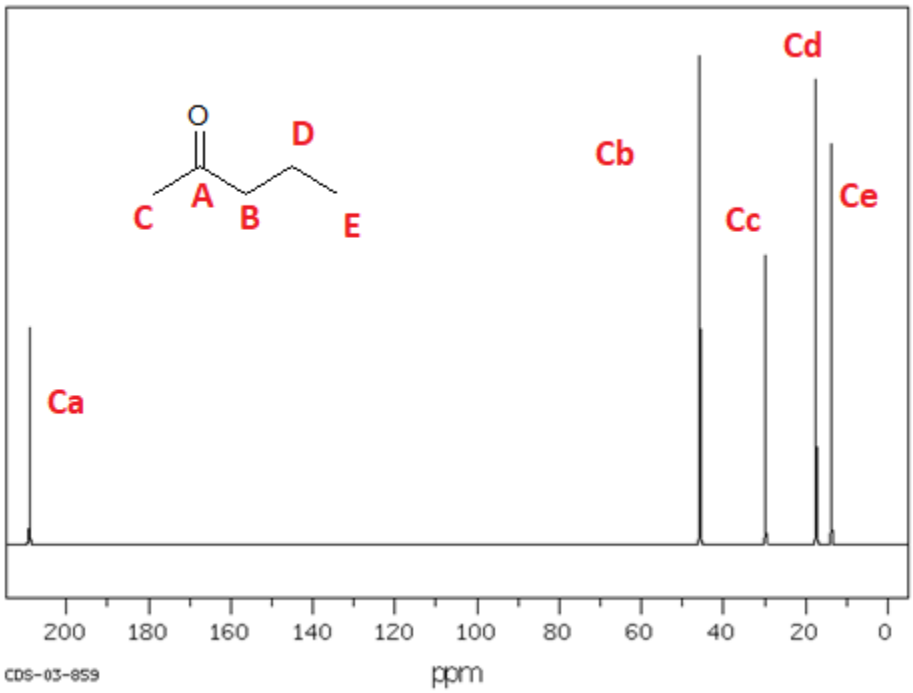
DOU= $\frac{(2\times4+2)-8}{2}$ =1, pi bond → carboxylic acid or ester



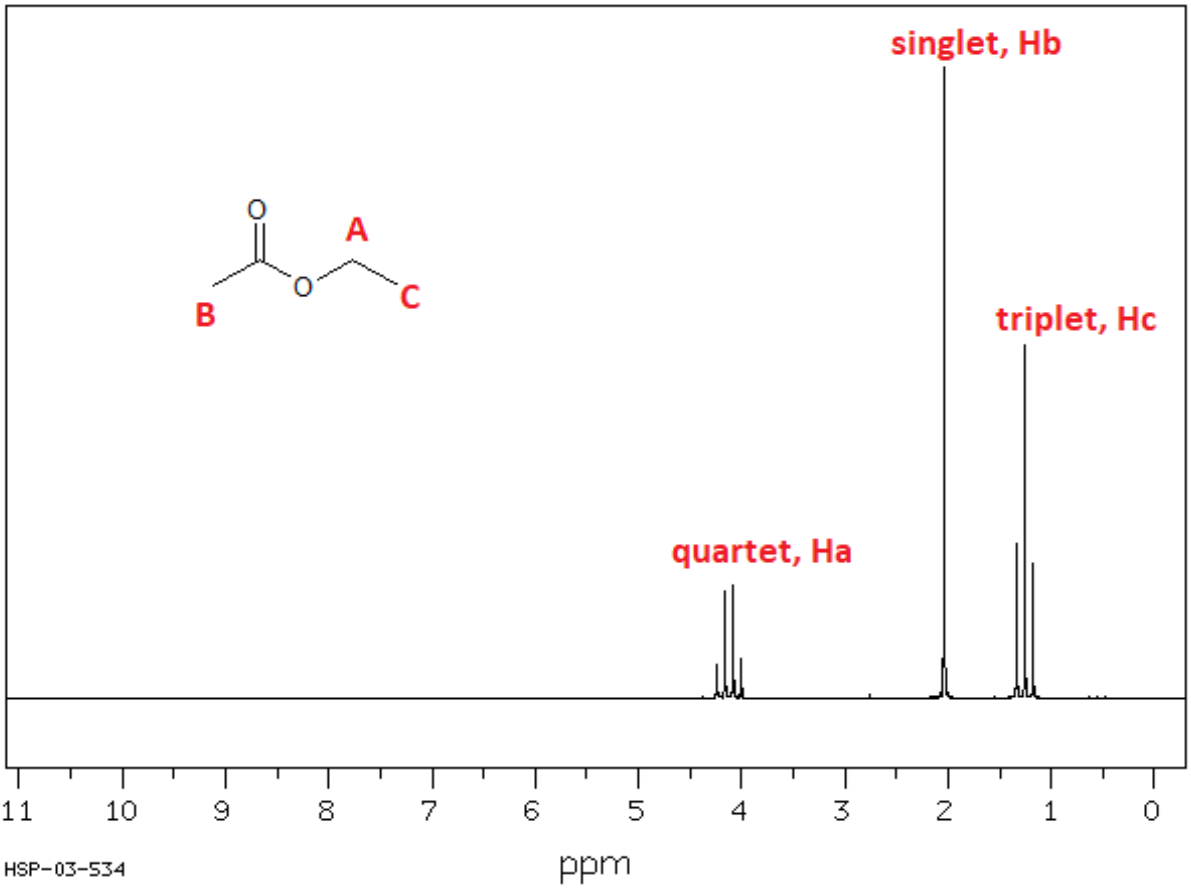
^{1}H NMR for $C_5H_{10}O$:



^{13}C NMR for $C_5H_{10}O$:



^{1}H NMR for $C_4H_8O_2$:



^{13}C NMR for $C_4H_8O_2$: