

**PERIODIC TABLE OF THE ELEMENTS**

Atomic masses are based on <sup>12</sup>C. Atomic masses in parentheses are for the most stable isotope.

6 C 12.011																		2 He 4.00260																	
1 H 1.00079																		10 Ne 20.179																	
3 Li 6.941		4 Be 9.01218																		9 F 18.998403															
11 Na 22.98977		12 Mg 24.305																		17 Cl 35.453															
19 K 39.0963		20 Ca 40.08		21 Sc 44.9559		22 Ti 47.90		23 V 50.9415		24 Cr 51.996		25 Mn 54.9380		26 Fe 55.847		27 Co 58.9332		28 Ni 58.70		29 Cu 63.546		30 Zn 65.38		31 Ga 69.72		32 Ge 72.59		33 As 74.9216		34 Se 78.96		35 Br 79.904		36 Kr 83.80	
37 Rb 85.4678		38 Sr 87.62		39 Y 88.9059		40 Zr 91.22		41 Nb 92.9064		42 Mo 95.94		43 Tc (98)		44 Ru 101.07		45 Rh 102.9055		46 Pd 106.4		47 Ag 107.868		48 Cd 112.41		49 In 114.82		50 Sn 118.69		51 Sb 121.75		52 Te 127.60		53 I 126.9045		54 Xe 131.30	
55 Cs 132.9054		56 Ba 137.33		57 La 138.9055		72 Hf 178.49		73 Ta 180.9479		74 W 183.85		75 Re 186.207		76 Os 190.2		77 Ir 192.22		78 Pt 195.09		79 Au 196.9665		80 Hg 200.59		81 Tl 204.37		82 Pb 207.2		83 Bi 208.9804		84 Po (209)		85 At (210)		86 Rn (222)	
87 Fr (223)		88 Ra 226.0254		89 Ac 227.0278		104 Unq (261)		105 Unp (262)		106 Unh (263)																									

\*Lanthanide series

58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.9254	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967
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† Actinide series

90 Th 232.0381	91 Pa 231.0359	92 U 238.029	93 Np 237.0482	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)
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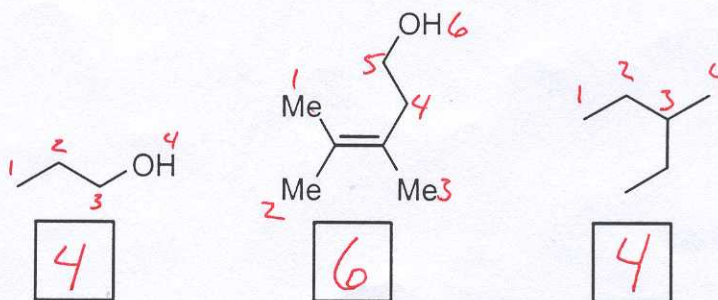
Question 1. (2 Points). What has the instructor said is the most important question in Organic Chemistry?

Where are the electrons going?

Question 2. Miscellaneous NMR questions.

(3 points) In the box below each molecule, indicate how many sets of equivalent hydrogens the molecule has. Each set will give rise to a different resonance signal in the <sup>1</sup>H NMR spectra.

No Partial Credit

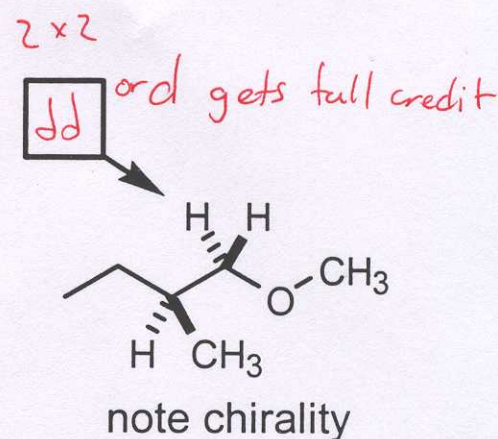
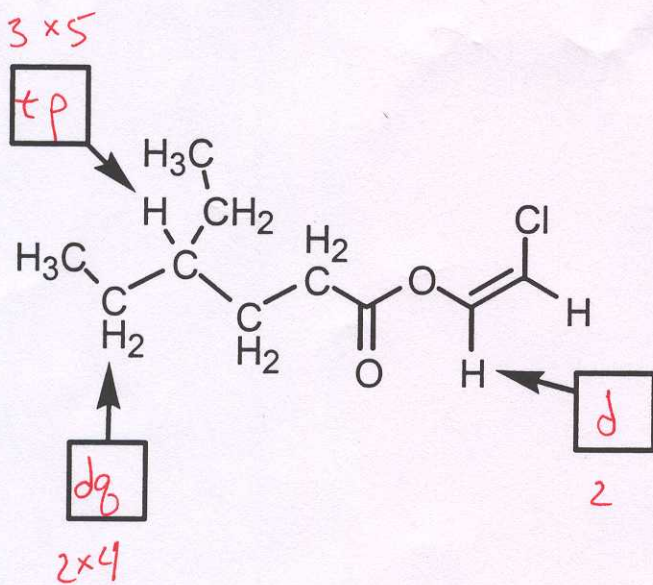




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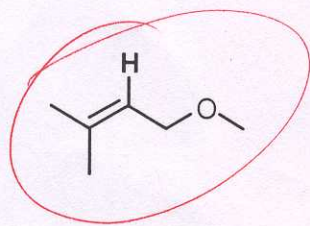
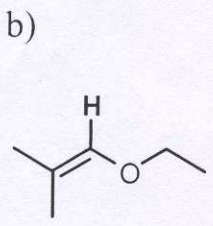
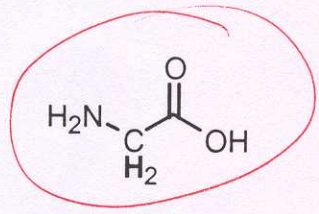
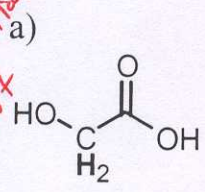
(4 points) Predict the splitting of the indicated hydrogens (i.e., dt or 2 x 3 for doublet of triplets).

*No Partial Credit*



(2 points) For each pair of compounds, in which molecule would the **bolded** hydrogens resonate upfield (towards the right of the spectra, smaller ppm). Circle your answer.

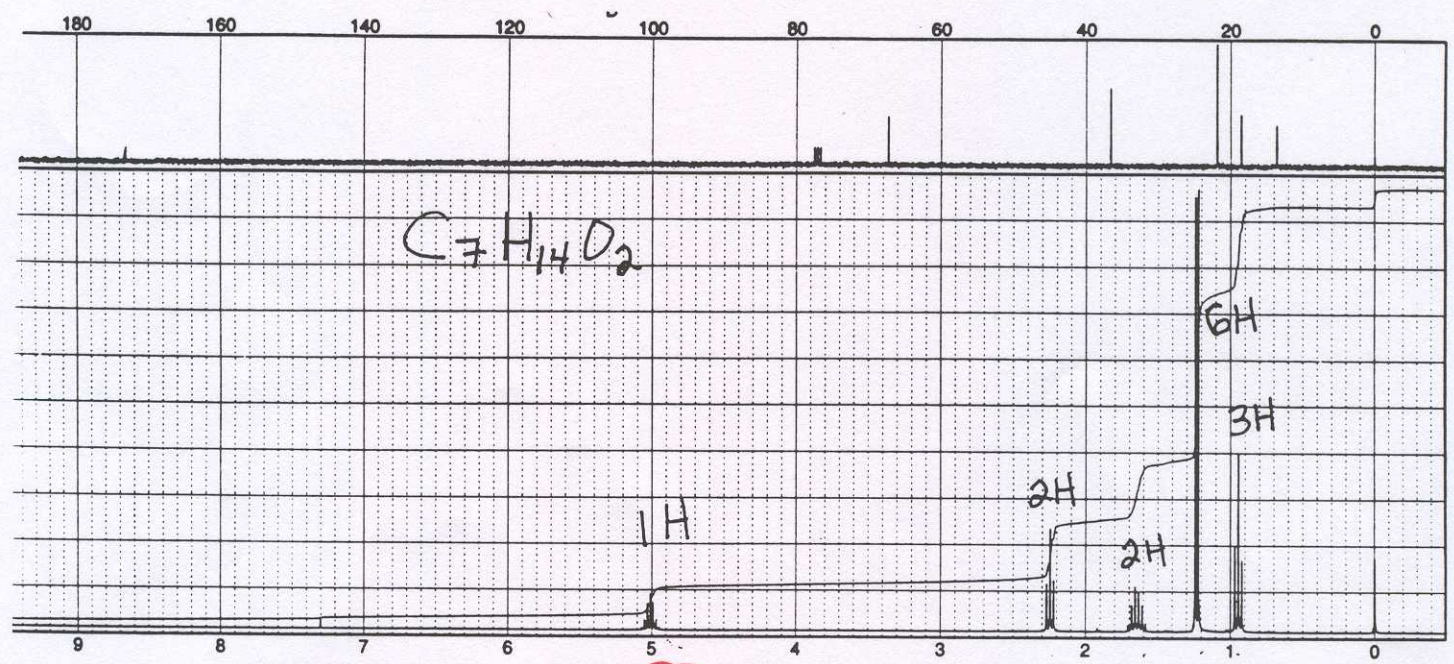
*No Partial Credit*



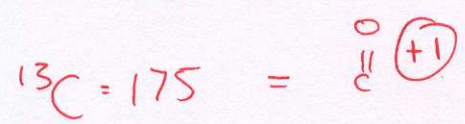


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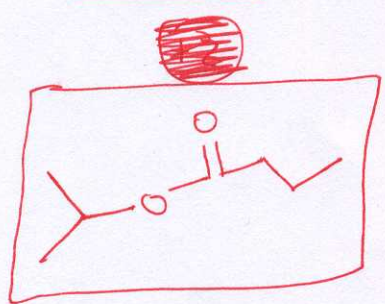
(10 points) NMR. Propose a structural formula based on the following NMR information. Show your work, and account for the observed patterns of splitting.



$$DoU = \frac{(2 \times 7) + 2 - 14}{2} = 1 \quad (+1)$$



Full Credit



$^1H$	5.0	1H	m	$\rightarrow$ $HO-CH$ (+1)
	2.2	2H	t	$\rightarrow$ $\{ \overset{O}{\parallel} CH_2 - CH_2 \}$ (+1)
	1.6	2H	sextuplet	
	1.2	6H	d	$\rightarrow$ $\left. \begin{matrix} CH_3 \\ CH_3 \end{matrix} \right\} - CH$ (+1)
	0.9	3H	t	$\rightarrow$ $\{ CH_2 - CH_3 \}$ (+1)

14H

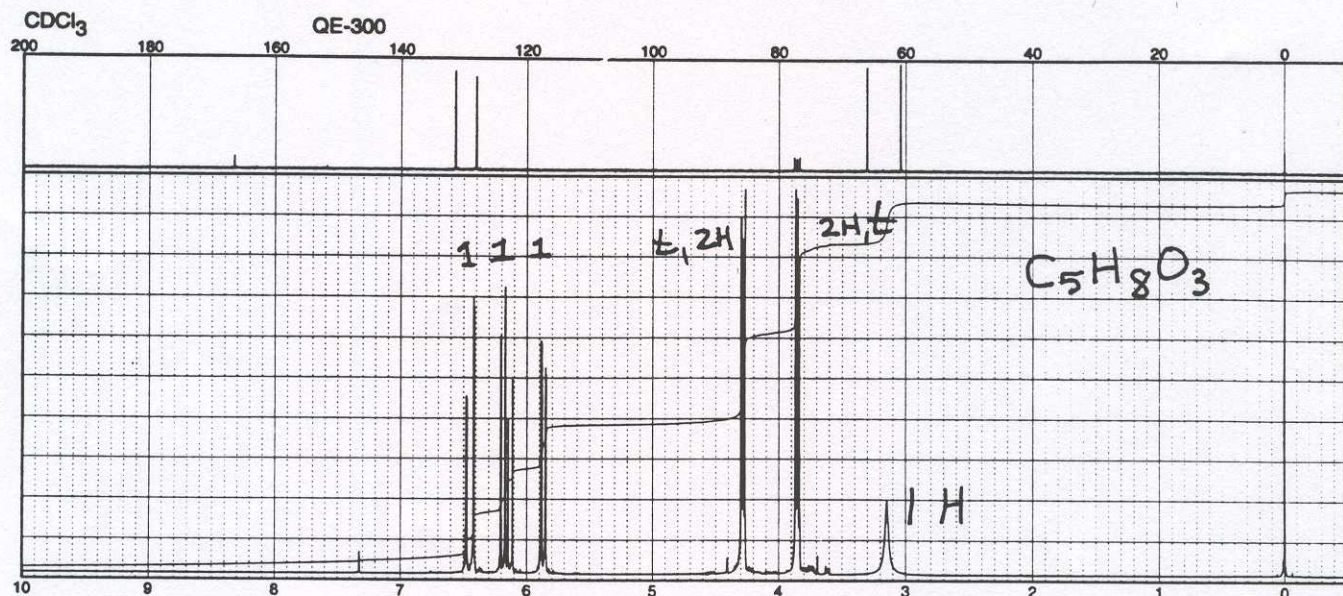
+2 points

- Does your answer make sense (i.e. splitting, integrals, chemical shift)?

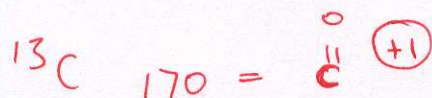


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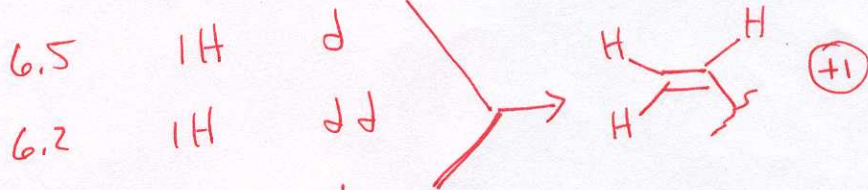
(10 points) NMR. Propose a structural formula based on the following NMR information. Show your work, and account for the observed patterns of splitting.



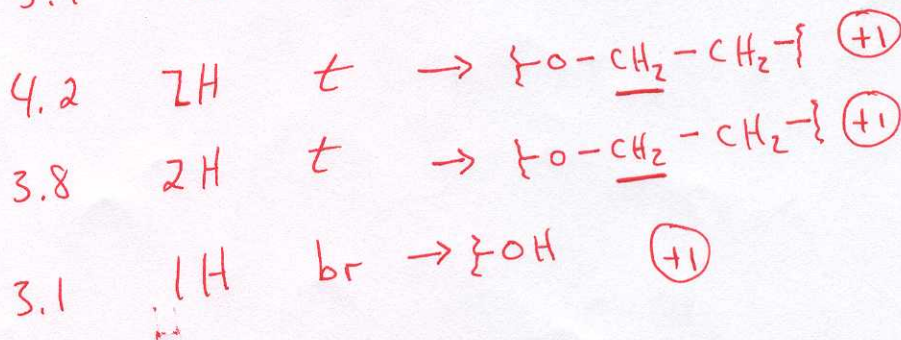
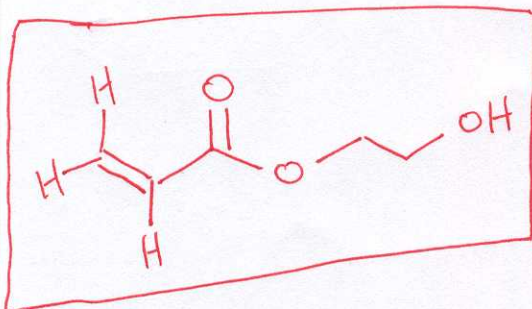
$$DOU = \frac{[(2 \times 5) + 2] - 8}{2} = 2 \text{ (+1)}$$



$^1H$



Full Credit



(+4) - Clear, rationale explanation for your answer (i.e. splitting, Integrals, chemical shift)



NAME: \_\_\_\_\_

Exam 1/610B/Pagenkopf

(5 points) Nomenclature. Provide a structure for each of the following.

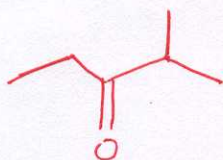
*No Partial Credit*  
a. 1-bromocyclopentene



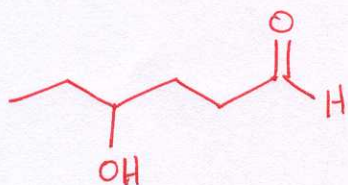
b. butylmagnesium chloride



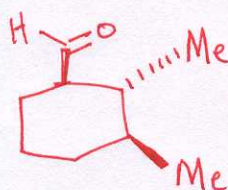
c. 2-methyl-3-pentanone



d. 4-hydroxyhexanal



e. trans-2,3-dimethylcyclohexanecarbaldehyde



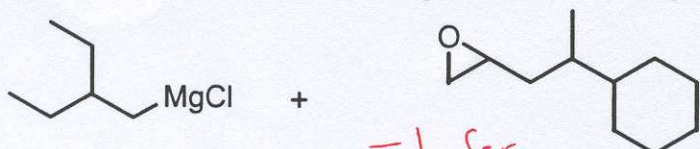
*Flawed question  
everyone got credit*



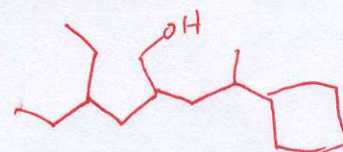
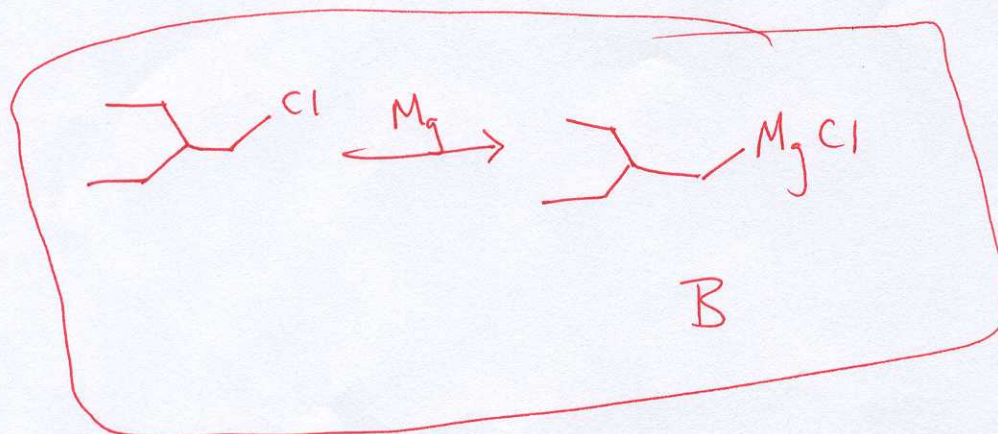
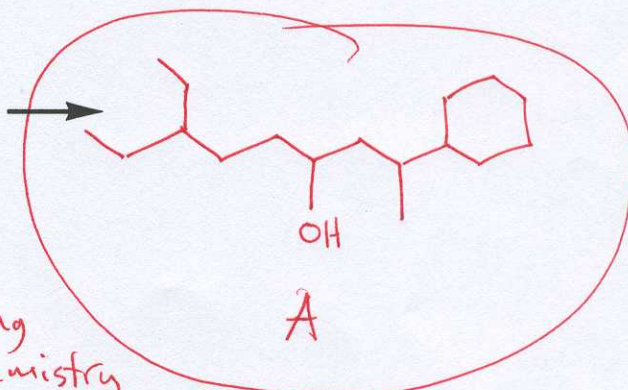
NAME: \_\_\_\_\_

(4 points) There are two parts for each of the following questions. For the part **a**, show the expected products from the reaction. In your answer to part **a** assume a work-up and show the alcohol products, not the metal alkoxides. For part **b** of each question, show how the organometallic reagent used in part **a** can be made from any inorganic reagents you need and an organic molecule containing any combination of the following atoms: carbon, hydrogen, chlorine, bromine, iodine, oxygen or nitrogen.

- 2 points → a. Show the product from the following reaction  
2 points → b. Show how to make the organometallic reagent



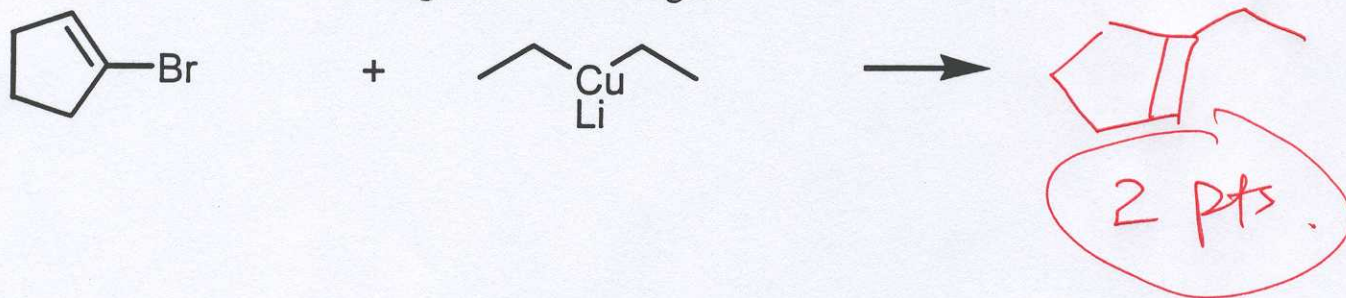
-1 for wrong # carbons  
ex) CC(C)CC(O)C1CCCC1 or wrong regiochemistry



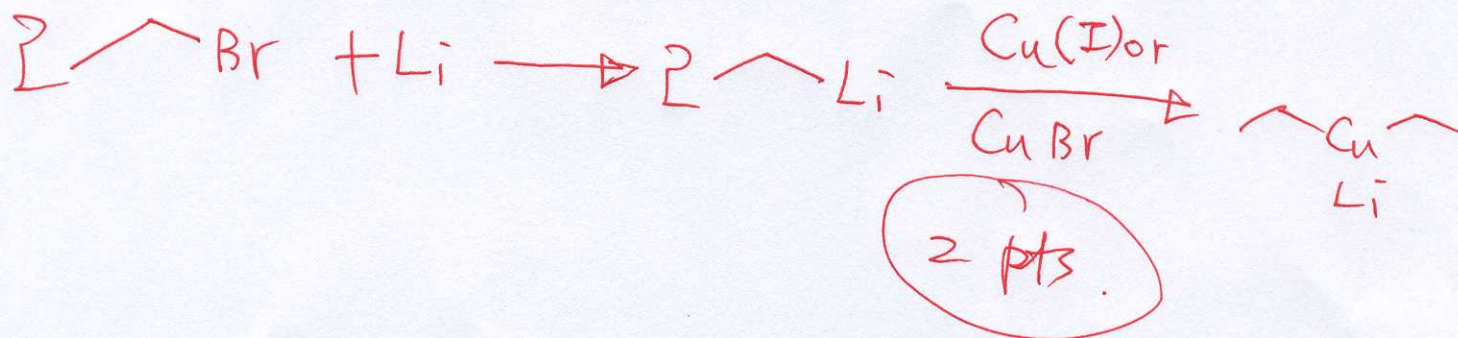


...continued (4 points).

- a. Show the product from the following reaction
- b. Show how to make the organometallic reagent



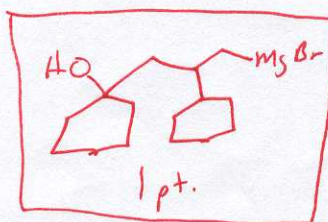
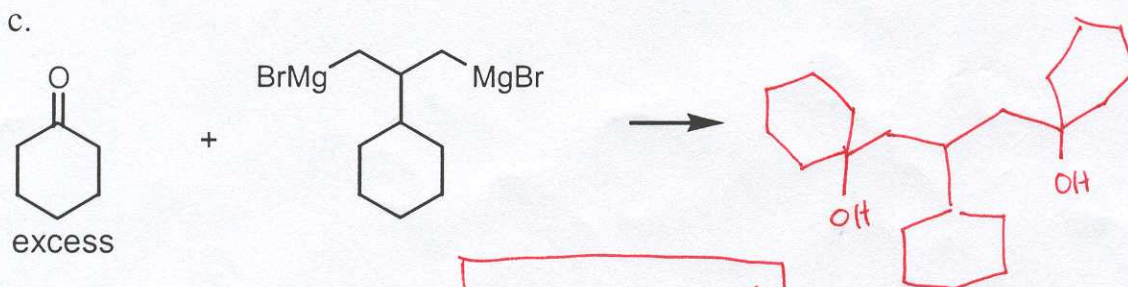
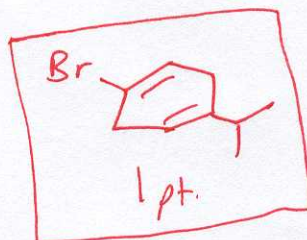
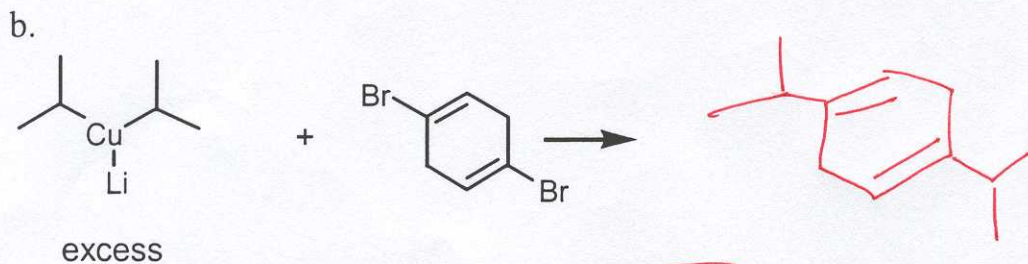
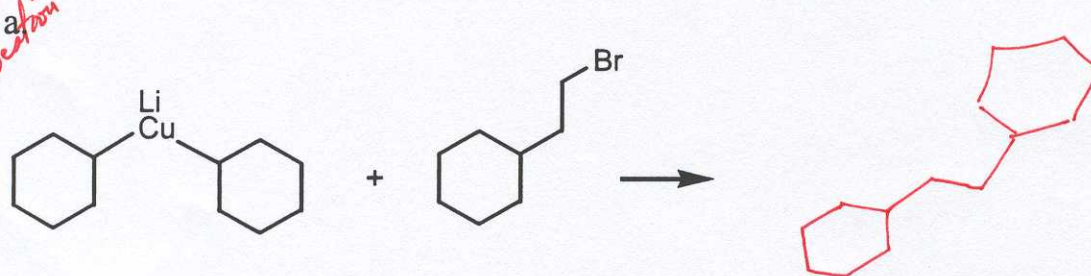
Making :





(9 points) Show the expected products from the following reactions. You may assume the reaction is finished with a standard workup if needed.

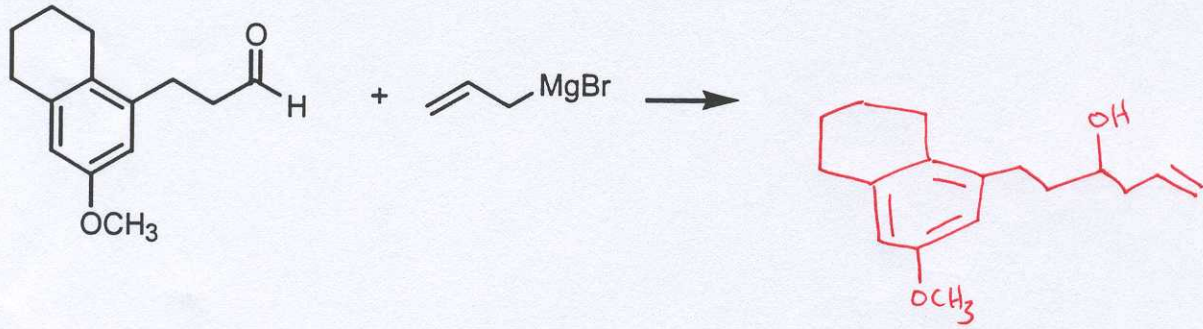
3 points  
per question



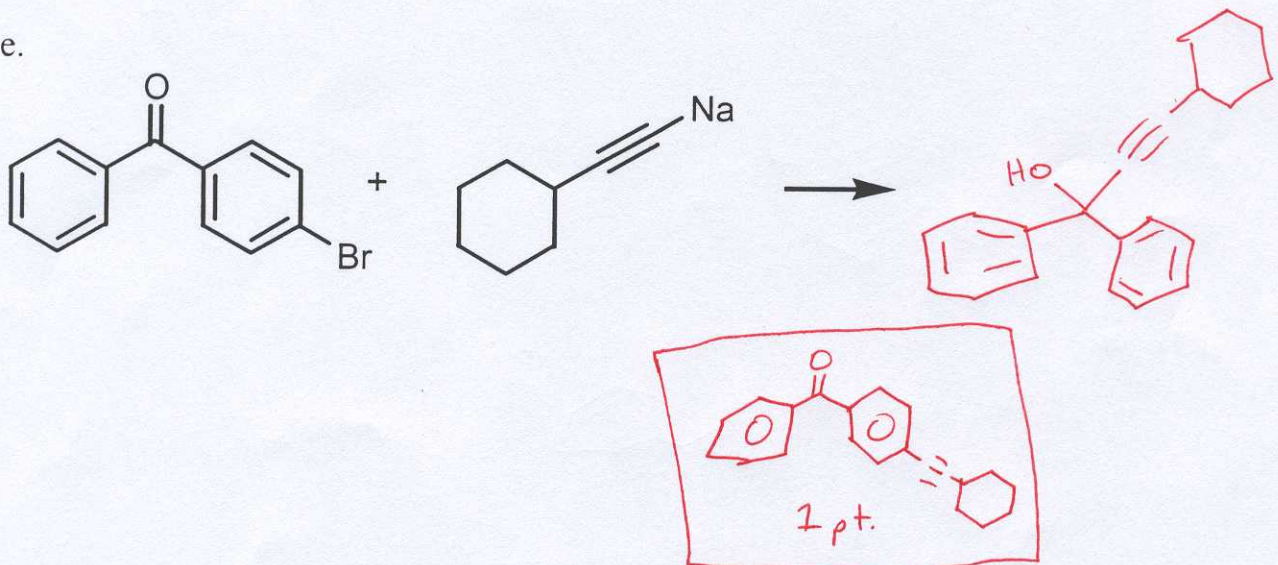


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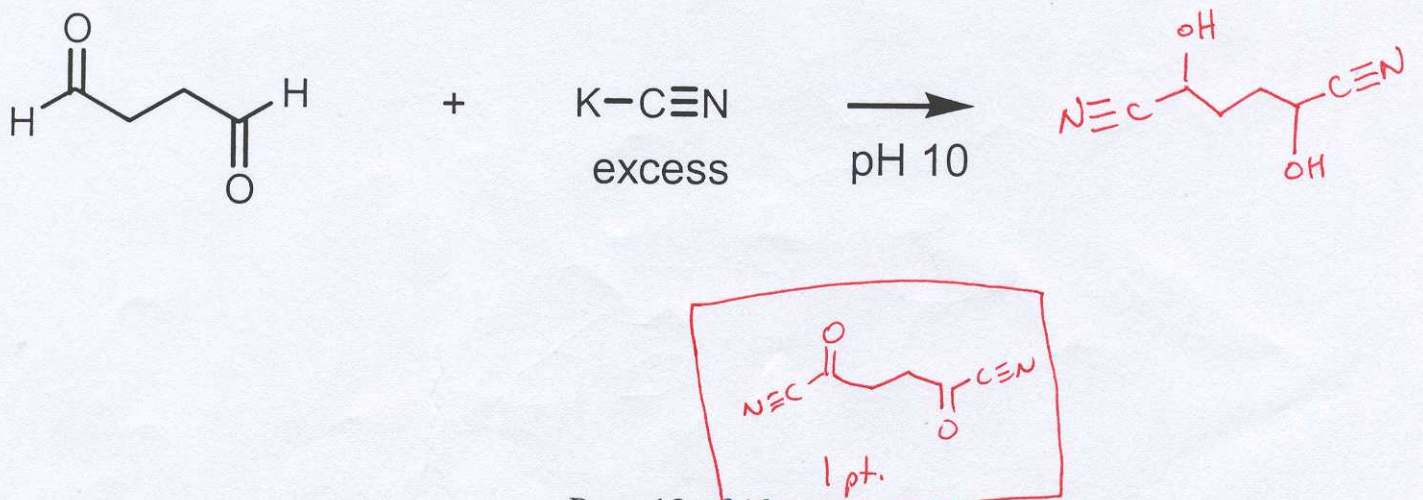
d.



e.

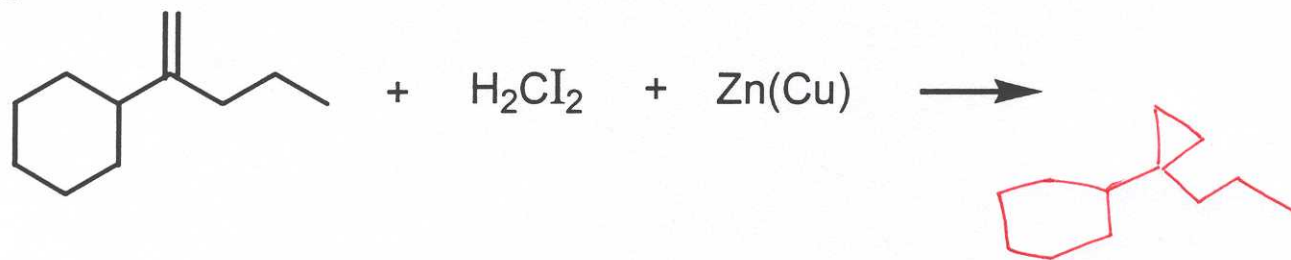


f.

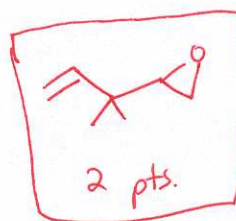




g.



h.

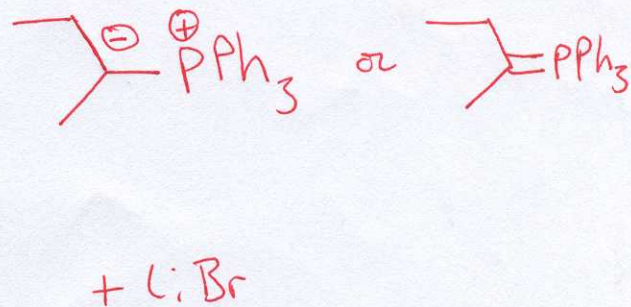
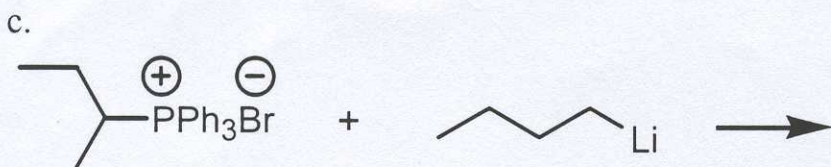
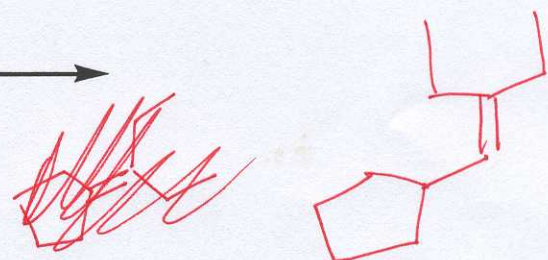
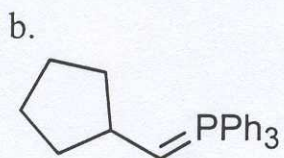
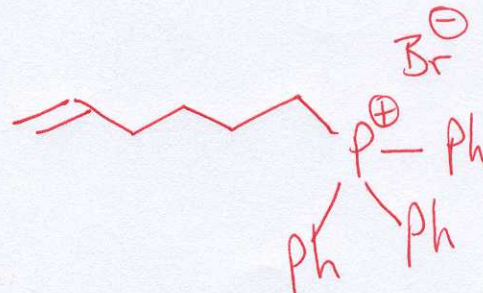
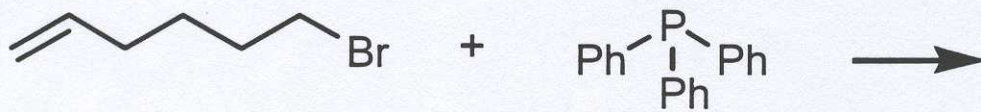




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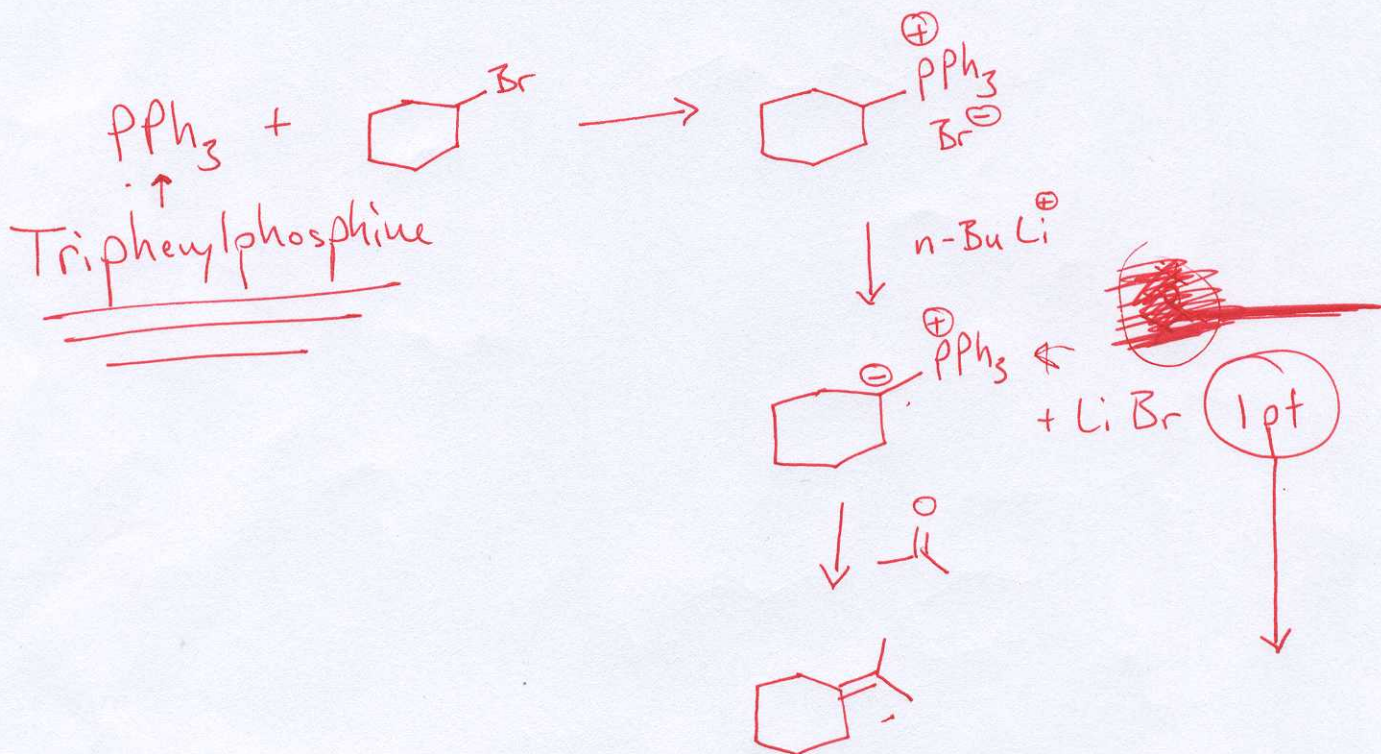
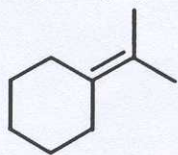
(9 points) Show the expected products from the following reactions.

*3 points each*

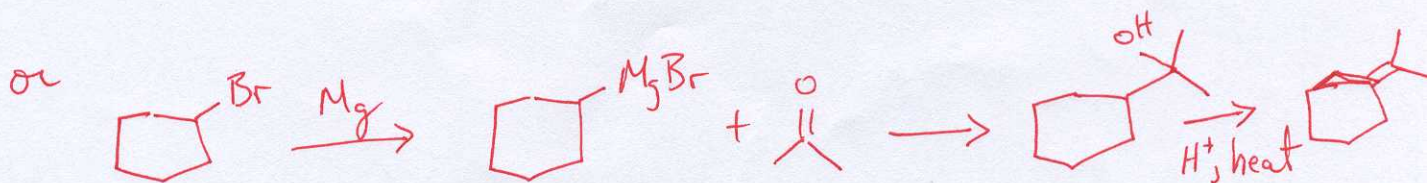
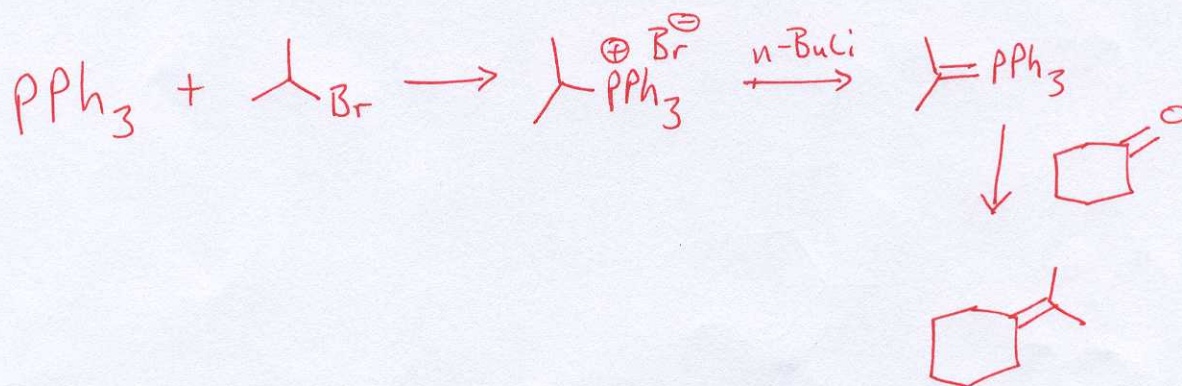




(3 points) Propose a synthesis of the following structure starting with a molecule of 6 carbons or less and any organic, organometallic or inorganic reagents. You may use triphenylphosphine (which contains more than 6 carbons) as a reagent in your synthesis.



or





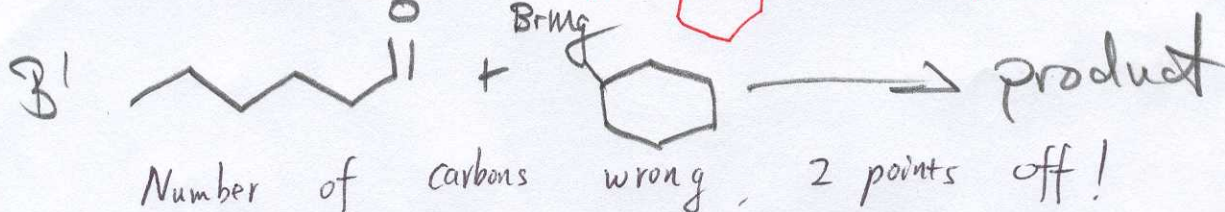
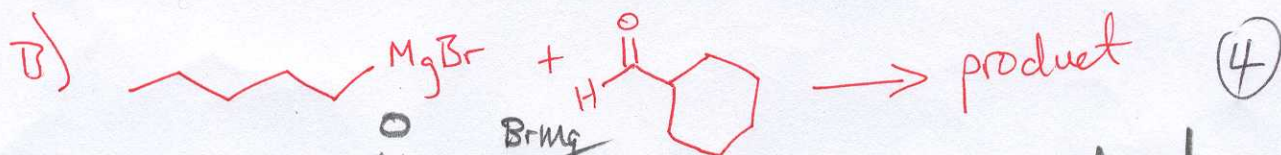
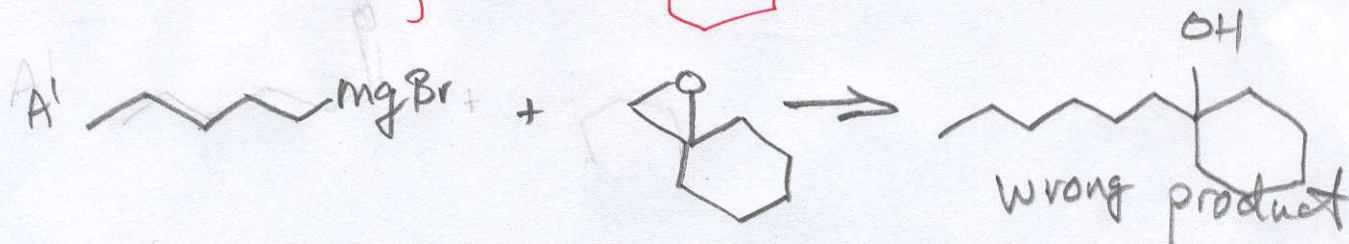
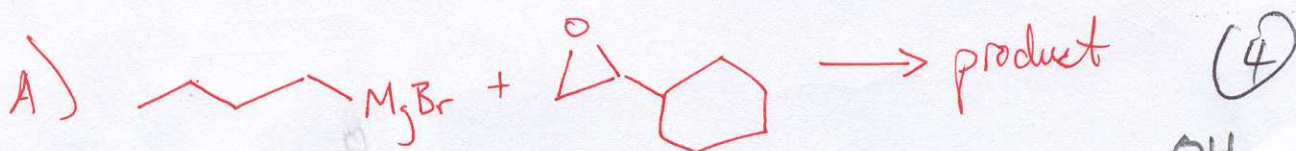
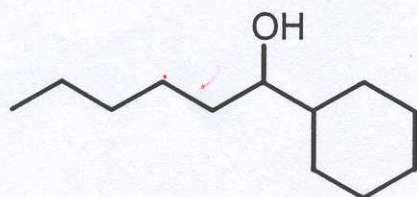
NAME: \_\_\_\_\_

Exam I/610B/Pagenkopf

(8 points) Each of the following alcohols can be prepared by both of the following reactions:

- 4 points →  
4 points →  
a) epoxide + organometallic reagent → alcohol  
b) aldehyde or ketone + an organometallic reagent → alcohol

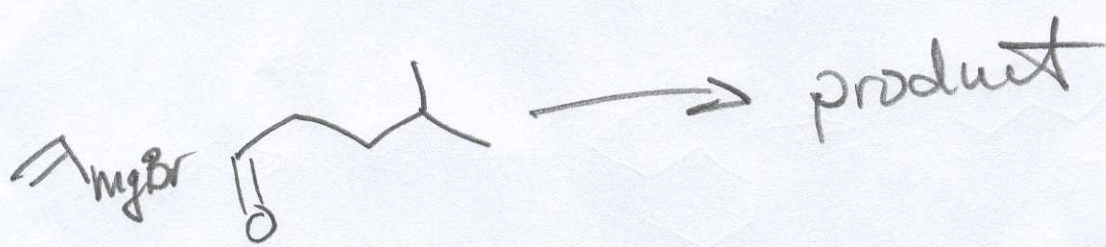
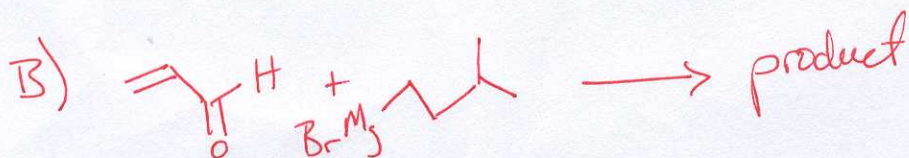
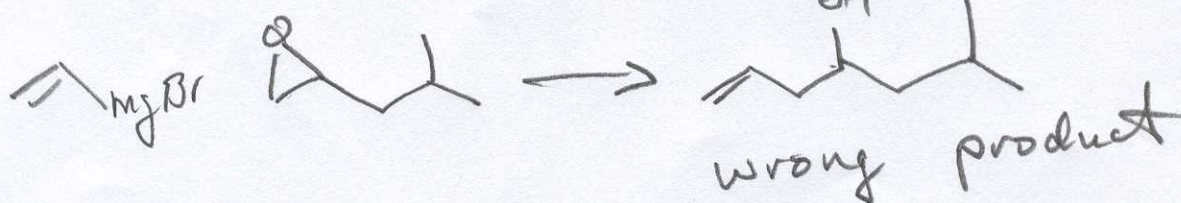
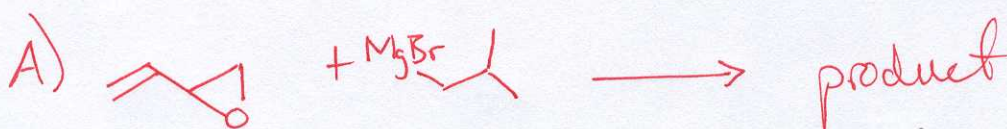
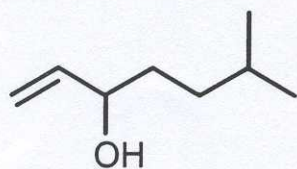
Propose two syntheses for following molecule starting from a) an epoxide and b) a carbonyl compound (aldehyde, ketone, etc.).





NAME: \_\_\_\_\_

... continued (8 points) Propose two syntheses for following molecule starting from a) an epoxide and b) a carbonyl compound (aldehyde, ketone, etc.) and an organometallic reagent.

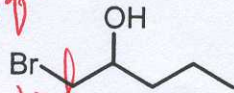




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(4 points) Show the expected products from the following reactions. You may assume the reaction is finished with a standard workup if needed.

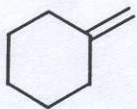
*1 point per question  
No Partial Credit*



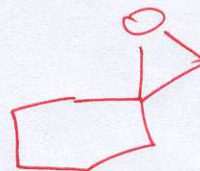
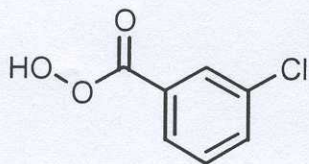
NaOH or NaH



b.



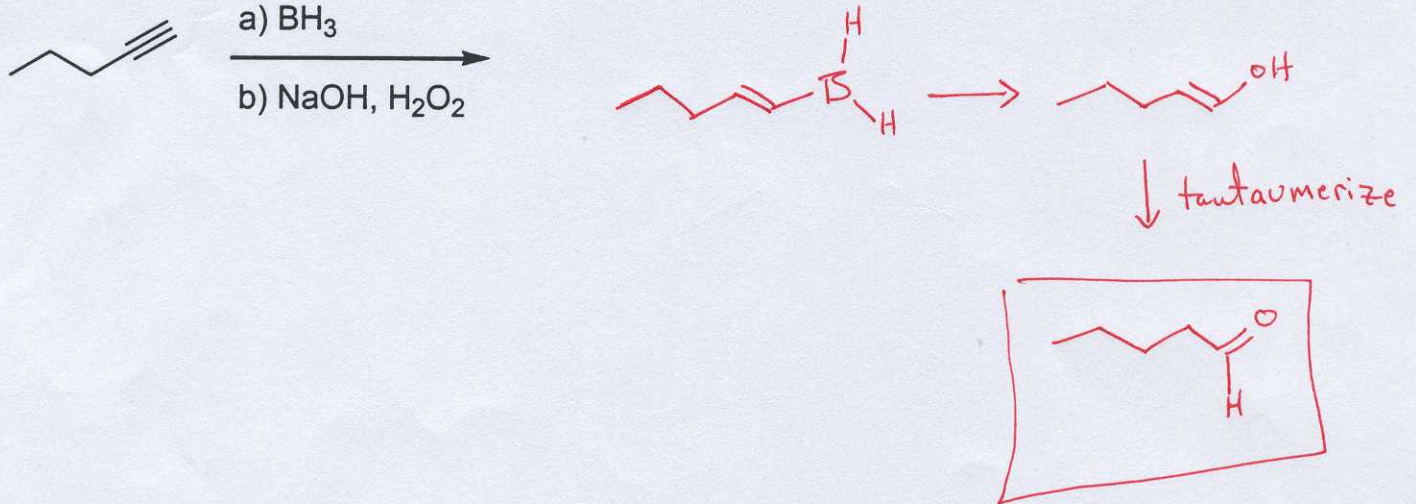
+



*(m-CPBA)*



c.



d)

