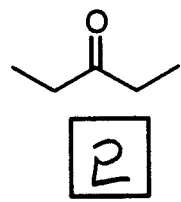
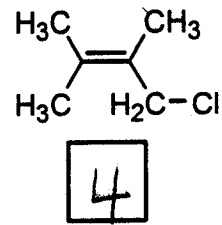
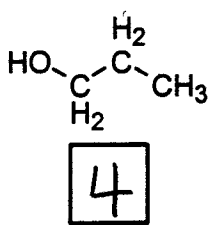
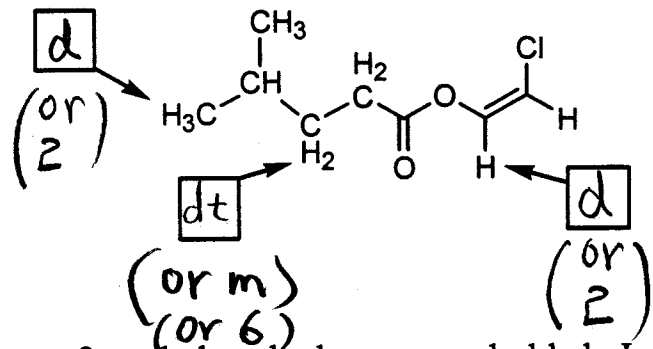


Question 1 (8 points) Miscellaneous NMR questions.

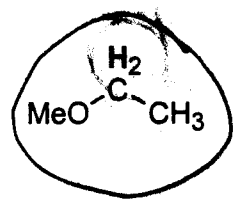
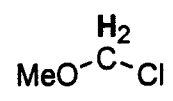
a) In the box below each molecule, indicate how many sets of equivalent hydrogens the molecule has. Each set will give rise to a different resonance signal in the ¹H NMR spectra.



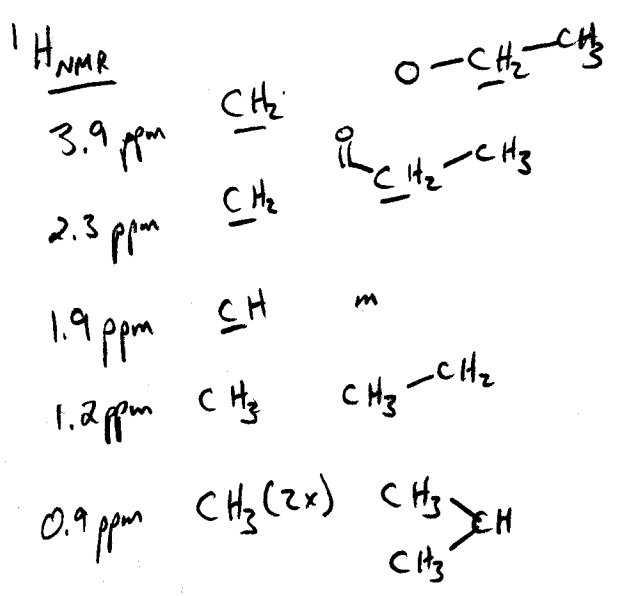
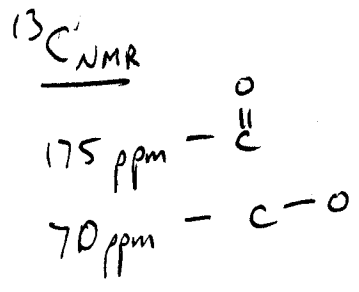
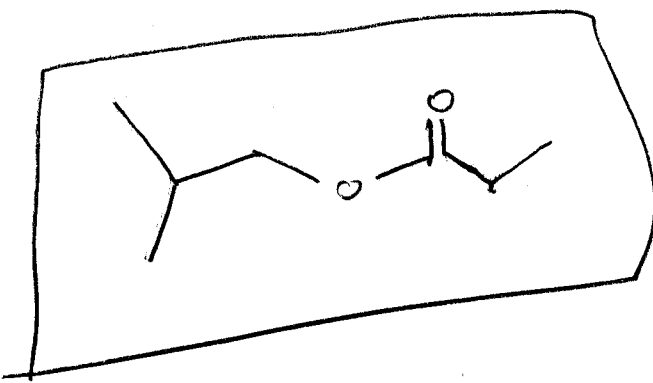
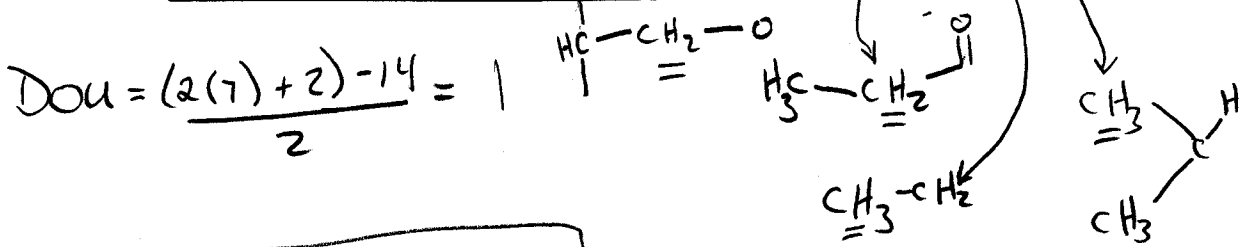
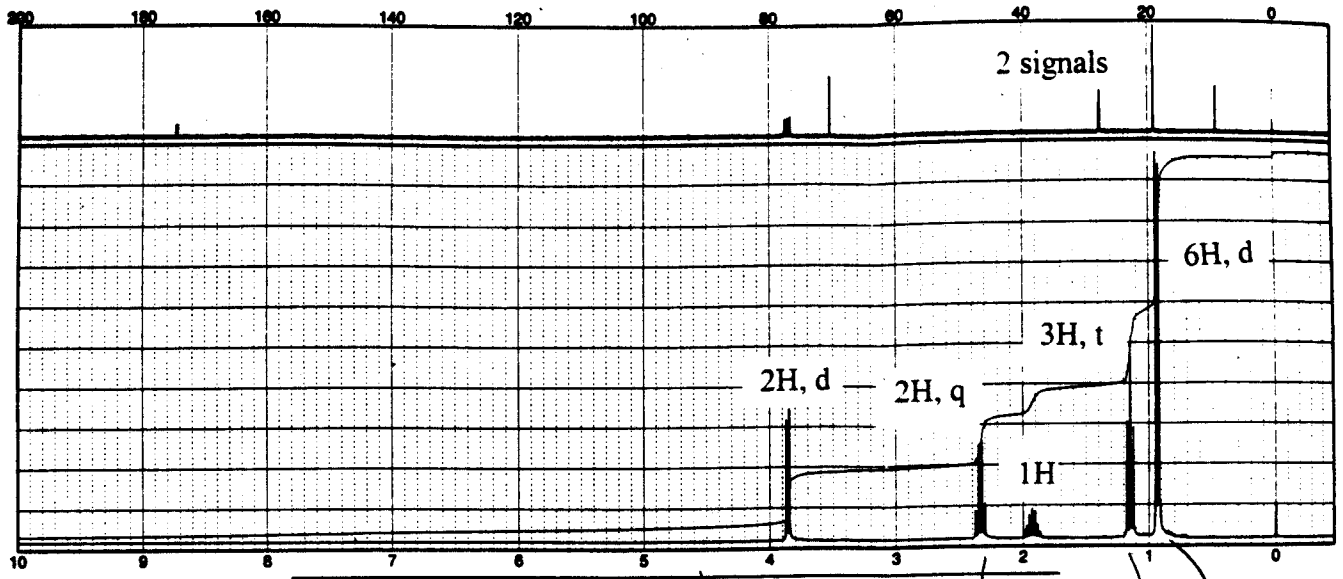
b) Predict the splitting of the indicated hydrogens.



d) In the following structures 2 methylene hydrogens are bolded. In which compound would the bolded methylene hydrogens resonate **upfield** (towards the right of the spectra, smaller ppm). Circle your answer.

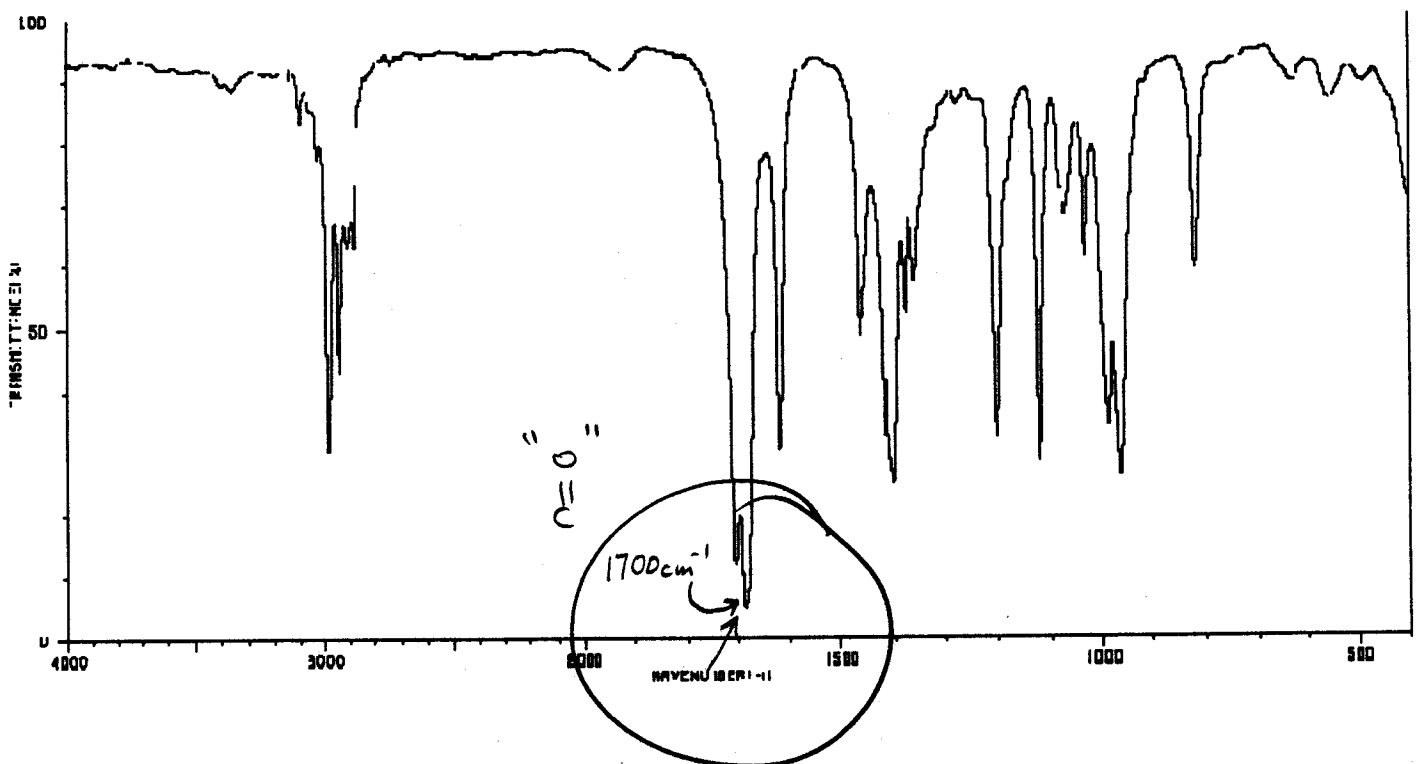
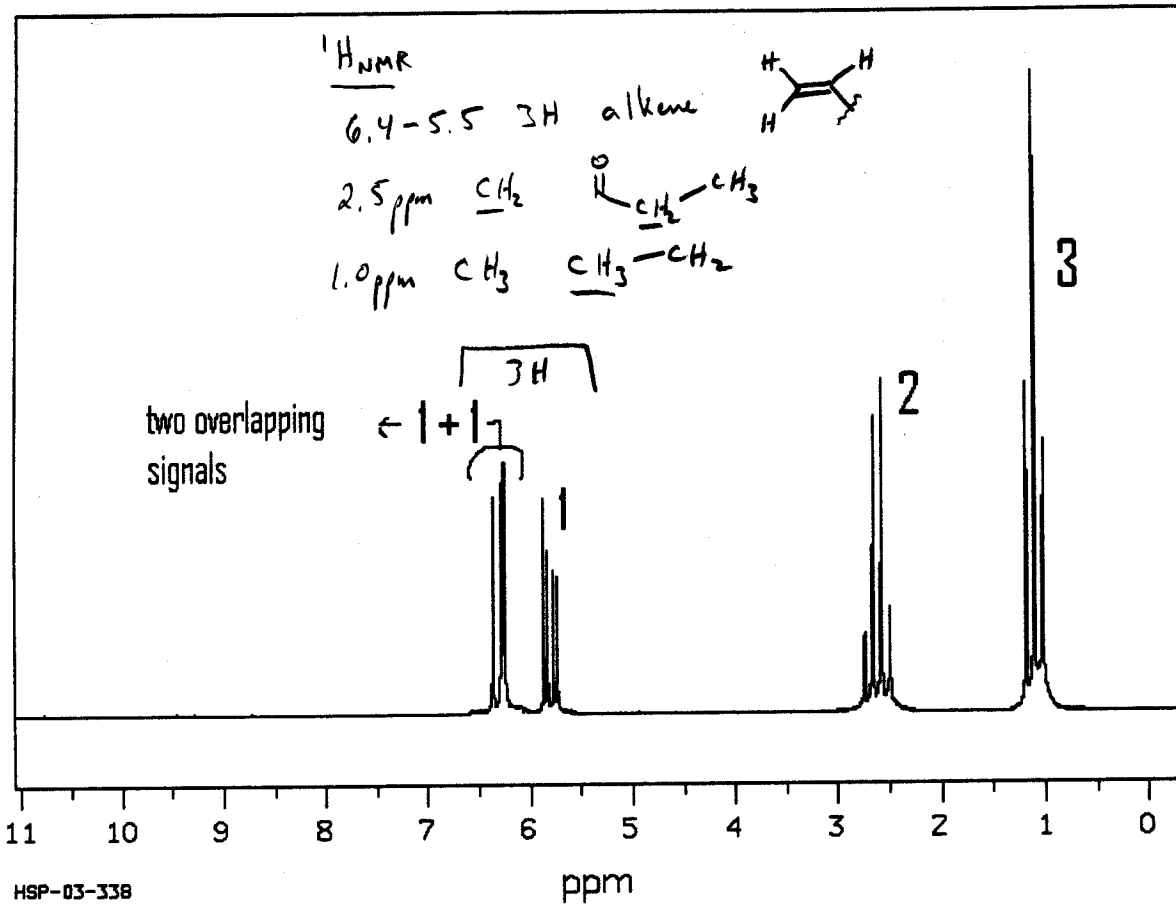


2. (9 points) NMR. The IR spectrum of a compound, molecular formula $C_7H_{14}O_2$, shows a strong absorption around 1700 cm^{-1} . From this information and the hydrogen and carbon NMR spectra provided below determine the structure.



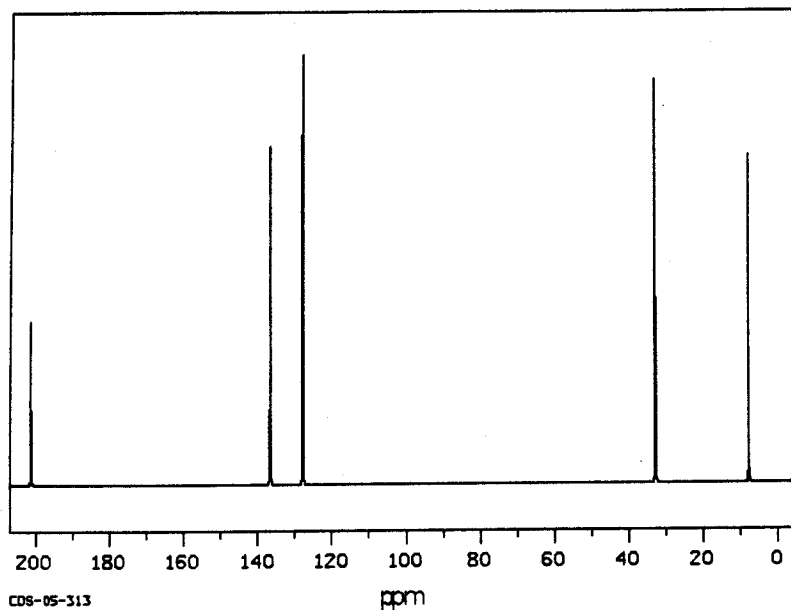
NAME: _____

3. (9 points) NMR. Molecular formula C_5H_8O . From this information and the hydrogen and carbon NMR spectra provided below determine the structure.



NAME: _____

...continued.



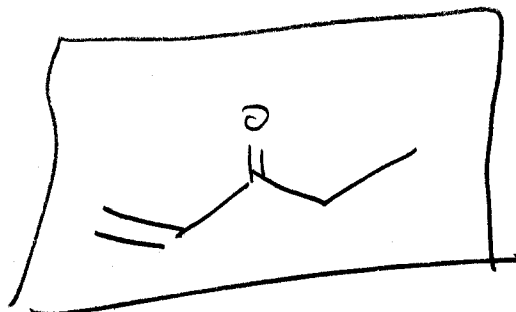
^{13}C NMR

200 ppm C=O

135 ppm C=C

125 ppm C=C

30

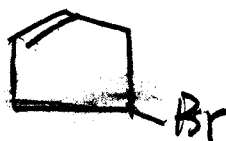


NAME: _____

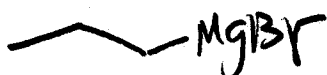
Exam 1/610B/Pagenkopf

4. (10 points) Nomenclature. Provide a structure for each of the following.

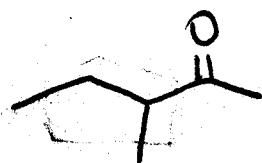
a. 4-bromocyclopentene



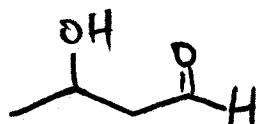
b. propylmagnesium bromide



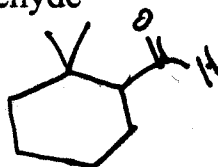
c. 3-methyl-2-pentanone



d. 3-hydroxybutanal



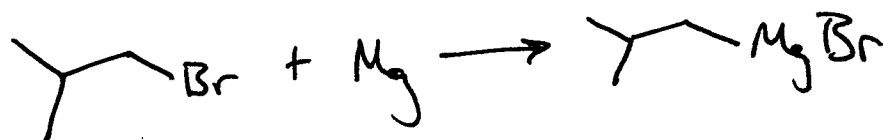
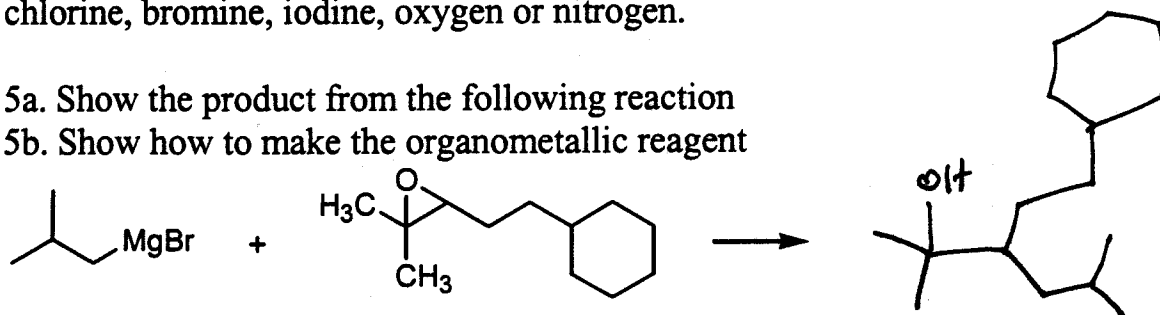
e. 2,2-dimethylcyclohexanecarboxaldehyde



(12 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.

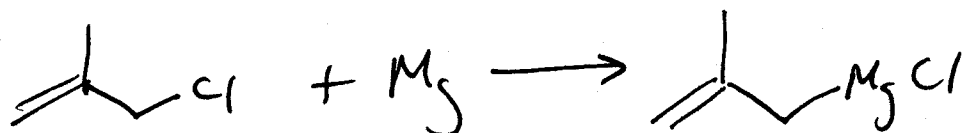
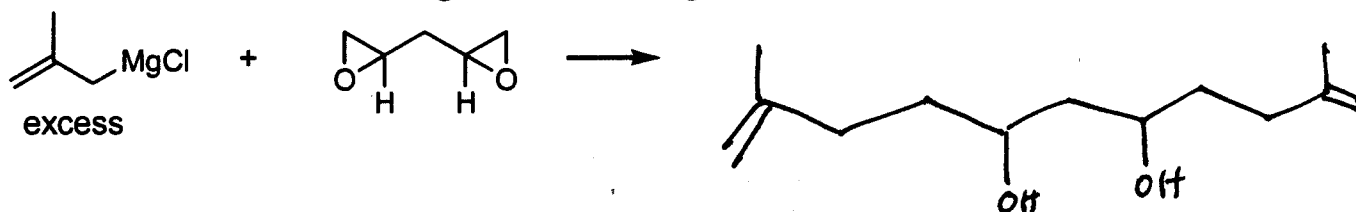
5a. Show the product from the following reaction

5b. Show how to make the organometallic reagent

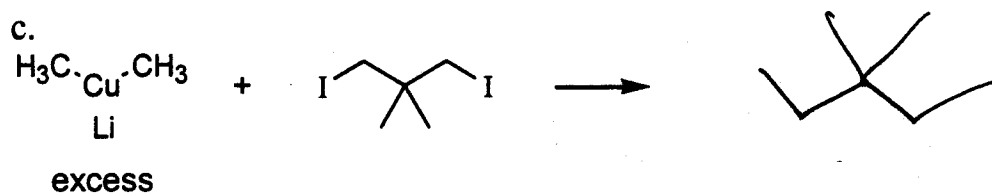
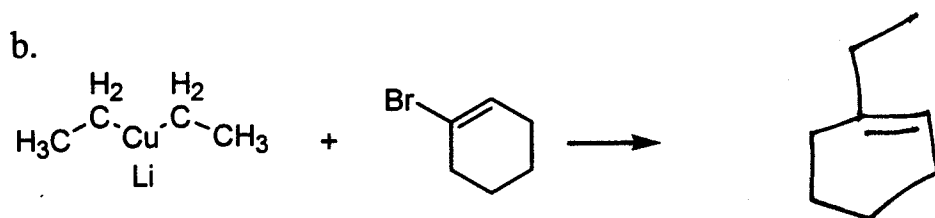
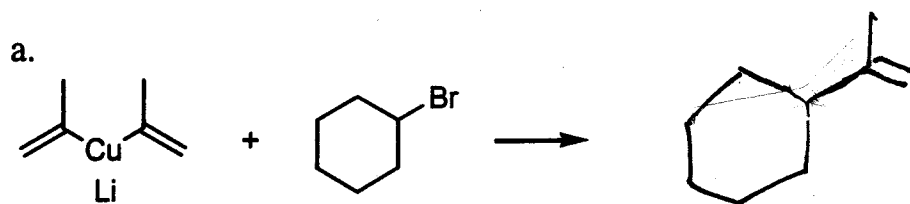


6a. Show the product from the following reaction

6b. Show how to make the organometallic reagent



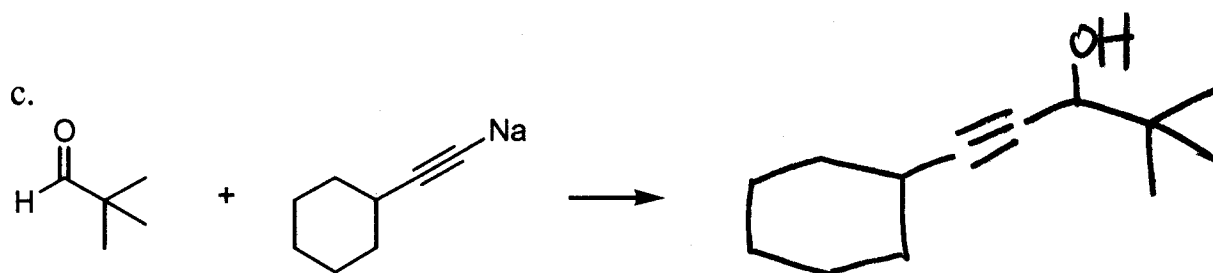
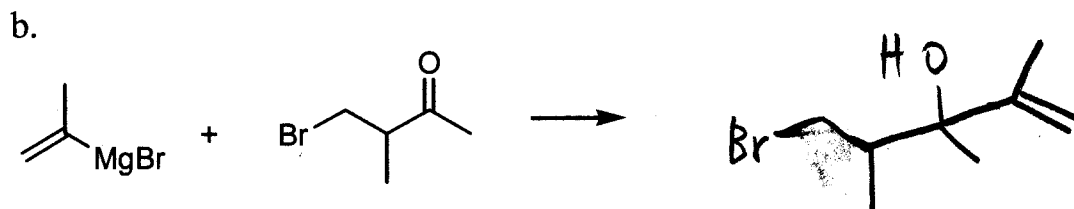
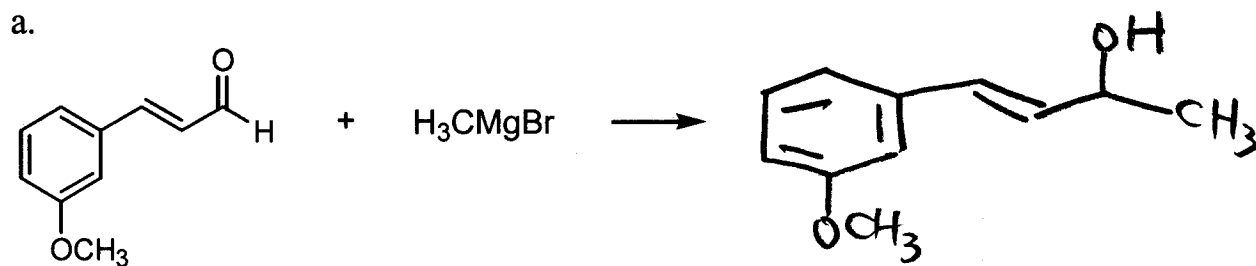
7. (9 points) Show the expected products from the following reactions. You may assume the reaction is finished with a standard workup if needed.



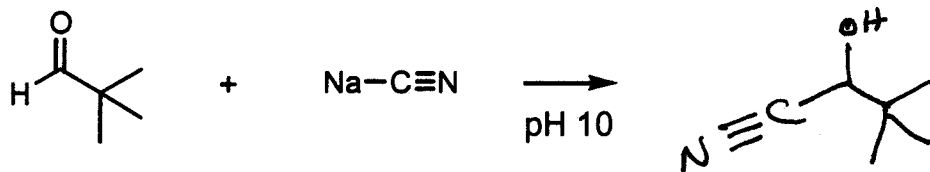
NAME: _____

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8. (12 points) Show the expected products from the following reactions. You may assume the reaction is finished with a standard workup if needed.



d.



6 — Atomic number
 C — Symbol
 12.011 — Atomic mass

PERIODIC TABLE OF THE ELEMENTS

Atomic masses are based on ¹²C. Atomic masses in parentheses are for the most stable isotope.

Groups																VIIA			
1A																2			
Periods																VIIA			
1																	2		
H																	He		
1.00079																	4.00260		
IIA														IIIA		IVA	VA	VIA	VIIA
3	4													5	6	7	8	9	10
Li	Be													B	C	N	O	F	Ne
6.941	9.01218													10.81	12.011	14.0067	15.9994	18.998403	20.179
IIIB		IVB	VB	VIB	VIIA	VIII		IB	IIIB	IIIA		IVA	VA	VIA	VIIA	VIIIA			
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
22.98977	24.305	26.98154	28.0855	30.97376	32.06	35.453	39.948	39.0983	40.08	44.9559	47.90	50.9415	51.996	54.9380	55.847	58.9332	58.70	63.546	65.38
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	Cs	Ba
85.4678	87.62	88.9059	91.22	92.9064	95.94	(98)	101.07	102.9055	106.4	107.868	112.41	114.82	118.69	121.75	127.60	126.9045	131.30	132.9054	137.33
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	Fr	Ra
132.9054	137.33	138.9055	178.49	180.9478	183.85	186.207	190.2	192.22	195.09	196.9665	200.59	204.37	207.2	208.9804	(209)	(210)	(222)	(223)	226.0254
89	90	91	104	105	106														
Ac	Unq	Unp	Unh																
(261)	(261)	(262)	(263)																

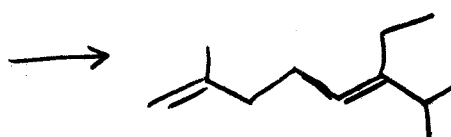
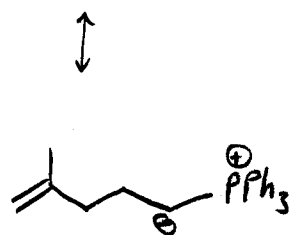
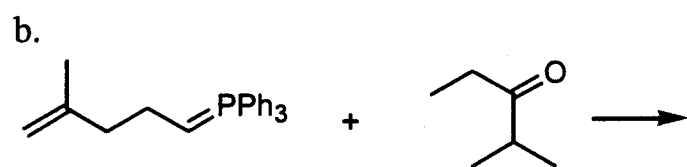
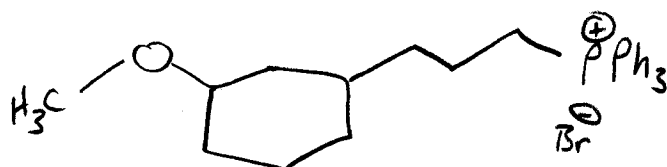
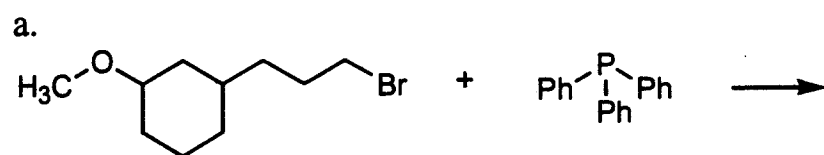
*Lanthanide series

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

†Actinide series

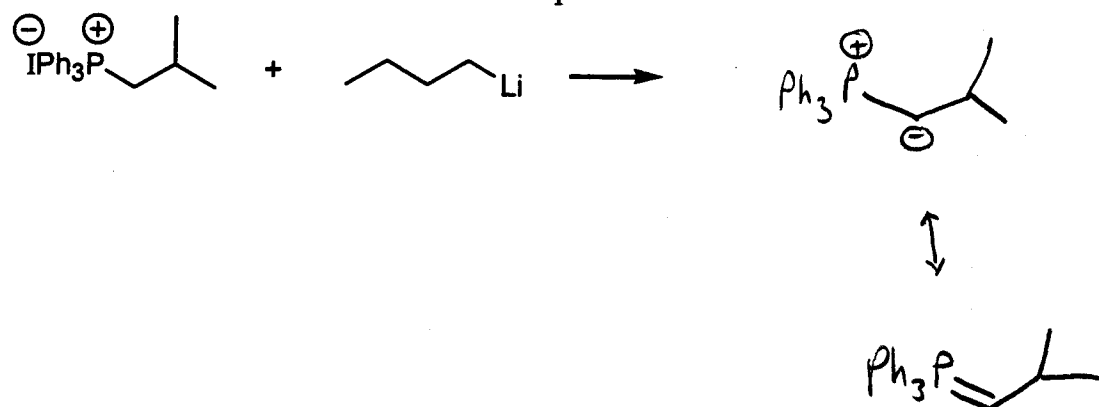
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
232.0377	231.0369	238.0289	237.0482	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(260)

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

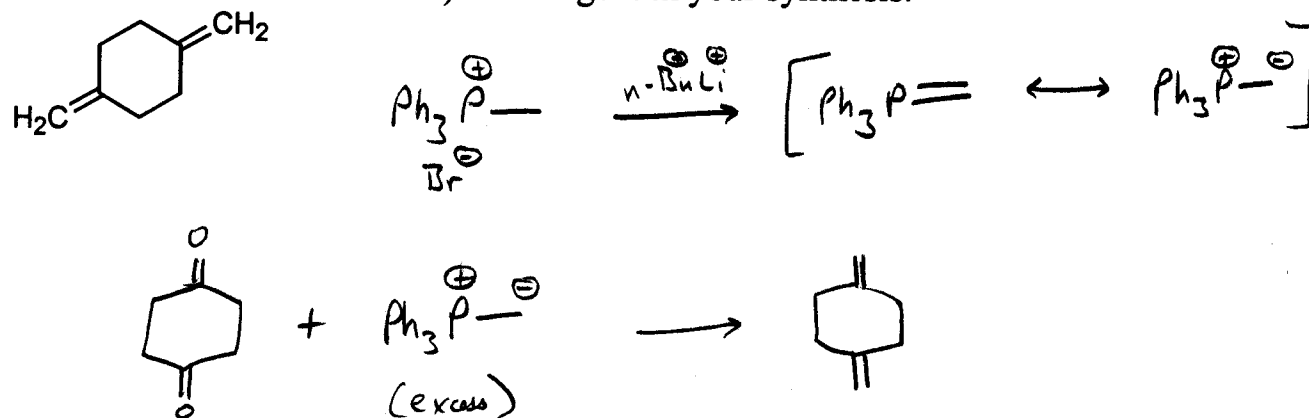


...continued

c. Draw a resonance structure of the product.



10. (4 points) Propose a synthesis of the following structure starting with a molecule of 6 carbons or less and any inorganic reagents. You may use triphenylphosphine (which contains more than 6 carbons) as a reagent in your synthesis.

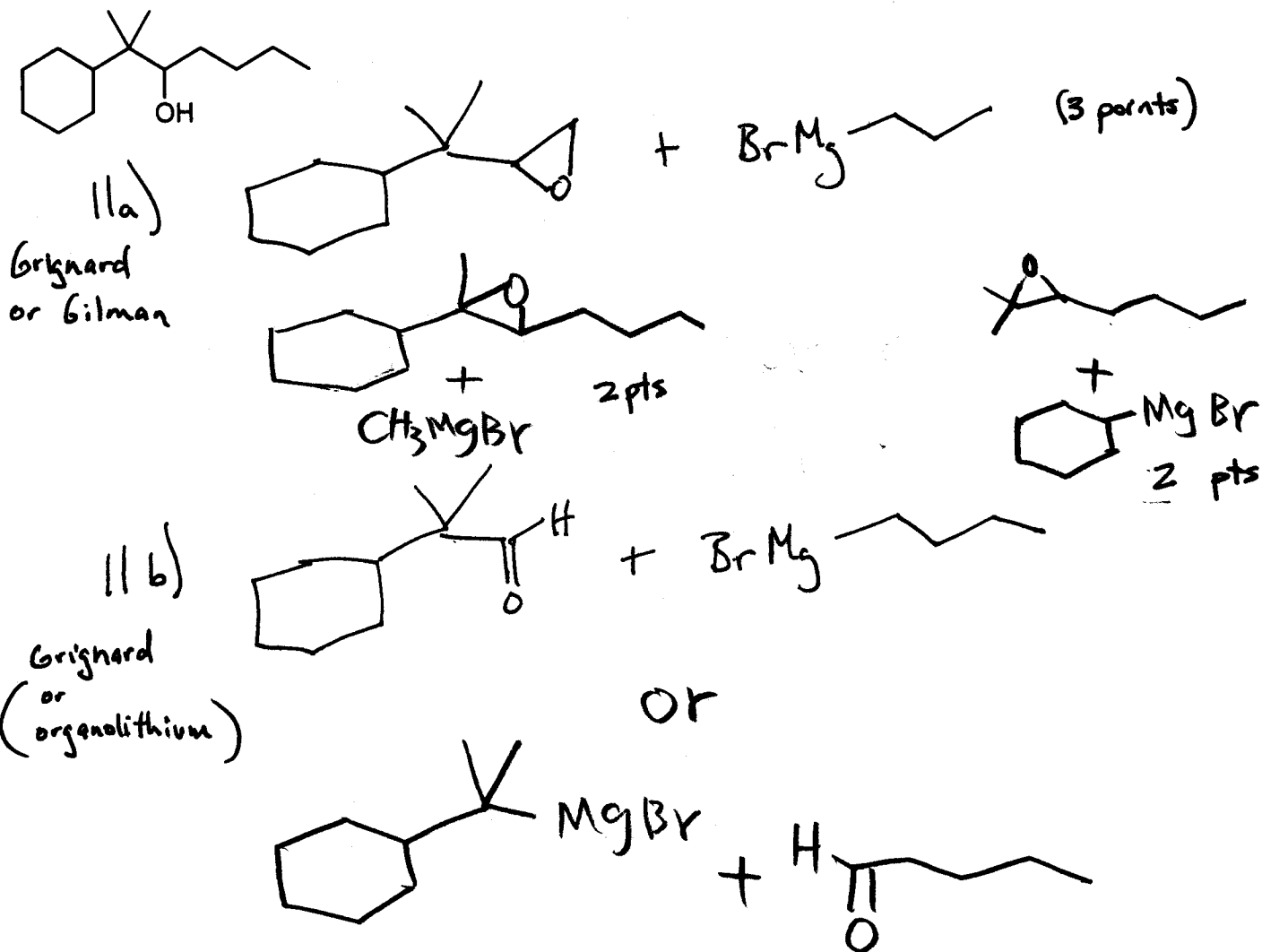


(12 points) Each of the following alcohols can be prepared by both of the following reactions:

- a) epoxide + organometallic reagent \rightarrow alcohol
 b) aldehyde or ketone + an organometallic reagent \rightarrow alcohol

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

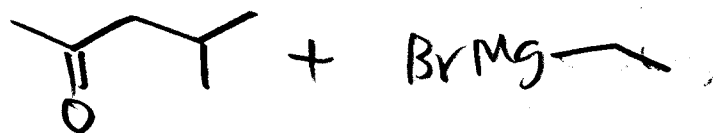
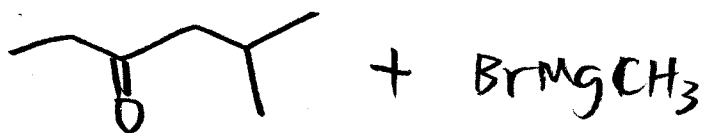
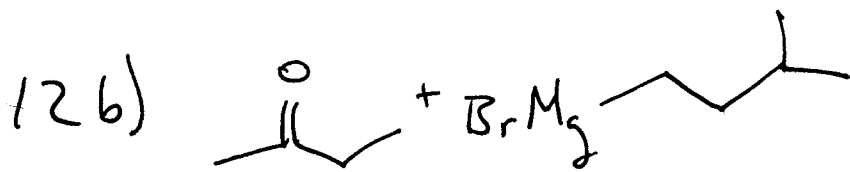
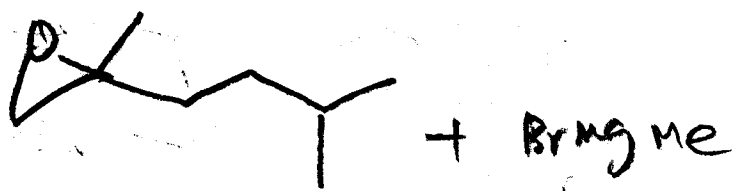
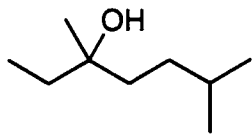
11a and 11b.



NAME: _____

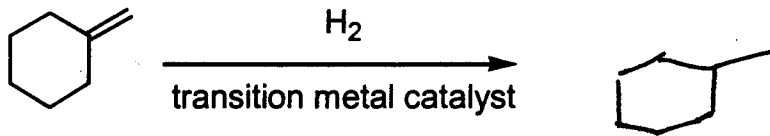
...continued

12a and 12b

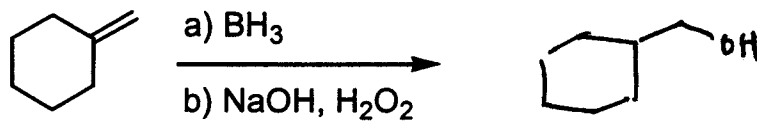


13. (6 points) Show the expected products from the following reactions. You may assume the reaction is finished with a standard workup if needed.

a.



b.



c.

