NAME:_____

Email:_____

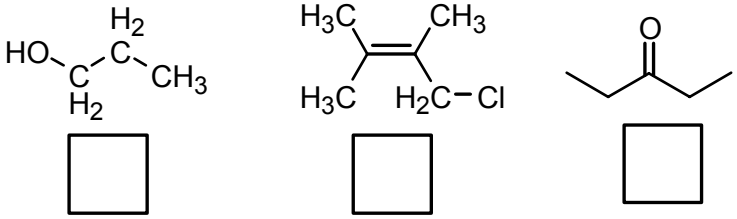
The exam must be written in ink. **No calculators of any sort allowed.**
You have 2 hours to complete the exam.

CHEM 610B
Exam 1
Spring 2002
Instructor: Dr. Brian Pagenkopf

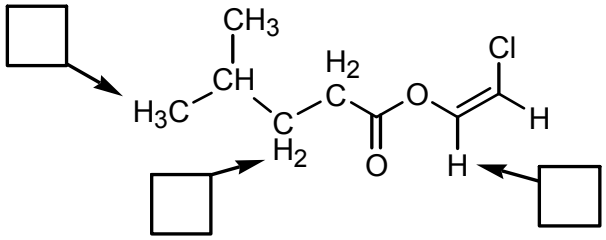
Page	Points
2	**8**
3	**9**
5	**9**
6	**10**
7	**12**
8	**9**
9 & 10	**12**
11	**6**
12	**7**
13	**6**
14	**6**
15	**6**
	100

Question 1 (8 points) Miscellaneous NMR questions.

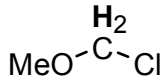
a) In the box below each molecule, indicate how many sets of equivalent hydrogens the molecule has. Each set will give rise to a different resonance signal in the ^{1}H NMR spectra.

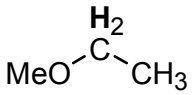


b) Predict the splitting of the indicated hydrogens.

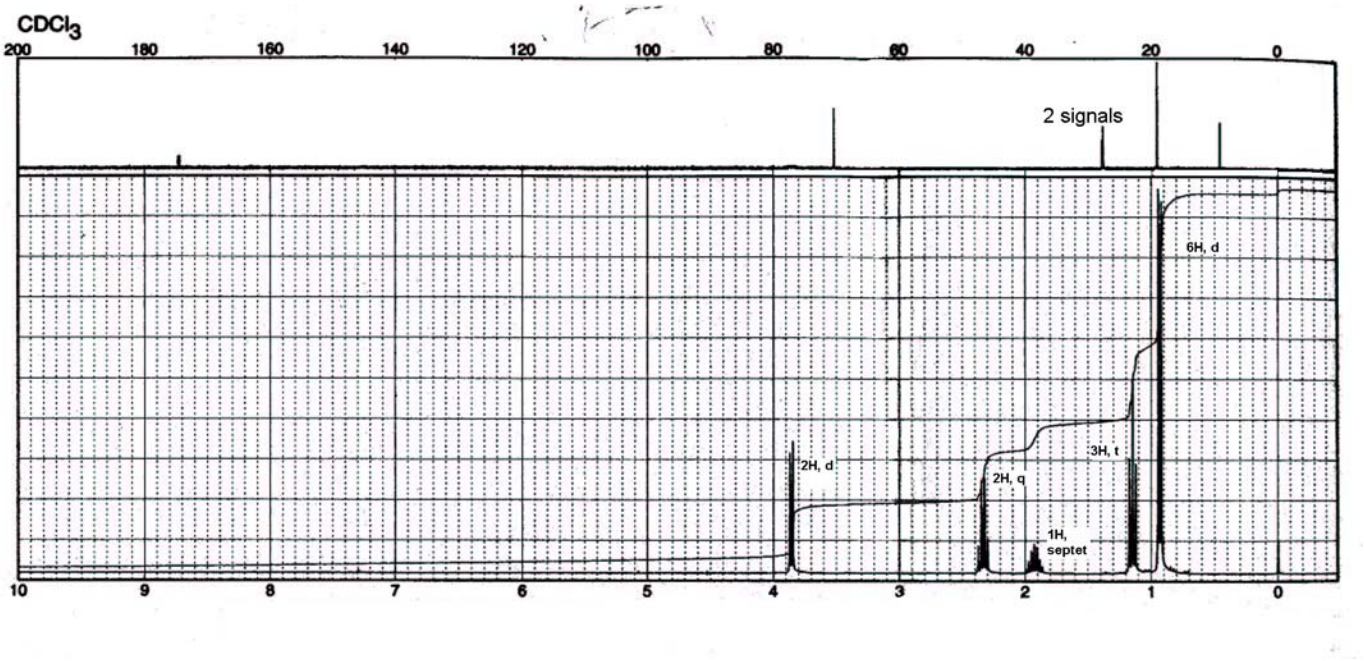


d) In the following structures 2 methylene hydrogens are bolded. In which compound would the bolded methylene hydrogens resonate **upfield** (towards the right of the spectra, smaller ppm). Circle your answer.

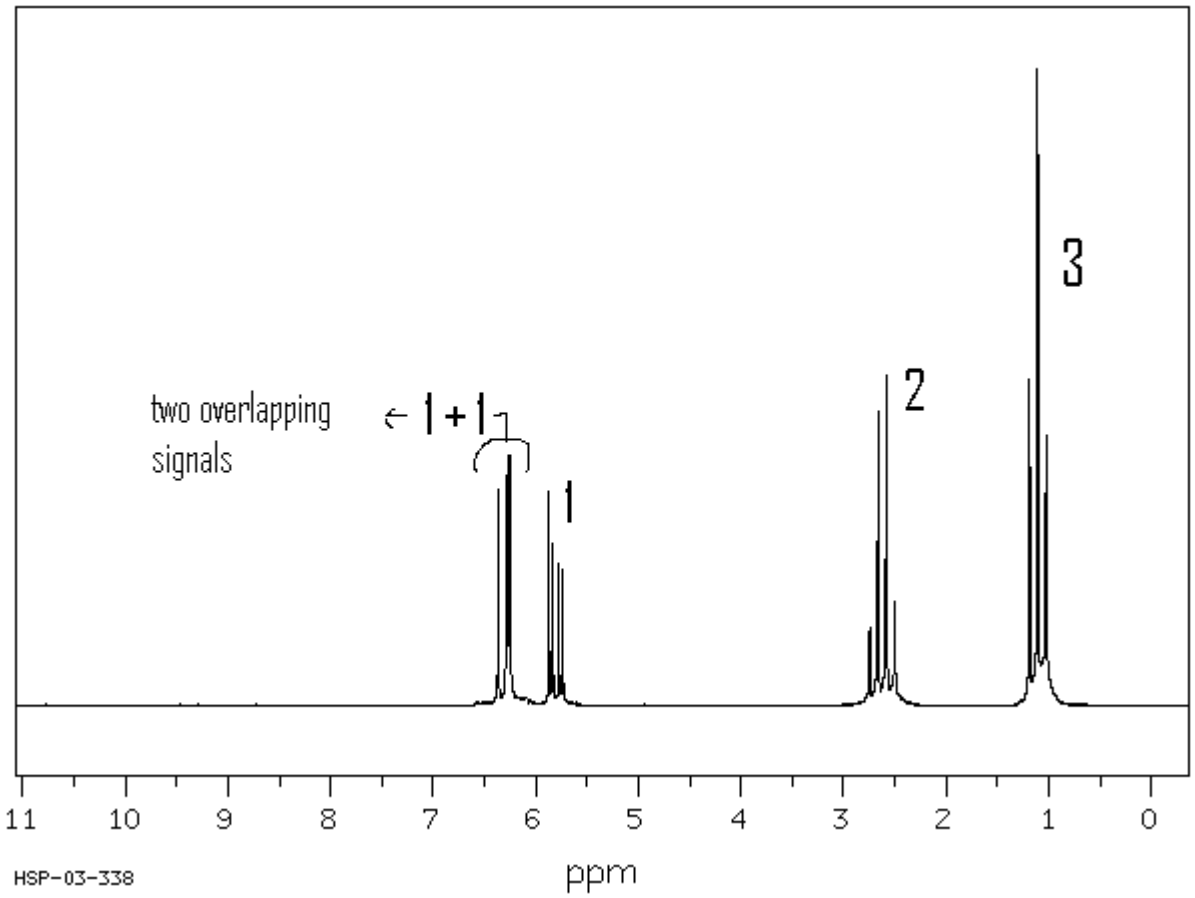


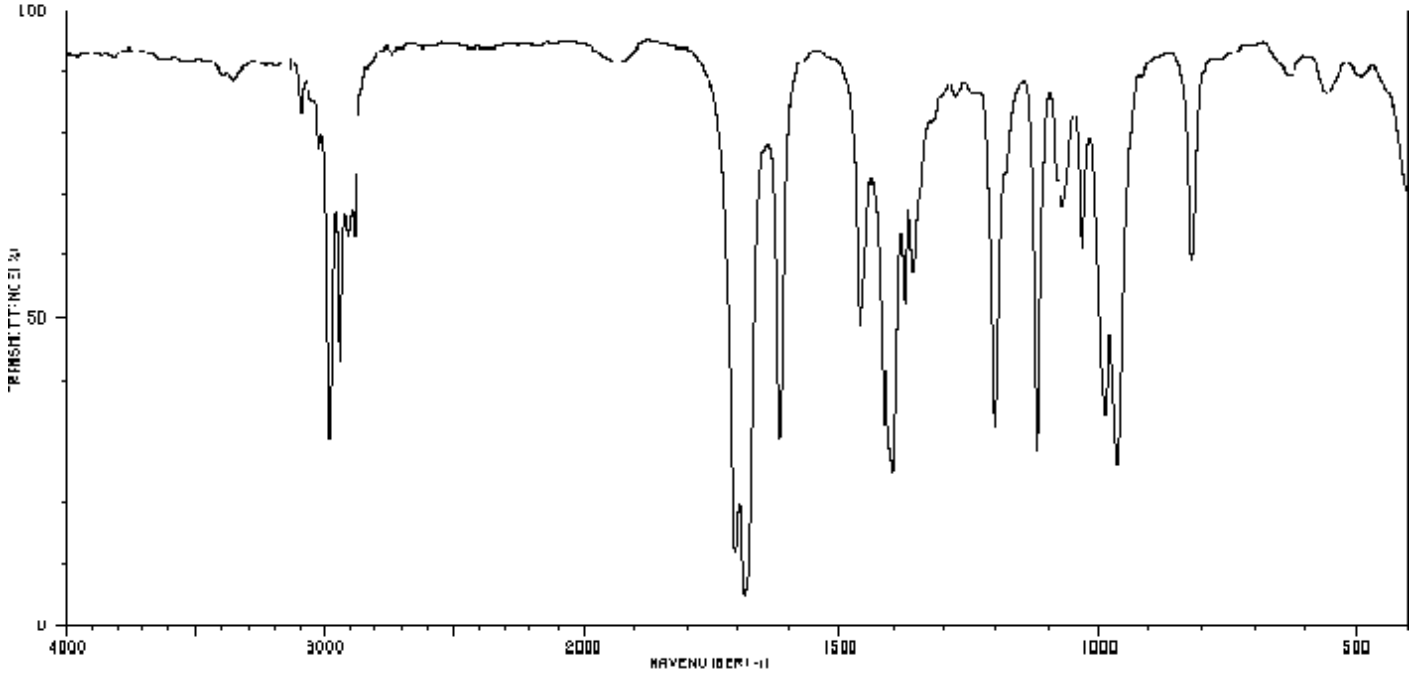


2. (9 points) NMR. The IR spectrum of a compound, molecular formula $C_7H_{14}O_2$, shows a strong absorption around 1700 cm^{-1}. From this information and the hydrogen and carbon NMR spectra provided below determine the structure.



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





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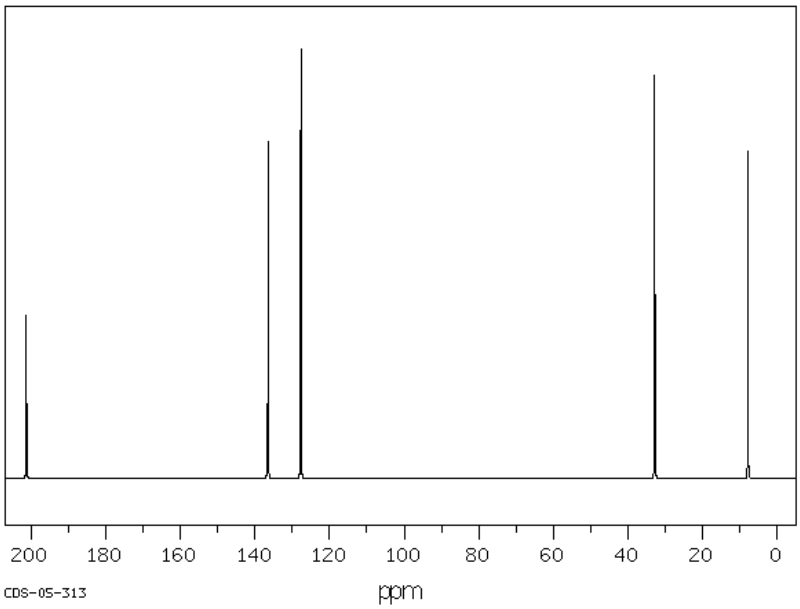


4. (10 points) Nomenclature. Provide a structure for each of the following.

a. 4-bromocyclopentene

b. propylmagnesium bromide

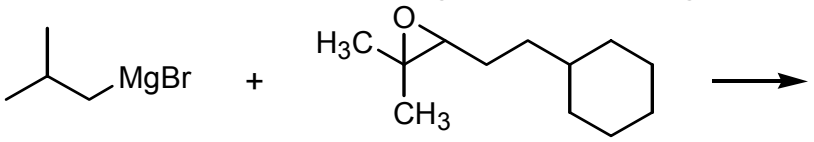
c. 3-methyl-2-pentanone

d. 3-hydroxybutanal

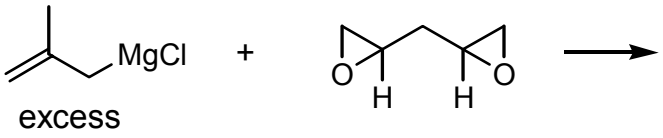
e. 2,2-dimethylcyclohexanecarbaldehyde

(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

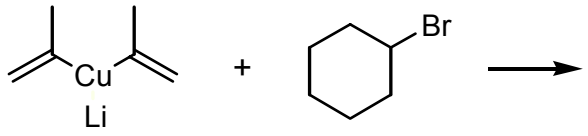


6a. Show the product from the following reaction
6b. Show how to make the organometallic reagent

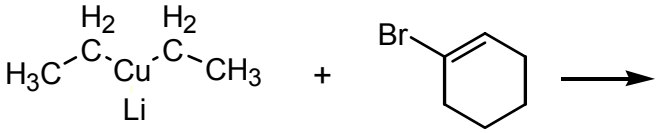


7. (9 points) Show the expected products from the following reactions. You may assume the reaction is finished with a standard workup if needed.

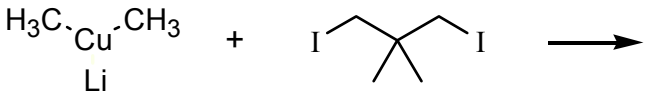
a.



b.



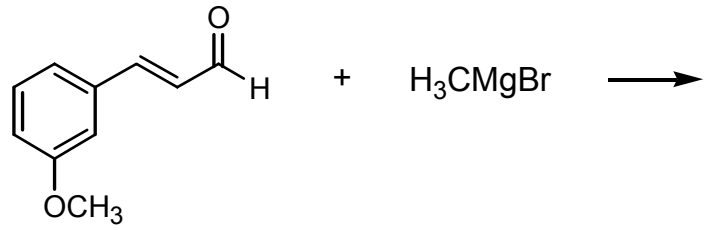
c.



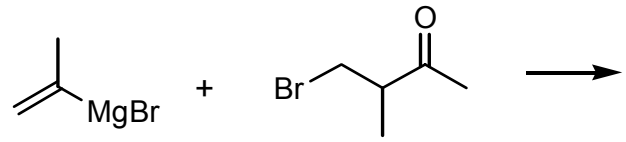
excess

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

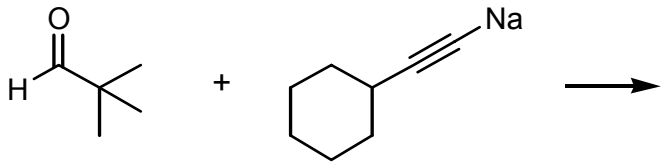
a.



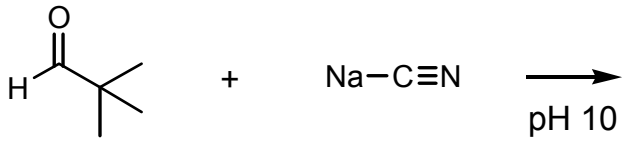
b.



c.



d.



PERIODIC TABLE OF THE ELEMENTS

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

6 — Atomic number
C — Symbol
12.011 — Atomic mass

Periods	Groups 1A												IIIA	IVA	VA	VIA	VIIA	VIIIA
	1 H 1.00079	IIA																2 He 4.00260
	3 Li 6.941	4 Be 9.01218											5 B 10.81	6 C 12..011	7 N 14.0067	8 O 15.9994	9 F 18.998403	10 Ne 20.179
	11 Na 22.98977	12 Mg 24.305	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	13 Al 26.98154	14 Si 28.0855	15 P 30.97376	16 S 32.06	17 Cl 35.453	18 Ar 39.948
	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

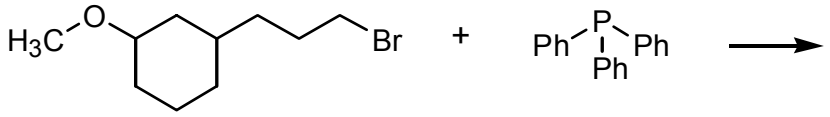
58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.9254	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967

†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)

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

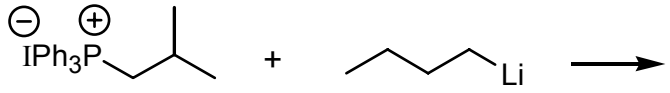
a.



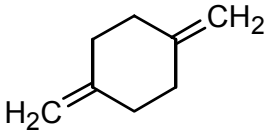
b.

…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.

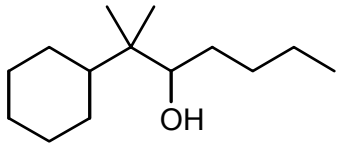


(12 points) Each of the following alcohols can be prepared by both of the following reactions:

a) epoxide + organometallic reagent → alcohol
b) aldehyde or ketone + an organometallic reagent → 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.



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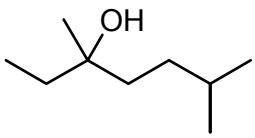
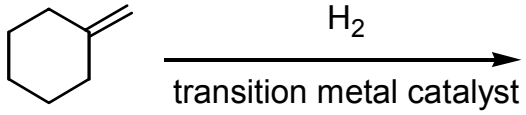
12a and 12b

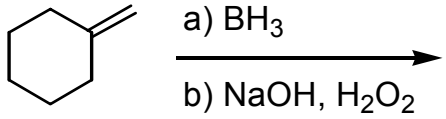


13. (6 points) Show the expected products from the following reactions. You may assume the reaction is finished with a standard workup if needed.

a.



b.



c.