CHM 2120
SAMPLE Final Exam

DATE Professor: Alison Flynn

Time: 3 hours

Name: _____

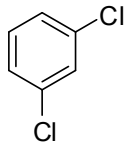
Student Number: _____

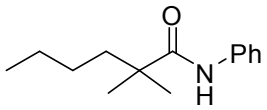
Notes:

- The final 2 pages contain a periodic table, a table of IR stretching frequencies, and a table of ^{1}H NMR chemical shifts. These pages may be detached.
- A calculator, ruler, and molecular models are permitted
- Total number of pages: 15
- Approximate number of points:
    - The marks are given as a guide and are subject to minor changes

GOOD LUCK!

1. Name the following molecules using IUPAC nomenclature or accepted trivial names: **(2 points)**

a. 

b. 

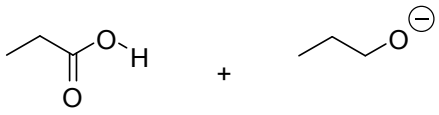
2. Draw clear structures for the following molecules: **(2 points)**

   a. (*Z*)-but-2-enal

   b. Methyl 2-hydroxybutanoate

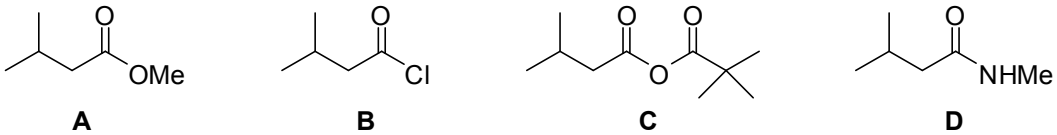
3.

   a. Write equations for the following reactions using arrow notation. **(2 points)**
   b. Will the reaction favour the starting materials or the products? **(1 point)**
   c. Justify your choice. **(3 points)**



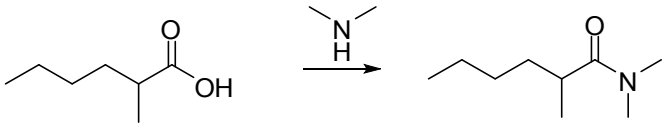
4.

a. Rank the following molecules in *increasing* order of reactivity with H_2NEt. **(3 points)**



_____ < _____ < _____ < _____

5. The following reaction won't work as shown:



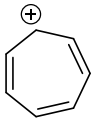
a. Show what would happen instead. **(2 points)**

b. How could you obtain the desired product? Show the reagents to be used and the structures of any intermediates. **(3 points)**

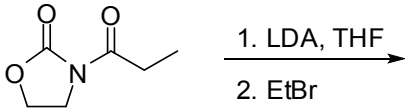
6.

a. What are the three criteria for aromaticity? **(3 points)**

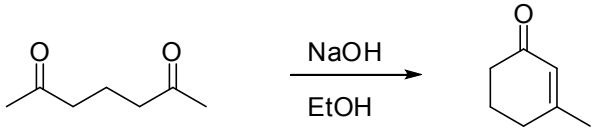
b. Is the following ion aromatic? Explain clearly how you came to this conclusion. **(2 points)**



7. Give a mechanism for each step in the following reaction sequence: **(5 points)**

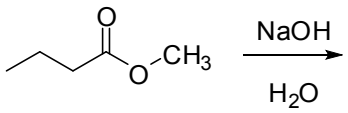


8. Provide a mechanism for the following reaction: **(6 points)**



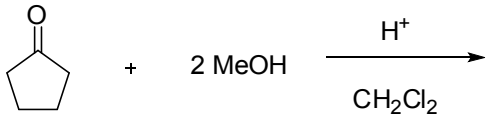
9.

a. Provide a mechanism and product for the following reaction **(5 points)**
b. Identify and name the key intermediate in the reaction **(1 point)**
c. Why is this reaction irreversible overall? **(1 point)**



10.

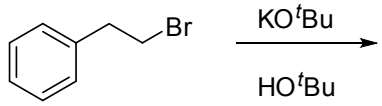
a. Provide a mechanism and product for the following reaction: **(6 points)**



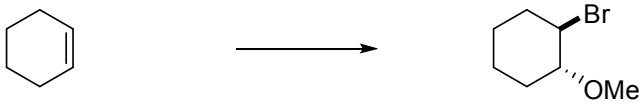
b. The yield of this reaction was somewhat low.
   i. Suggest *two* ways to improve the yield **(2 points)**
   ii. Briefly rationalize each suggestion. **(2 points)**

11. Give the missing reagent(s) or the major product of the following reactions: **(10 points—2 points each)**
Note: part marks might be given for incorrect answers with plausible mechanisms

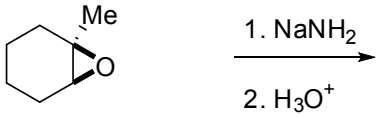
a.



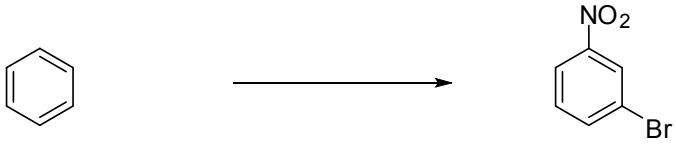
b.



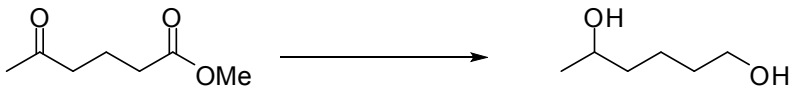
c.



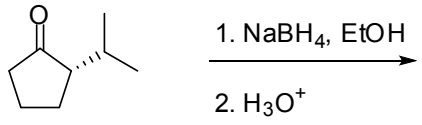
d.

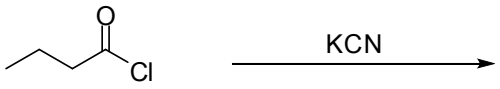


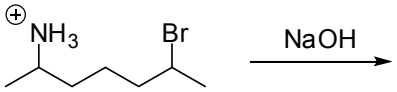
e.

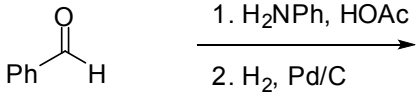


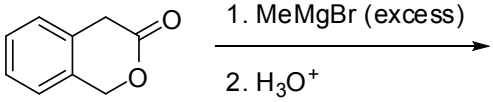
12. Give the major product of the following reactions: **(10 points—2 points each)**
Note: part marks might be given for incorrect answers with plausible mechanisms

g. 

h. 

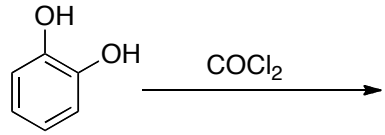
i. 

j. 

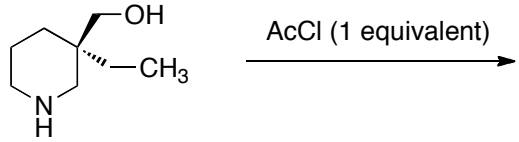
k. 

13. Give the major product(s) of each of the following reactions. **(10 points – 2 pts each)**

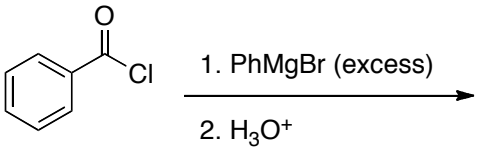
a)



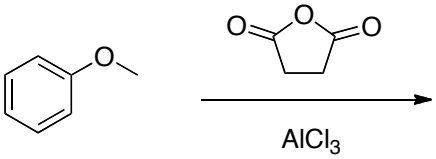
b)



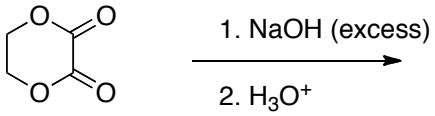
c)



d)

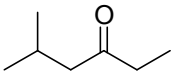


e)

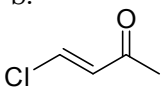


14. How many unique proton signals would be expected in the ^{1}H NMR of the following molecules? **(3 points)**

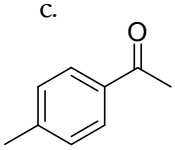
a.



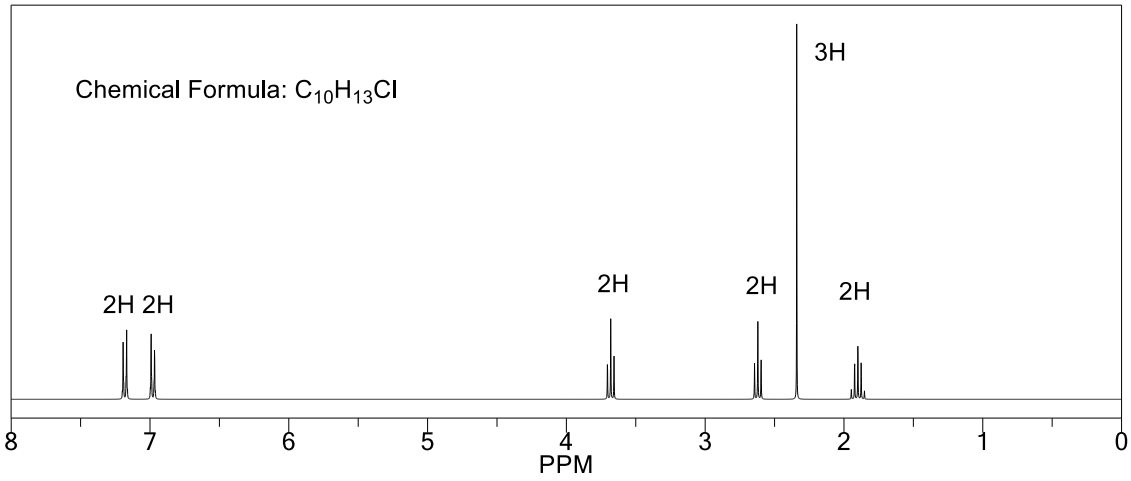
b.



c.



15. Determine the structure of the compound represented in the NMR spectrum below. **(6 points)**

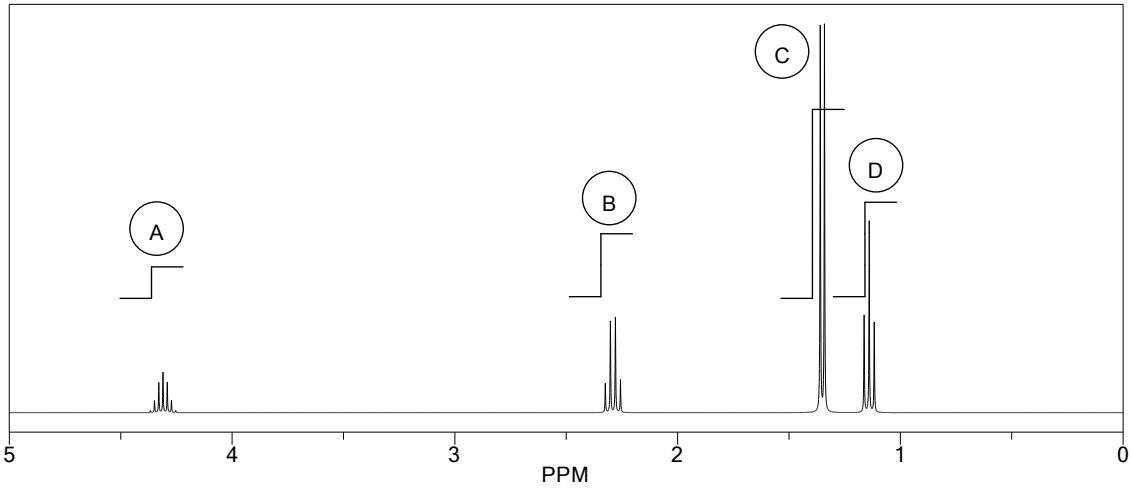


Peak	Chemical shift	Integra-tion	Multi-plicity	Comments

16.

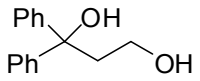
a. What is the structure of the unknown compound whose molecular formula is $\mathbf{C_6H_{12}O_2}$? The ^{1}H NMR spectrum of this compound is below. **(2 points)**
b. Justify your answer by accounting for all information given. **(10 points)**

Note: the infrared spectrum showed a number of absorbances from 2879 – 2960 cm^{-1}, and a strong absorbance at 1734 cm^{-1}.

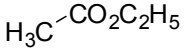


Peak	Chemical shift	Integra-tion	Multi-plicity	Comments

17. Propose a synthesis of the following molecule from the starting materials shown. An aldol reaction must be employed as part of the route **(8 points)**. A brainstorming/analysis IS required (bonds broken/formed, atoms added/removed, stereochemistry, & regiochemistry) **(4 points)**. A retrosynthesis is not required.

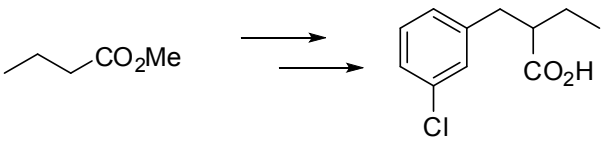


from

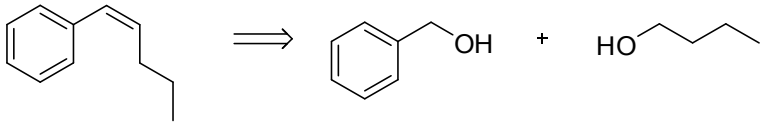


and any other required reagents

18. Propose a synthesis of the following molecule using the reagents described (retrosynthesis is not required). **(6 points)**



19. Design a synthesis of (*Z*)-hept-3-en-2-one from benzyl alcohol and 1-butanol. A Wittig reaction must be employed as a step (retrosynthesis is not required). **(8 points)**

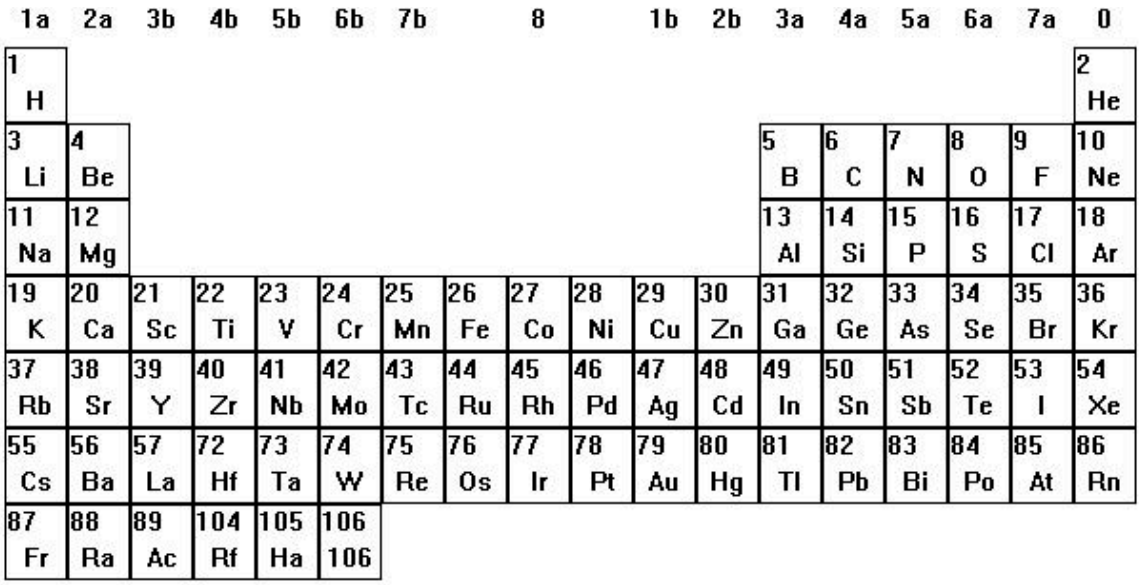


Happy holidays and good luck next semester!

Visit the course website at the beginning of January to see the hours during which you can review your final exam.

Unofficial final marks will be posted on Blackboard as soon as available.

Appendices:

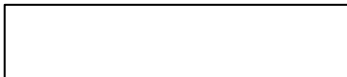
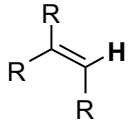
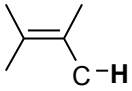
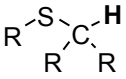
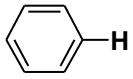
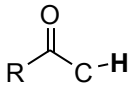
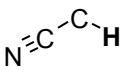
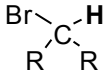
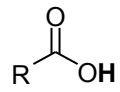
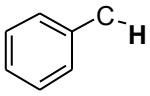
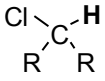
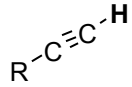
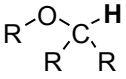
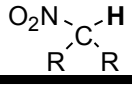


1a	2a	3b	4b	5b	6b	7b	8	1b	2b	3a	4a	5a	6a	7a	0
1 H															2 He
3 Li	4 Be									5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg									13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Ha	106 106												

IR: K**ey Absorptions (cm^{-1}):**

C-H Alkyl	C-H	2850-2960	m, sharp
Alcohol	R**O-H**	3200-3650	s, broad
Carboxylic acid	RC(=O)**O-H**	2500-3300	s, broad
Amine	R_2**N-H**	3300-3500	s, broad
Carbonyl	R_2**C=O**	1650-1780	s, sharp
Nitrile	R**C≡N**	2220-2260	v, sharp
Alkynyl	C≡**C-H**	~3300	m, sharp
Alkynyl	**C≡C**	2100-2260	v, sharp

NMR – Key chemical shifts (ppm):

R-C-CH_n	0.7 - 1.7		2.2 - 2.9		4.5 - 7.0
	1.6 - 2.6		2.0 - 3.0		6.5 - 8.0
	2.1-2.5		2.0 - 4.0		9.0 - 10.0
	2.1 - 3.0		2.7 - 4.1		11.0 - 12.0
	2.3 - 2.7		3.1 - 4.1		
	1.7 - 2.7		4.2 - 4.8		
			3.0 - 5.0		
			4.1 - 4.3