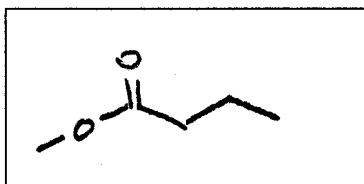


NAME: \_\_\_\_\_

Exam 2/610B/Pagenkopf

Question 1 (10 points). Below is the NMR spectrum of molecule A of formula  $C_5H_{10}O_2$  that reacts with two equivalents of ethyl magnesium bromide to give a structure of formula  $C_8H_{18}O$ . Draw the structure of molecule A in the box above the spectra.

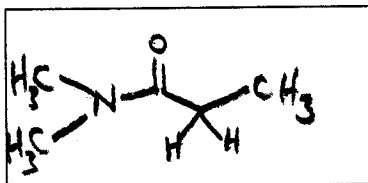


s	3H	3.7 ppm	$CH_3-O$
t	2H	2.3 ppm	$\begin{array}{c} O \\    \\ CH_2-CH_2 \end{array}$
m	2H	1.7 ppm	$\begin{array}{c} O \\    \\ CH_2-CH_2-CH_3 \end{array}$
t	3H	1.0 ppm	$CH_3-CH_2$

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

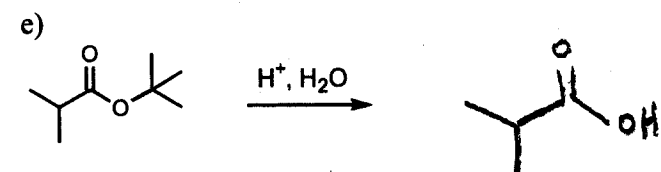
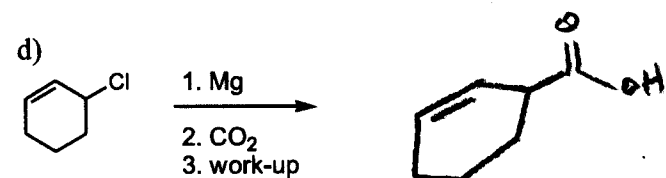
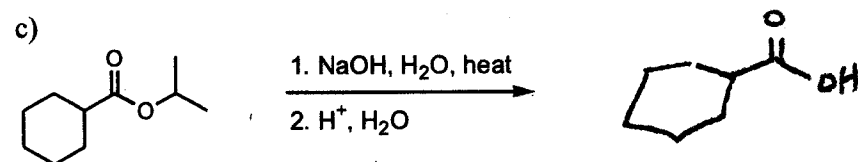
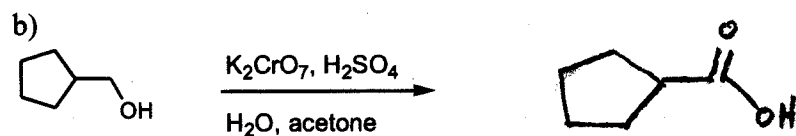
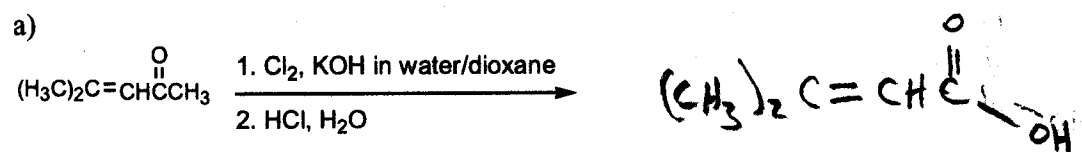
Exam 2/610B/Pagenkopf

Question 2. (10 points). Below is the NMR spectrum of a molecule B of formula  $C_5H_{11}NO$  that reacts with  $LiAlH_4$  to provide a new molecule of formula  $C_5H_{13}N$ . Draw the structure of molecule B in the box above the spectrum.



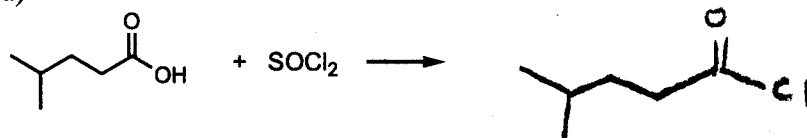
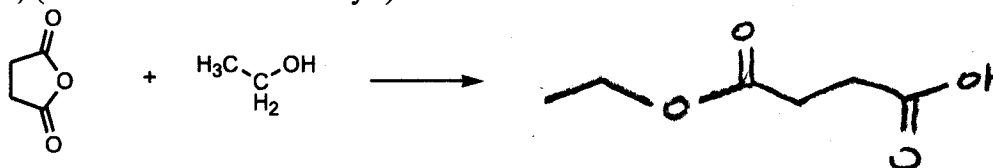
s	3H	3.01 ppm	$CH_3-N$
s	3H	2.98 ppm	$CH_3-N$
q	2H	2.3 ppm	$\overset{O}{\parallel}CH_2-CH_3$
t	3H	1.1 ppm	$\underline{CH_3}-CH_2$

Question 3 (25 points). Preparations of carboxylic acids. Draw the major product(s) expected from each of the following reactions. Any product(s) containing a carbon atom should be shown.

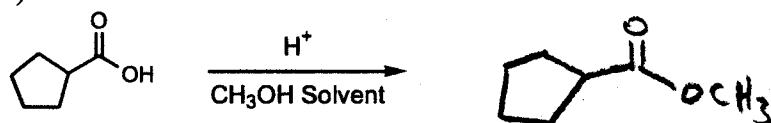


Question 4 (20 points). Reactions of carboxylic acids and derivatives. Draw the major product(s) expected from each of the following reactions. Any product containing a carbon atom should be indicated.

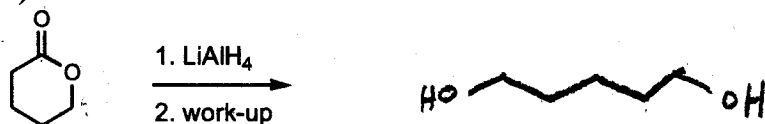
a)

b) (hint: note lack of  $\text{H}^+$  catalyst)

c)



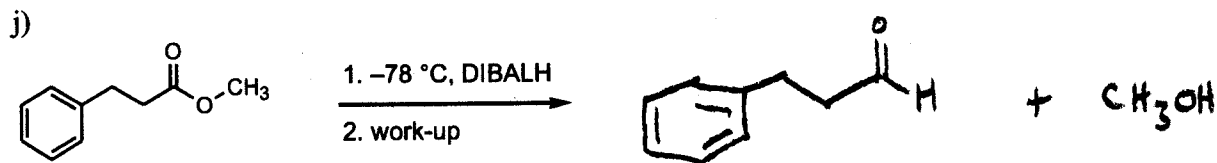
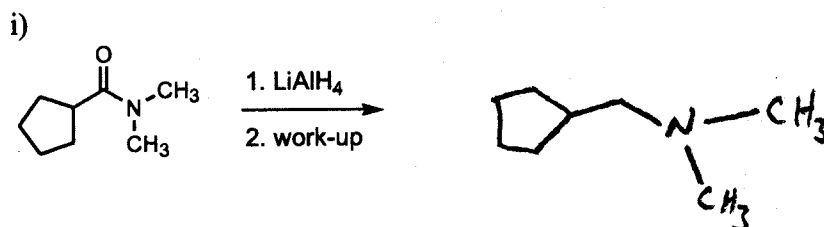
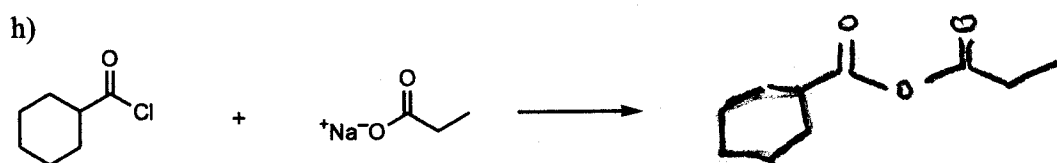
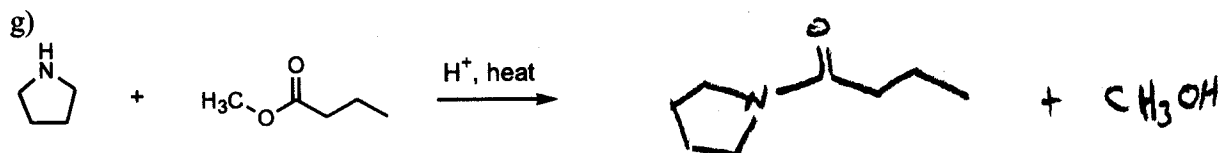
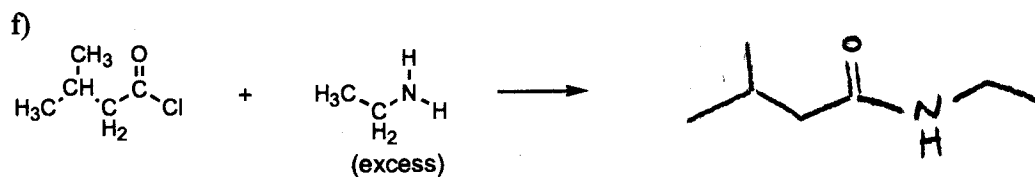
d)



e)

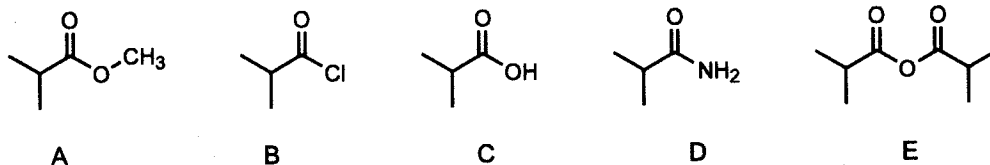


## Reactions continued (25 points).



clue:  $(i\text{-Bu})_2\text{AlH} = \text{DIBALH}$

Question 5 (5 points). Arrange the following in order of increasing reactivity towards NH<sub>3</sub>.



Which number designates the right order?

- ~~1.~~ B D A C E  
 ② D C A E B  
~~3.~~ C D B E A  
~~4.~~ E B D A C

**PERIODIC TABLE OF THE ELEMENTS**

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

6 — Atomic number C — Symbol 12.011 — Atomic mass																			
Groups																			
Periods																			
1A	2A											3A	4A	5A	6A	7A	8A		
1	2											3	4	5	6	7	8	9	10
H	He											B	C	N	O	F	Ne		
1.0079	4.0026											10.81	12.011	14.0067	15.9994	18.9984	20.179		
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	18.9984	20.179		
11	12											13	14	15	16	17	18		
Na	Mg											Al	Si	P	S	Cl	Ar		
22.98977	24.305											26.9815	28.0855	30.97376	32.06	35.453	39.948		
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
39.0983	40.08	44.9559	47.90	50.9415	51.996	54.9380	55.847	58.9332	58.70	63.546	65.38	69.72	72.59	74.9216	78.96	79.904	83.80		
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
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		
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
132.9054	137.33	138.9055	178.49	180.9478	183.85	186.207	190.2	192.22	195.08	196.9665	200.59	204.37	207.2	208.9804	(209)	(210)	(222)		
87	88	89	104	105	106														
Fr	Ra	Ac	Unq	Unp	Unh														
(223)	226.0254	227.0278	(261)	(262)	(263)														

\*Lanthanide series

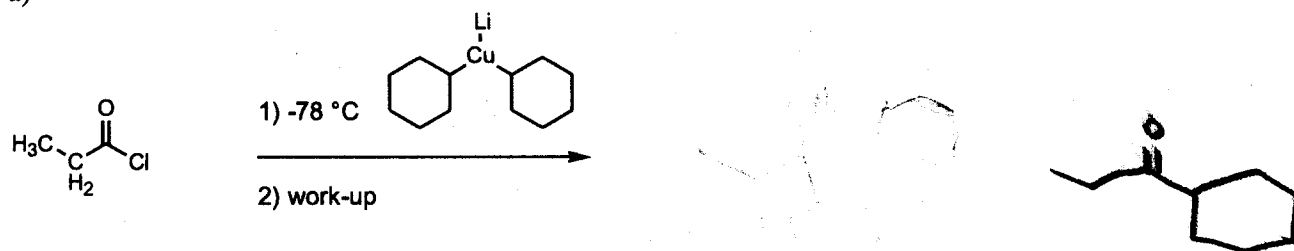
58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
140.12	140.9077	144.24	(145)	150.4	151.96	157.25	158.9254	162.50	164.9304	167.26	168.9342	173.04	174.967

†Actinide series

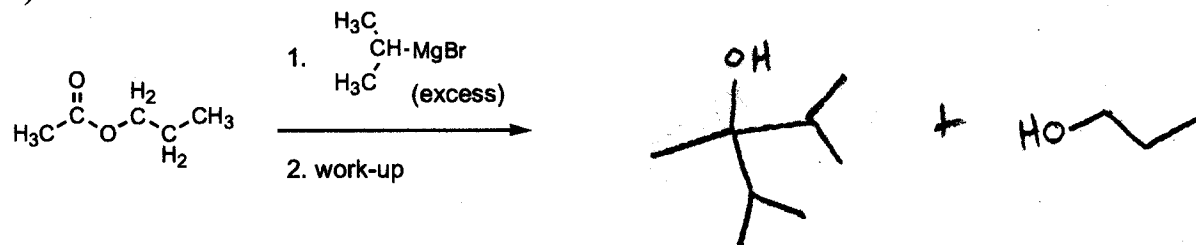
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
232.038	231.0359	238.029	(237.0482)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(260)

Question 6 (20 points). Draw the major product(s) expected from each of the following reactions. Any product containing a carbon atom should be shown.

a)



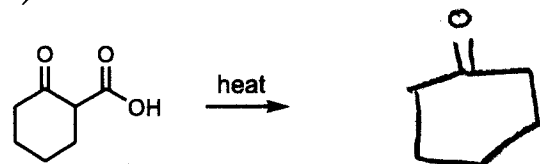
b)



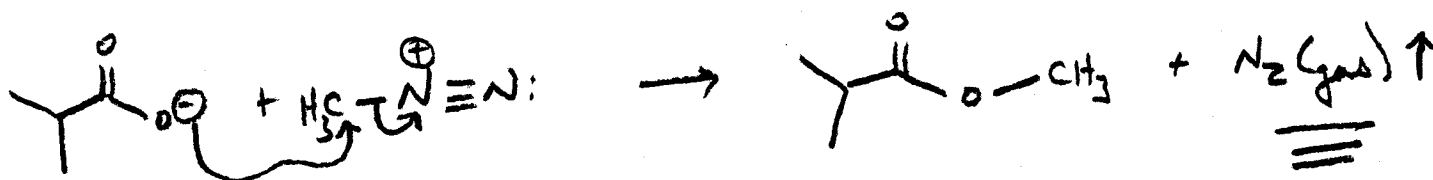
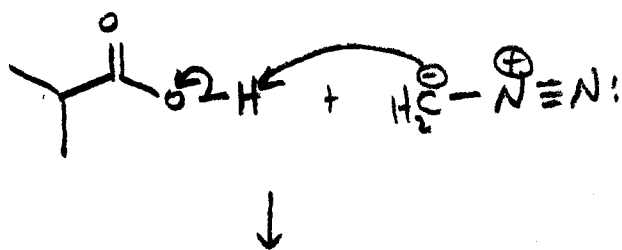
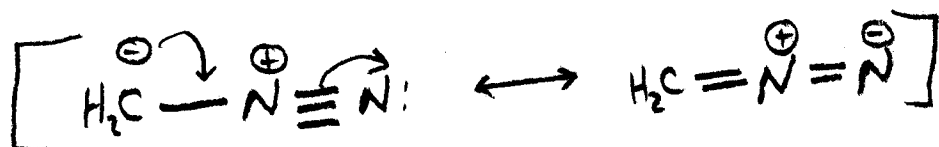
c)



d)



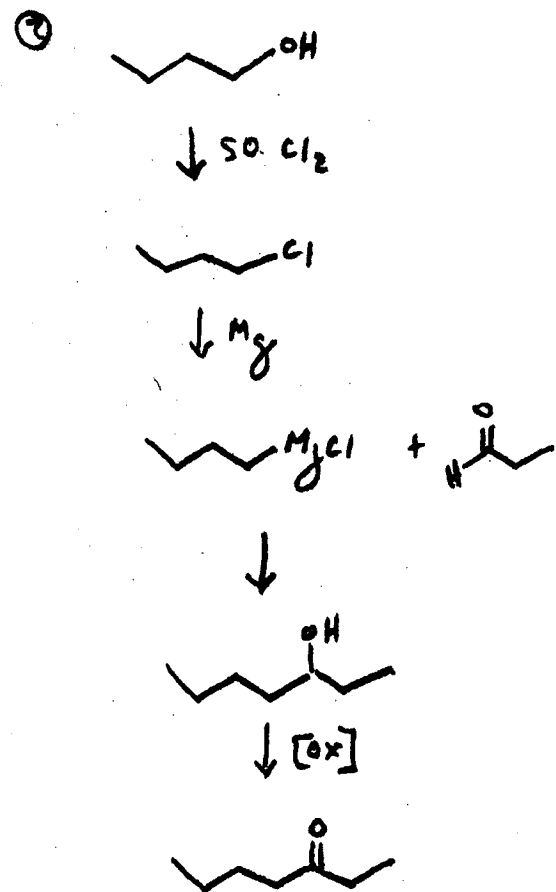
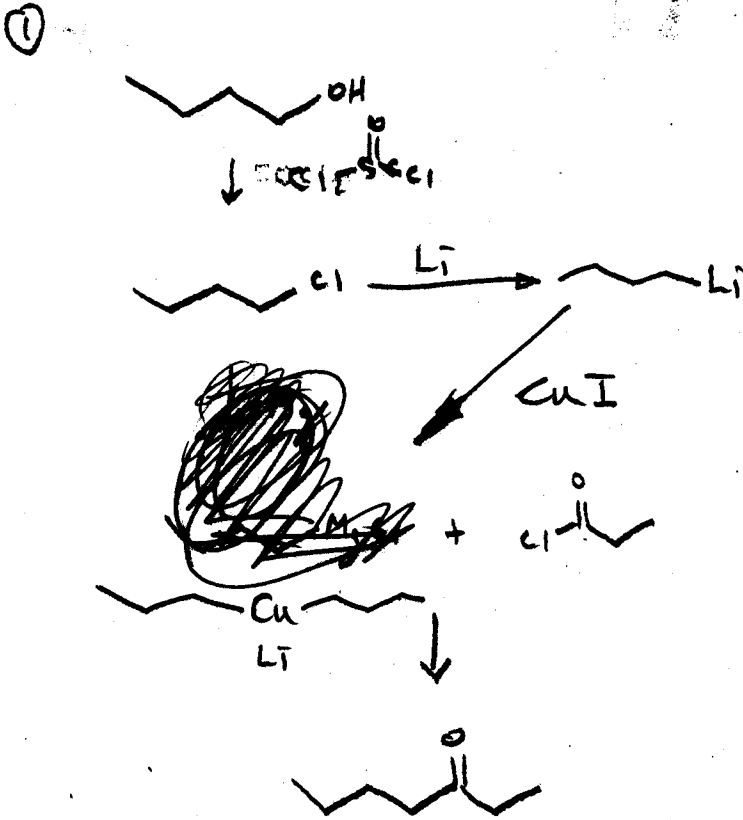
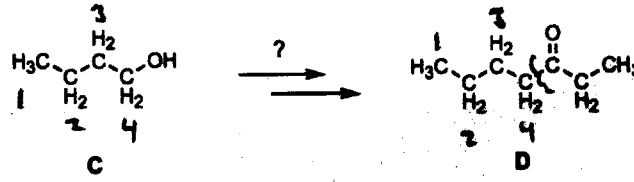
Question 7 (20 points). Mechanisms. The preparation of methyl esters by the reaction of carboxylic acids with diazomethane is an important method for it allows the synthesis of methyl esters under extremely mild reaction conditions. Show a detailed mechanism for the following reaction. Be sure to show all formal charges. Draw diazomethane and show resonance structures. Is this reaction reversible (yes or no)?



- The reaction is not reversible because of the loss of  $\text{N}_2(\text{g})$ .



Question 8 (25 points). Synthesis. Starting with molecule C, show how it might be converted into molecule D using any reagents you want. Count carbons carefully on this problem.



End of exam.