

Chem 41c Midterm Exam

Stoltz, Spring 2005, May 2, 2005

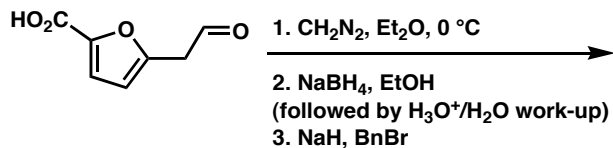
The exam begins when you turn to page 2. You have 55 minutes to complete the exam. This is a closed note and closed book exam with no collaboration. You may use the periodic table at the front of the room or the one on the last page of this packet. You may not use any other materials. The exam has a total of 135 points. Your grade will be calculated based on 120 points (i.e., you have 15 bonus points built-in). (Also, remember that your midterm counts 60 points toward your final grade, e.g., 5 quiz points = 10 points here). Good luck.

There are 9 pages in this exam packet.

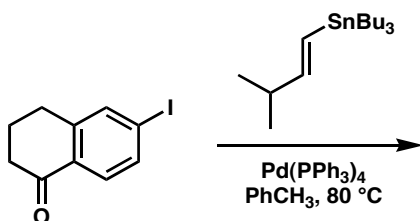
Name: _____

1. Predict the major non-volatile products (if any) of the following reactions or sequences. (5 points each)

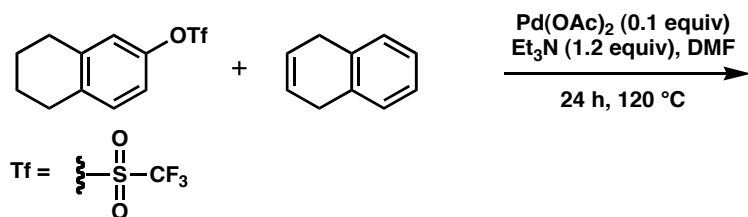
a.



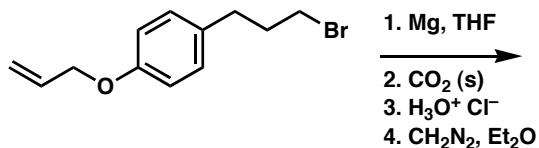
b.



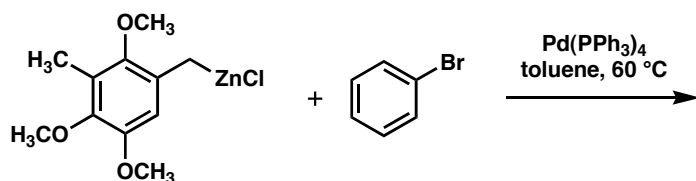
c.



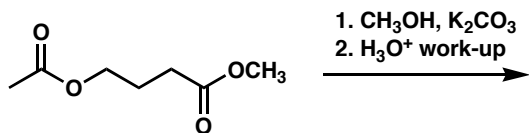
d.



e.

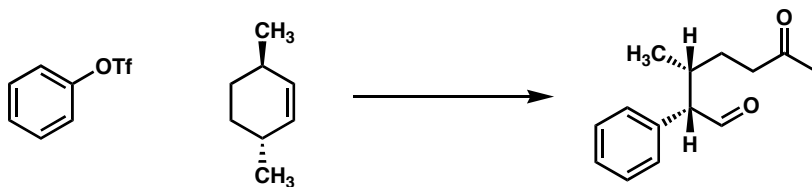


f.

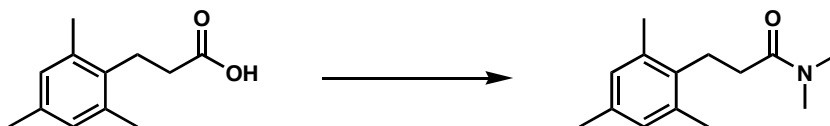


2. Provide reagents for the following transformations. They may be multistep processes (none are longer than 5 steps). (5 points each)

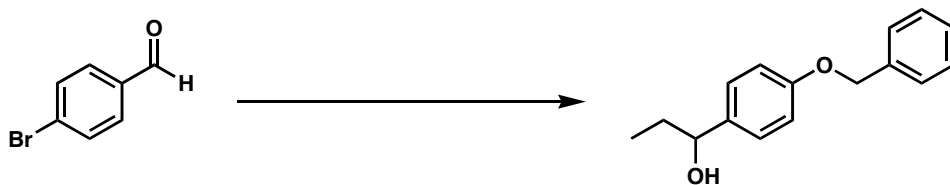
a.



b.

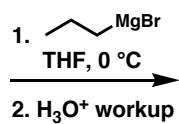
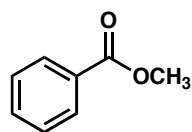


c.

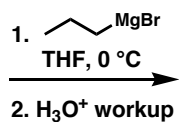
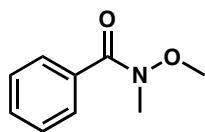


3. Provide the product of the following reactions and give a mechanistic rationale complete with curved arrows for the formation of two different products. Be sure to clearly indicate at which stage the work-up begins. (20 points)

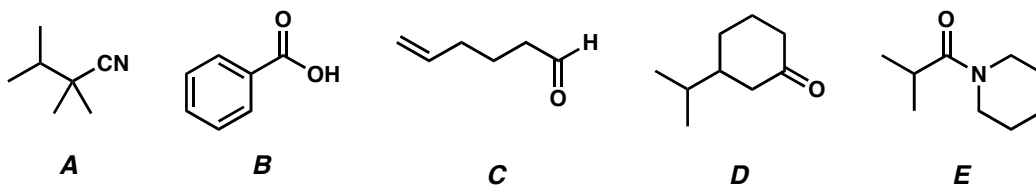
a)



b)

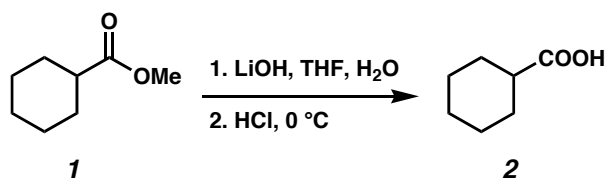


4. Rank the following compounds in order of reactivity with MeMgBr. (5 points)

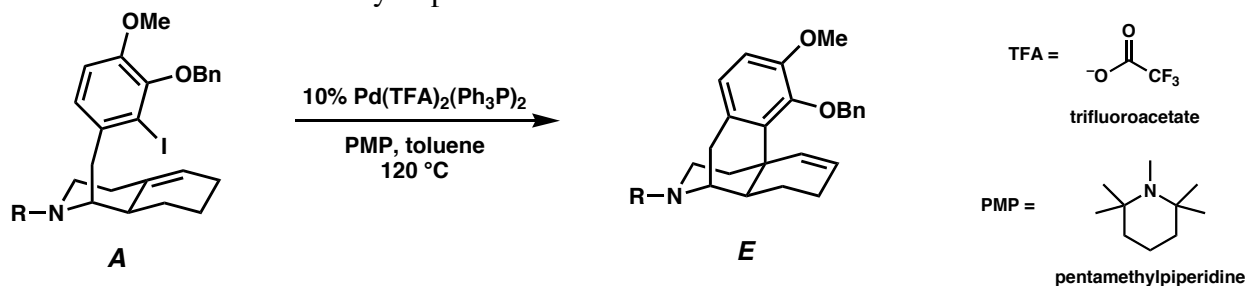


$$\square > \square > \square > \square > \square$$

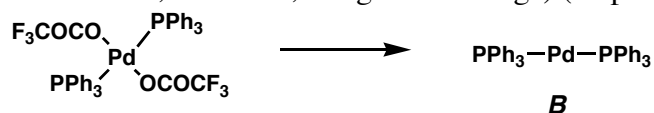
5. Provide a detailed curved arrow mechanism for the following reaction. What drives the equilibrium to the product side? (10 points)



6. Recently, an asymmetric synthesis of (-)-Morphine was reported utilizing the Palladium-catalyzed reaction described below as the key step.

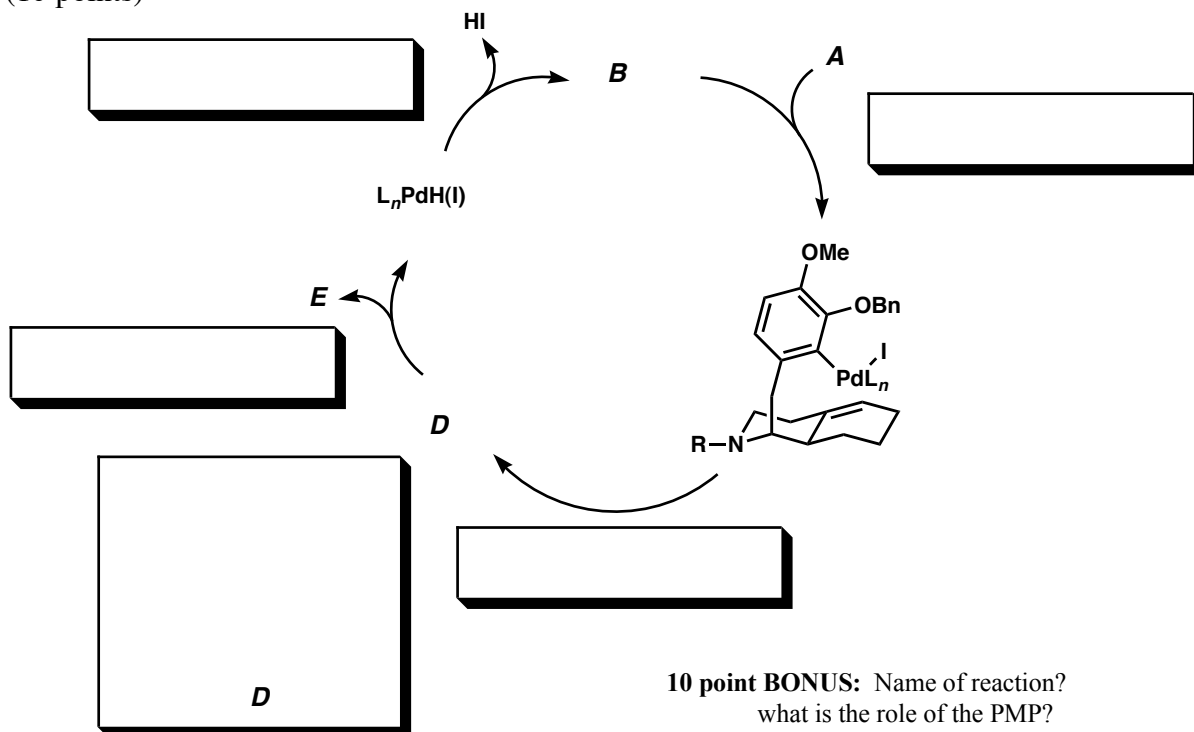


a) The active catalyst for the reaction is believed to be **B**, not $\text{Pd}(\text{TFA})_2(\text{Ph}_3\text{P})_2$. Give the formal oxidation state, d^n descriptor, and electron count for each complex. Also, what is a general name for the process to get to **B** from $\text{Pd}(\text{TFA})_2(\text{Ph}_3\text{P})_2$? (HINT: oxidation, reduction, or ligand exchange) (10 points)



formal oxidation state:	_____	_____
d^n descriptor:	_____	_____
electron count:	_____	_____
type of process:	_____	

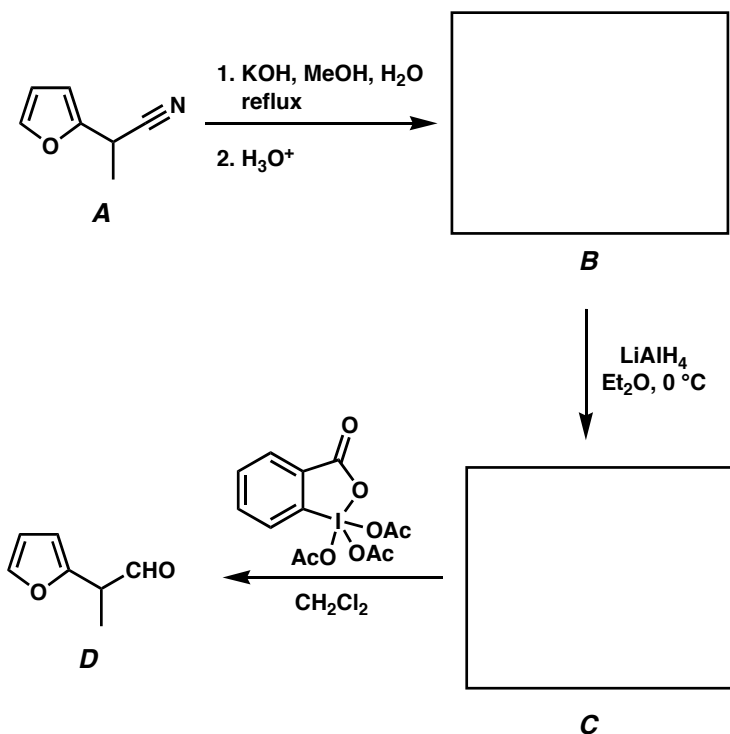
b) Label each of the boxes below describing the key steps in the catalytic cycle. Also, what is the structure of **D**? (10 points)



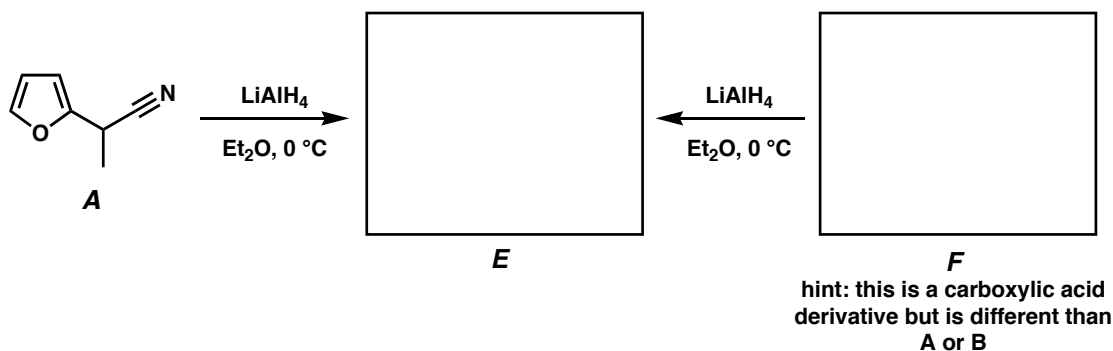
7. (25 points total) Imagine yourself as a graduate student in a famous laboratory working on a complex synthetic problem. After a long day of frustrating chemistry at the "cutting edge", you decide to rattle off some easy chemistry for the synthesis of compounds needed for simpler work (i.e., **A**→**B**→**C**→**D**). After a few hours of this "sophomore" organic chemistry, you return to your desk to realize that you have not labeled your IR spectra for compounds **B** through **D**.

(a) Draw compounds **B** and **C** into the boxes below

(b) Looking at your three IR spectra, you take note of a key peak in each. These key peaks fall at 3200 (broad), 1725 and 1710 cm^{-1} . (hint: the spectrum that has a strong peak at 1710 cm^{-1} also has a large, broad peak from 2400-3600 cm^{-1}). Assign your spectra to compounds **B**-**E** below by writing the key frequency below the corresponding compound.



b) Since the chemistry was so simple, you decide to scale up the process. Unfortunately, as a result of this somewhat rushed series of experiments and your general sleepiness, you completely forget the first step and mistakenly treat compound **A** with LiAlH₄. What is the structure of your product **E**? Fortunately, your labmate happens to need this compound, but usually synthesizes it from an alternative carboxylic acid derivative. Please provide the structure of **E** from your mistake and predict the compound that your lab-mate uses as starting material (i.e., **F**).



PERIODIC TABLE OF THE ELEMENTS
<http://www.kjf-split.hr/periodni/en/>

GROUP NUMBERS
IUPAC RECOMMENDATION (1985)

GROUP NUMBERS
CHEMICAL ABSTRACT SERVICE (1986)

ATOMIC NUMBER

SYMBOL

RELATIVE ATOMIC MASS (1)

ELEMENT NAME

1	IA	1	1.0079	1	1.0079	18	VIIIA	2	4.0026	18	VIIIA
1	IA	1	H	1	H	18	VIIIA	2	He	18	VIIIA
2	IIA	2	Li	2	Li	2	IIA	2	Be	2	IIA
3	IIIA	3	B	3	B	3	IIIA	3	B	3	IIIA
4	IVA	4	C	4	C	4	IVA	4	C	4	IVA
5	VA	5	N	5	N	5	VA	5	N	5	VA
6	VIA	6	O	6	O	6	VIA	6	O	6	VIA
7	VIIA	7	F	7	F	7	VIIA	7	F	7	VIIA
8	VIIIA	8	Ne	8	Ne	8	VIIIA	8	Ne	8	VIIIA
9	VIIIA	9	Na	9	Na	9	VIIIA	9	Na	9	VIIIA
10	VIIIA	10	Mg	10	Mg	10	VIIIA	10	Mg	10	VIIIA
11	VIIIA	11	Al	11	Al	11	VIIIA	11	Al	11	VIIIA
12	VIIIA	12	Si	12	Si	12	VIIIA	12	Si	12	VIIIA
13	VIIIA	13	P	13	P	13	VIIIA	13	P	13	VIIIA
14	VIIIA	14	S	14	S	14	VIIIA	14	S	14	VIIIA
15	VIIIA	15	Cl	15	Cl	15	VIIIA	15	Cl	15	VIIIA
16	VIIIA	16	Ar	16	Ar	16	VIIIA	16	Ar	16	VIIIA
17	VIIIA	17	K	17	K	17	VIIIA	17	K	17	VIIIA
18	VIIIA	18	Ca	18	Ca	18	VIIIA	18	Ca	18	VIIIA
19	VIIIA	19	Sc	19	Sc	19	VIIIA	19	Sc	19	VIIIA
20	VIIIA	20	Ti	20	Ti	20	VIIIA	20	Ti	20	VIIIA
21	VIIIA	21	V	21	V	21	VIIIA	21	V	21	VIIIA
22	VIIIA	22	Cr	22	Cr	22	VIIIA	22	Cr	22	VIIIA
23	VIIIA	23	Mn	23	Mn	23	VIIIA	23	Mn	23	VIIIA
24	VIIIA	24	Fe	24	Fe	24	VIIIA	24	Fe	24	VIIIA
25	VIIIA	25	Co	25	Co	25	VIIIA	25	Co	25	VIIIA
26	VIIIA	26	Ni	26	Ni	26	VIIIA	26	Ni	26	VIIIA
27	VIIIA	27	Cu	27	Cu	27	VIIIA	27	Cu	27	VIIIA
28	VIIIA	28	Zn	28	Zn	28	VIIIA	28	Zn	28	VIIIA
29	VIIIA	29	Ga	29	Ga	29	VIIIA	29	Ga	29	VIIIA
30	VIIIA	30	Ge	30	Ge	30	VIIIA	30	Ge	30	VIIIA
31	VIIIA	31	As	31	As	31	VIIIA	31	As	31	VIIIA
32	VIIIA	32	Se	32	Se	32	VIIIA	32	Se	32	VIIIA
33	VIIIA	33	Br	33	Br	33	VIIIA	33	Br	33	VIIIA
34	VIIIA	34	Kr	34	Kr	34	VIIIA	34	Kr	34	VIIIA
35	VIIIA	35	Rb	35	Rb	35	VIIIA	35	Rb	35	VIIIA
36	VIIIA	36	Sr	36	Sr	36	VIIIA	36	Sr	36	VIIIA
37	VIIIA	37	Y	37	Y	37	VIIIA	37	Y	37	VIIIA
38	VIIIA	38	Zr	38	Zr	38	VIIIA	38	Zr	38	VIIIA
39	VIIIA	39	Nb	39	Nb	39	VIIIA	39	Nb	39	VIIIA
40	VIIIA	40	Mo	40	Mo	40	VIIIA	40	Mo	40	VIIIA
41	VIIIA	41	Tc	41	Tc	41	VIIIA	41	Tc	41	VIIIA
42	VIIIA	42	Ru	42	Ru	42	VIIIA	42	Ru	42	VIIIA
43	VIIIA	43	Rh	43	Rh	43	VIIIA	43	Rh	43	VIIIA
44	VIIIA	44	Pd	44	Pd	44	VIIIA	44	Pd	44	VIIIA
45	VIIIA	45	Ag	45	Ag	45	VIIIA	45	Ag	45	VIIIA
46	VIIIA	46	Cd	46	Cd	46	VIIIA	46	Cd	46	VIIIA
47	VIIIA	47	In	47	In	47	VIIIA	47	In	47	VIIIA
48	VIIIA	48	Sn	48	Sn	48	VIIIA	48	Sn	48	VIIIA
49	VIIIA	49	Sb	49	Sb	49	VIIIA	49	Sb	49	VIIIA
50	VIIIA	50	Te	50	Te	50	VIIIA	50	Te	50	VIIIA
51	VIIIA	51	I	51	I	51	VIIIA	51	I	51	VIIIA
52	VIIIA	52	Xe	52	Xe	52	VIIIA	52	Xe	52	VIIIA
53	VIIIA	53	Cs	53	Cs	53	VIIIA	53	Cs	53	VIIIA
54	VIIIA	54	Ba	54	Ba	54	VIIIA	54	Ba	54	VIIIA
55	VIIIA	55	La-Lu	55	La-Lu	55	VIIIA	55	La-Lu	55	VIIIA
56	VIIIA	56	Hf	56	Hf	56	VIIIA	56	Hf	56	VIIIA
57	VIIIA	57	Ta	57	Ta	57	VIIIA	57	Ta	57	VIIIA
58	VIIIA	58	W	58	W	58	VIIIA	58	W	58	VIIIA
59	VIIIA	59	Re	59	Re	59	VIIIA	59	Re	59	VIIIA
60	VIIIA	60	Os	60	Os	60	VIIIA	60	Os	60	VIIIA
61	VIIIA	61	Ir	61	Ir	61	VIIIA	61	Ir	61	VIIIA
62	VIIIA	62	Pt	62	Pt	62	VIIIA	62	Pt	62	VIIIA
63	VIIIA	63	Au	63	Au	63	VIIIA	63	Au	63	VIIIA
64	VIIIA	64	Hg	64	Hg	64	VIIIA	64	Hg	64	VIIIA
65	VIIIA	65	Tl	65	Tl	65	VIIIA	65	Tl	65	VIIIA
66	VIIIA	66	Pb	66	Pb	66	VIIIA	66	Pb	66	VIIIA
67	VIIIA	67	Bi	67	Bi	67	VIIIA	67	Bi	67	VIIIA
68	VIIIA	68	Po	68	Po	68	VIIIA	68	Po	68	VIIIA
69	VIIIA	69	At	69	At	69	VIIIA	69	At	69	VIIIA
70	VIIIA	70	Rn	70	Rn	70	VIIIA	70	Rn	70	VIIIA
71	VIIIA	71	Fr	71	Fr	71	VIIIA	71	Fr	71	VIIIA
72	VIIIA	72	Ra	72	Ra	72	VIIIA	72	Ra	72	VIIIA
73	VIIIA	73	Ac-Lr	73	Ac-Lr	73	VIIIA	73	Ac-Lr	73	VIIIA
74	VIIIA	74	Rf	74	Rf	74	VIIIA	74	Rf	74	VIIIA
75	VIIIA	75	Db	75	Db	75	VIIIA	75	Db	75	VIIIA
76	VIIIA	76	Sg	76	Sg	76	VIIIA	76	Sg	76	VIIIA
77	VIIIA	77	Bh	77	Bh	77	VIIIA	77	Bh	77	VIIIA
78	VIIIA	78	Hs	78	Hs	78	VIIIA	78	Hs	78	VIIIA
79	VIIIA	79	Mt	79	Mt	79	VIIIA	79	Mt	79	VIIIA
80	VIIIA	80	Uun	80	Uun	80	VIIIA	80	Uun	80	VIIIA
81	VIIIA	81	Uuu	81	Uuu	81	VIIIA	81	Uuu	81	VIIIA
82	VIIIA	82	Uub	82	Uub	82	VIIIA	82	Uub	82	VIIIA
83	VIIIA	83	Uuq	83	Uuq	83	VIIIA	83	Uuq	83	VIIIA

(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001).
 Relative atomic mass is shown with five significant figures. For elements having no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.
 However three such elements (Tl, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

Editor: Aditya Vardhan (advarg@netline.com)

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The End