

# CHEM 3311 (Richardson) Final Exam – Dec. 18, 2017

Your Name: Key

Student ID: \_\_\_\_\_

- Recitation (check one)       1:00 Mon (Zhenhao Chen)  
 8:00 Tue (Rachel Weintraub)     11:00 Tue (Patrick Li)  
 2:00 Tue (Zhenhao Chen)         1:00 Wed (Zepeng Lei)  
 3:00 Wed (Rachel Weintraub)     9:00 Thu (Rachel Weintraub)  
 12:00 Thu (Patrick Li)             3:00 Thu (Zepeng Lei)  
 2:00 Fri (Rachel Weintraub)       3:00 Fri (Rachel Weintraub)

Question	Score	Out of
1		20
2		20
3		45
4		20
5		20
6		40
7		20
8		15
9		15 e.c.
<b>Total</b>		<b>200</b>

This is a closed-book exam. The use of notes, calculators, or cell phones will not be allowed during the exam. You may use models sets brought in a clear ziplock bag. Use the backs of the pages for scratch work. If your final answer is not clearly specified, you will lose points. For mechanisms, show all intermediates including correct formal charges, but do not show transition states.

Period 1										Period 2													
1																				2			
H																				He			
Period 3		Period 4																		Period 5		Period 6	
3	4																	5	6	7	8	9	10
Li	Be																	B	C	N	O	F	Ne
Period 11		Period 12																		Period 13		Period 14	
11	12																	13	14	15	16	17	18
Na	Mg																	Al	Si	P	S	Cl	Ar
Period 19		Period 20		Period 21		Period 22		Period 23		Period 24		Period 25		Period 26		Period 27		Period 28		Period 29		Period 30	
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						
Period 37		Period 38		Period 39		Period 40		Period 41		Period 42		Period 43		Period 44		Period 45		Period 46		Period 47		Period 48	
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						
Period 55		Period 56		Period 57-70		Period 71		Period 72		Period 73		Period 74		Period 75		Period 76		Period 77		Period 78		Period 79	
55	56	*	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86					
Cs	Ba	*	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn					
Period 87		Period 88		Period 89-102		Period 103		Period 104		Period 105		Period 106		Period 107		Period 108		Period 109		Period 110		Period 111	
87	88	* *	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120			
Fr	Ra	* *	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub	Uuq										

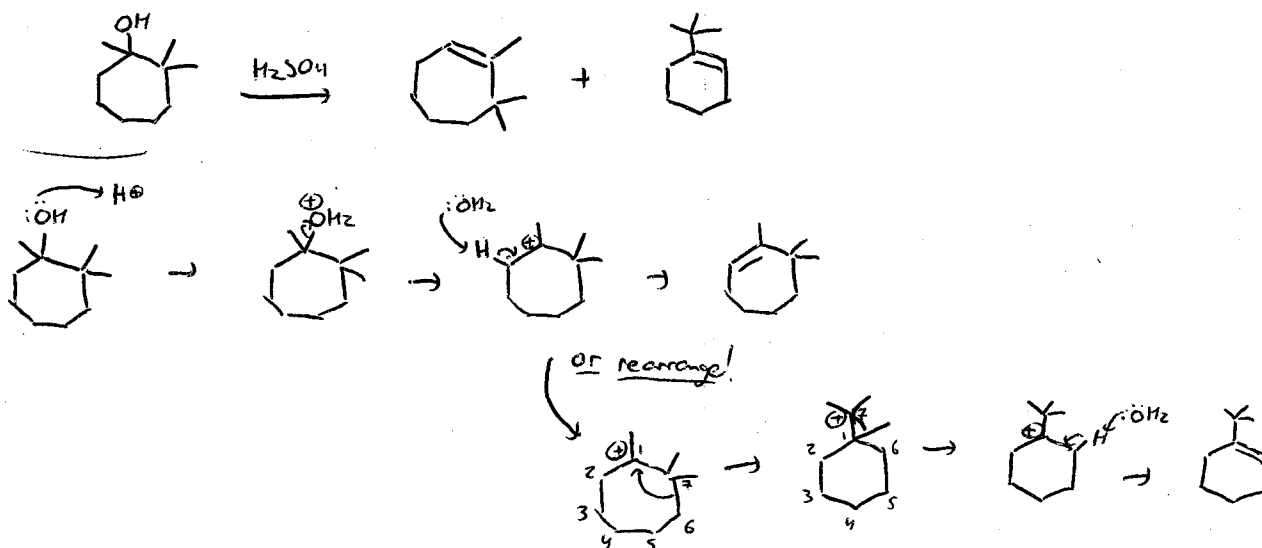
Lanthanide series	57	58	59	60	61	62	63	64	65	66	67	68	69	70
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
Actinide series	89	90	91	92	93	94	95	96	97	98	99	100	101	102
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

Average: 149.7  
 St. Dev: 40.3  
 Max: 207  
 Min: 6

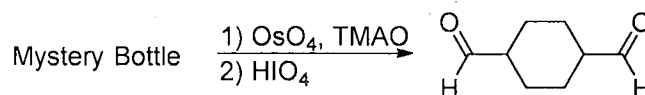
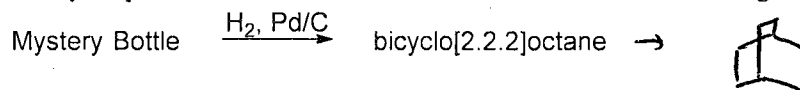
## pKa Values

HI	-10	CH <sub>3</sub> COOH	4.7	ArOH	10	H <sub>2</sub>	35
HBr	-8	HN <sub>3</sub>	4.7	RSH	10-12	NH <sub>3</sub>	36
HCl	-6	H <sub>2</sub> S	7.0	H <sub>2</sub> O	15.7	H <sub>2</sub> C=CH <sub>2</sub>	45
H <sub>3</sub> O <sup>+</sup>	-1.7	NH <sub>4</sub> <sup>+</sup>	9.3	ROH (R=alkyl)	16-18	CH <sub>4</sub>	60
HF	3.2	HCN	9.4	HC≡CH	26		

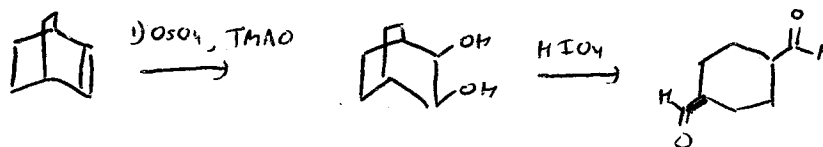
- 1) Treatment of 1,2,2-trimethylcycloheptanol with  $\text{H}_2\text{SO}_4$  gives a mixture of 1,7,7-trimethylcycloheptene and 1-*tert*-butylcyclohexene as the two major products. Write a reasonable mechanism to show how each of these products is formed. (20 pts)



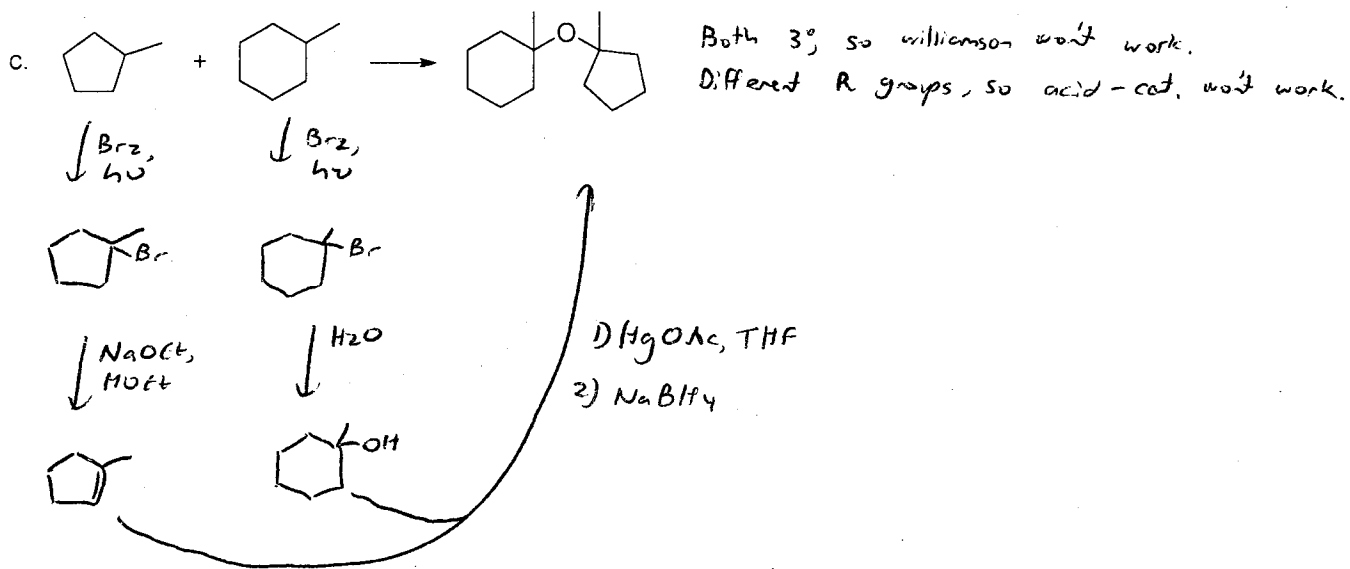
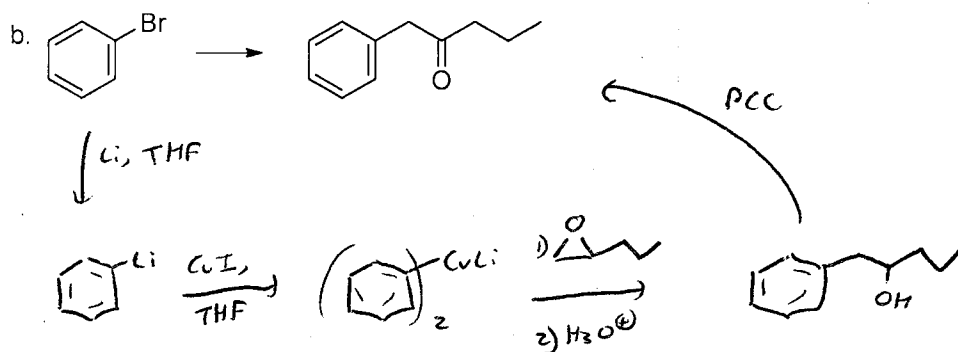
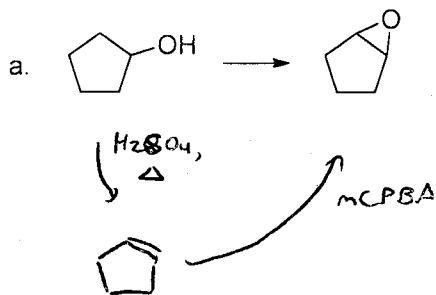
- 2) You have found a mysterious bottle in your lab bench. The label is too covered in weird stains to be legible, but your research advisor assures you that this compound is vital to the success of your career as a chemistry grad student and you must identify its structure. Since the NMR is not available, you perform a few reactions and observe the following results.



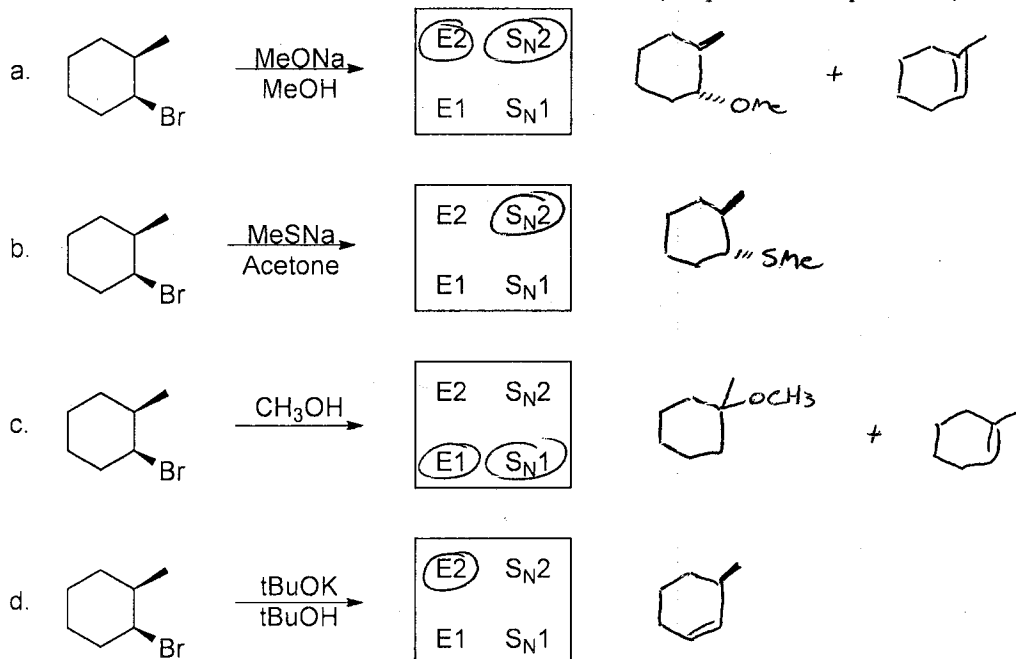
What is the structure of the compound in this mystery bottle? (20 pts)



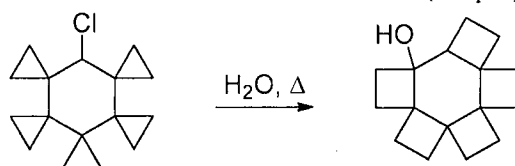
- 3) Find a way to synthesize the desired product from the given starting material. If more than one step is necessary, show the product of each step. Do not show mechanisms. (45 pts; 15 pts each)



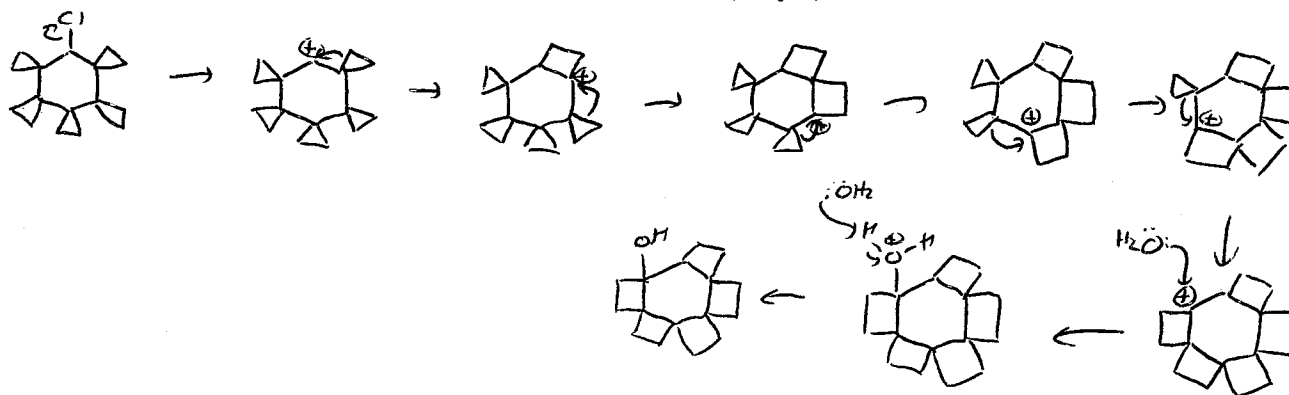
- 4) For each of the reactions shown below, **circle the mechanism(s)** you would expect to see, if any, and **draw the product(s)**. If a product has stereocenters, show its configuration using wedges and dashes. If two stereoisomers are formed, show both of them. If an elimination occurs, show only the major alkene product. If none of the mechanisms would take place in a reasonable time frame, write NR for No Reaction. (20 pts total; 5 pts each)



- 5) The reaction shown below was observed to occur in water. (20 pts)



- a. Draw a reasonable mechanism for this reaction. (18 pts)



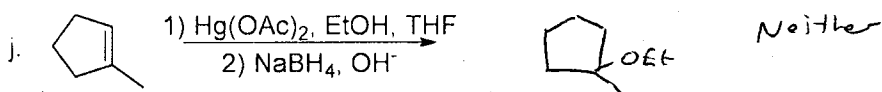
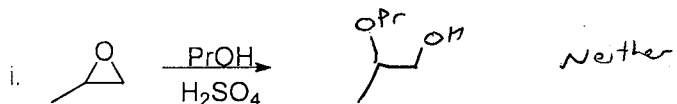
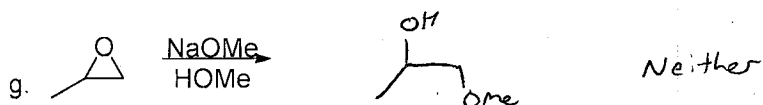
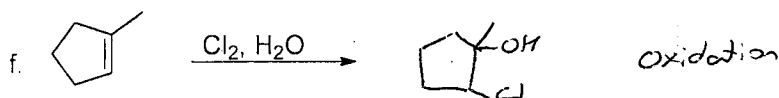
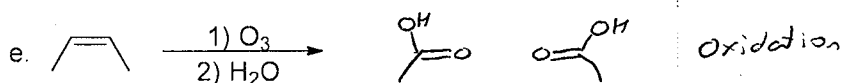
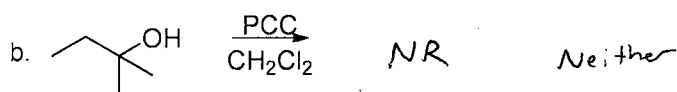
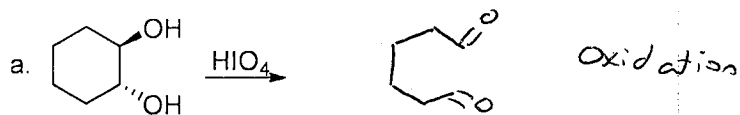
- b. Is this reaction awesome? Circle one answer. (2 pts)

Yes

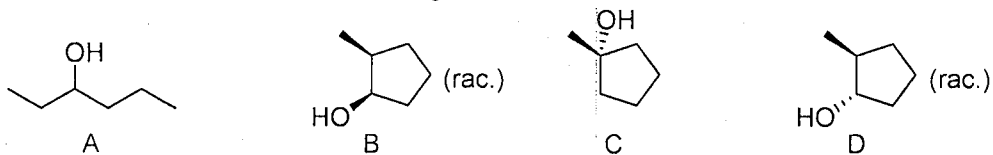
YES

VERY YES

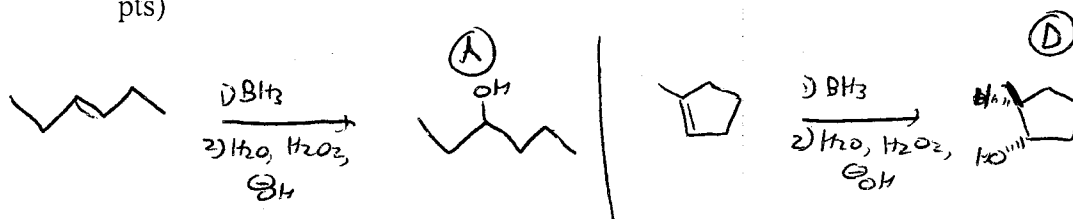
- 6) Predict the product of the following reactions, and choose the appropriate descriptor (reduction, oxidation, or neither) for what happens to the organic molecule during each reaction. You do not need to show stereochemistry. (40 pts; 4 pts each)



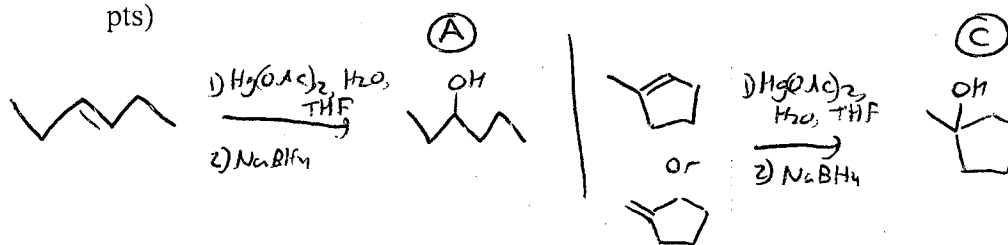
7) Four compounds are shown below. (20 pts)



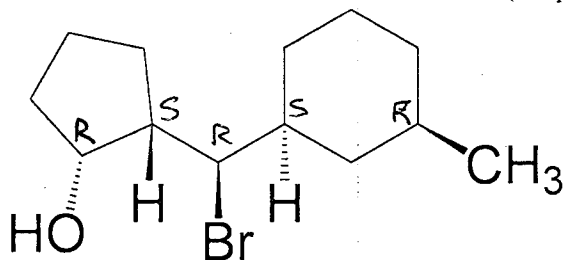
a. Which of these compounds can be synthesized as the major product of hydroboration-oxidation? Show the precursor alkene for each alcohol that can be prepared this way. (10 pts)



b. Which of these compounds can be synthesized as the major product of oxymercuration-reduction? Show the precursor alkene for each alcohol that can be prepared this way. (10 pts)



8) In the structure shown below, label each stereocenter as R or S. (15 pts)



9) Extra credit! Three different alkanes are constitutional isomers, all with the formula  $\text{C}_6\text{H}_{12}$ . When treated with chlorine and UV light, under conditions that lead to monochlorination, isomer A gives a single product, isomer B (which contains a quaternary carbon) gives a mixture of three products, and isomer C gives a mixture of four products. Based on this information, draw the structures of all three isomers, and draw each of the monochlorination products that they form. (15 pts extra credit)

