CHEM 3311 (Richardson) Final Exam – December 18, 2012

Your Name Key

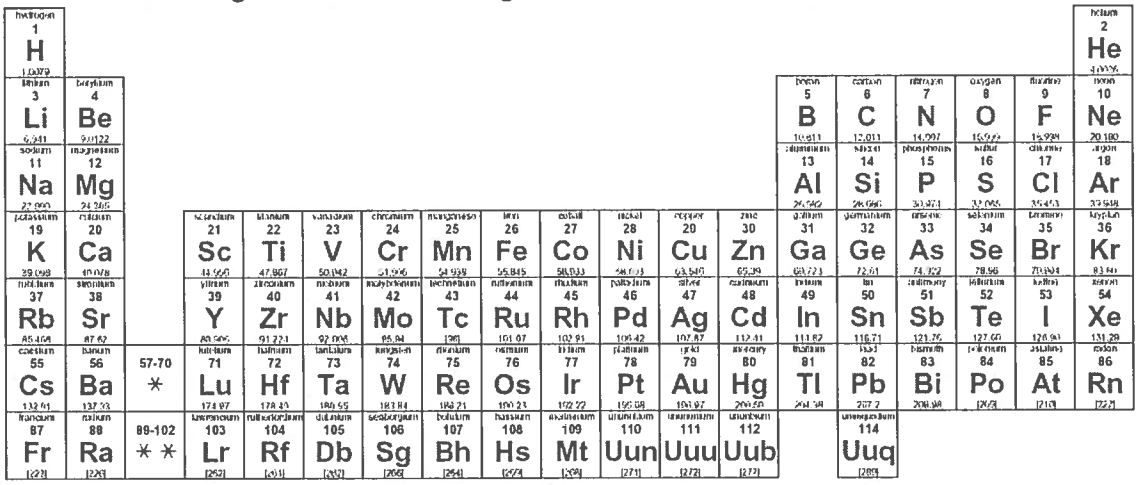
Student ID No. _____

Recitation Day/Time _____

Recitation TA (circle one) Thomas Carey, Adam Csakai, Jake Greenberg, Maria Kolber, Tim Rochelle, Mike Springer

Question	Score	Out of
1		40
2		40
3		15
4		10
5		20
6		15
7		12
8		18
9		30
10		(10 ec)
Total		200

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. Please put all your final answers on the test in pen, not pencil. 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.



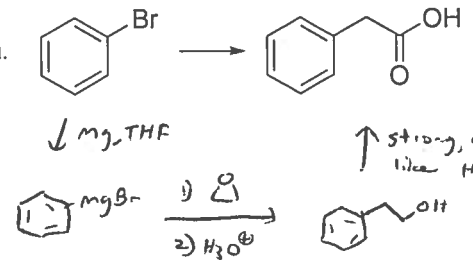
pKa Values

HI	-10	CH_3COOH	4.7	Phenol	10	H_2	35
HBr	-8	HN_3	4.7	RSH	10-12	NH_3	36
HCl	-6	H_2S	7.0	H_2O	15.7	$H_2C{=}CH_2$	45
H_3O^+	-1.7	NH_4^+	9.3	Alcohol (ROH)	16-18	CH_4	60
HF	3.2	HCN	9.4	HC≡CH	26		

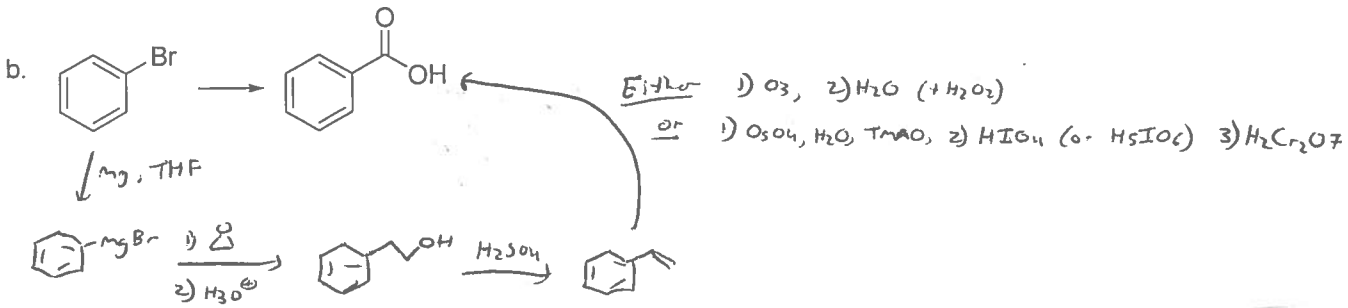
Average = 126.5
St Dev = 40.1
Max = 205
Min = 16

 Name_____

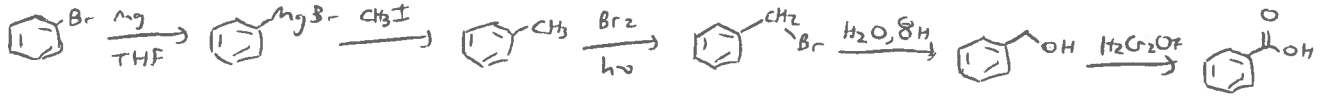
1) Find a way to synthesize the desired product from the given starting material. If more than one step is necessary, show the product of each step. Do not show mechanisms. (10 pts each)

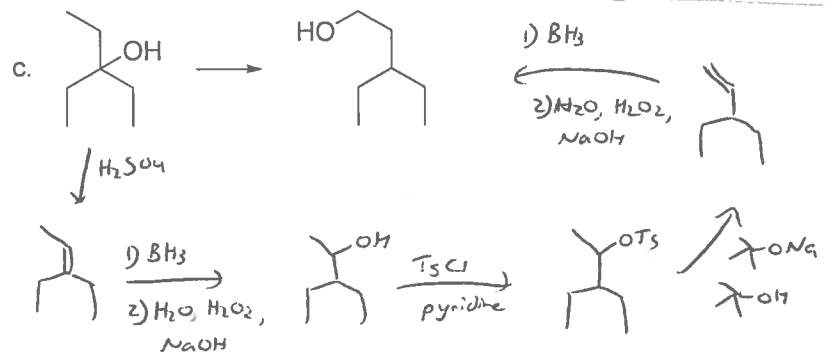
a. 

(Using the cuprate or the organolithium to attack the epoxide is also OK)

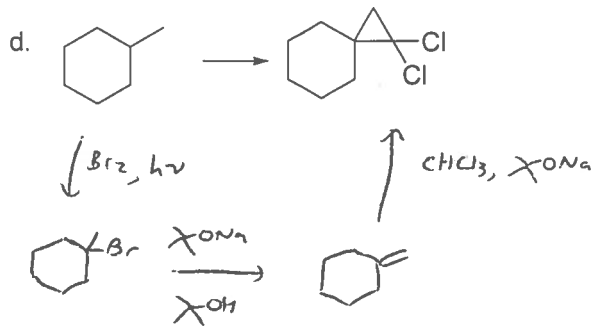
b. 

1st option

2nd option 

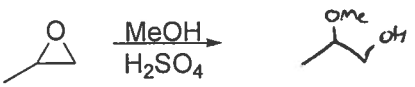
c. 

Note! either H_2SO_4 or tosylation/elimination is acceptable for the first elimination, but the second elimination must go by tosylation/elimination since it's anti-Zaitsev.

d. 

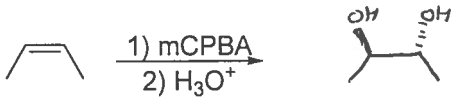
 Name_____

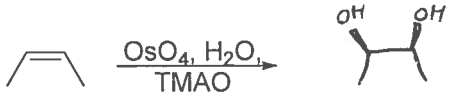
2) Predict the products of the following reactions. **Show stereochemistry for parts d and e.** (4 pts each)

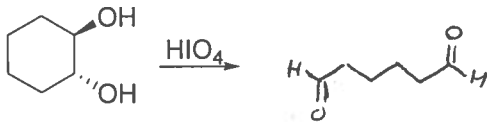
a. 

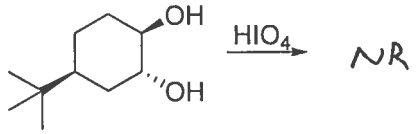
b. 

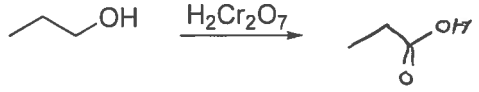
c. 

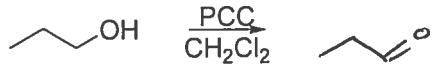
d. 

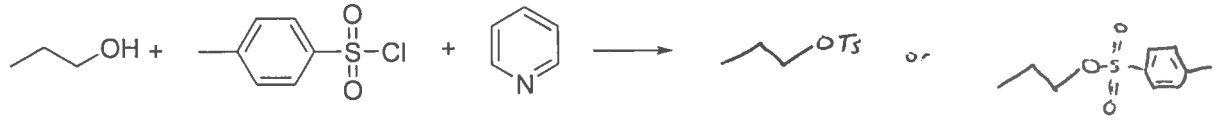
e. 

f. 

g. 

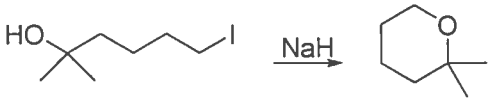
h. 

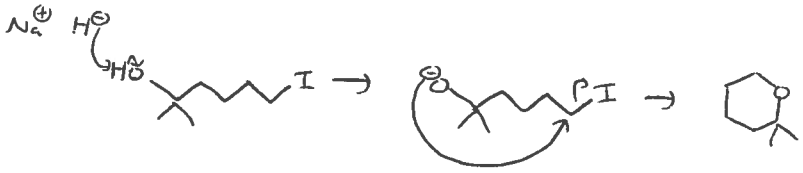
i. 

j. 

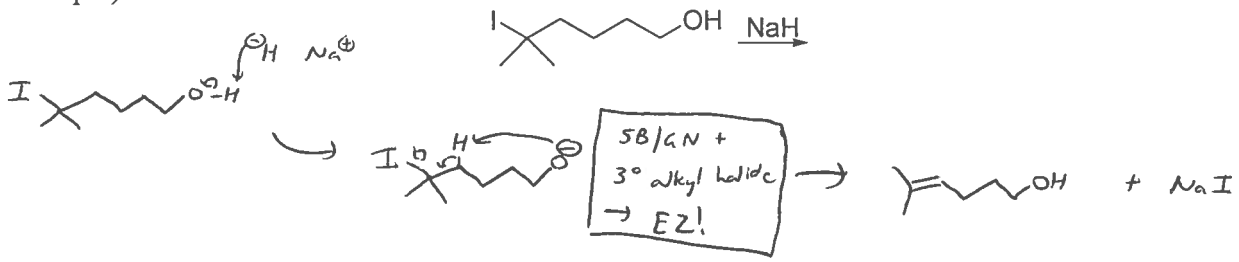
 Name_____

3) Williamson Ether Synthesis:
   a. Write an arrow-pushing mechanism for the reaction shown below. (4 pts)

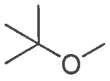


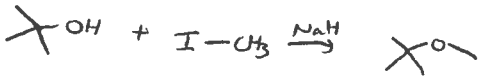


   b. Predict the product of the following reaction, and show a mechanism for its formation. (6 pts)



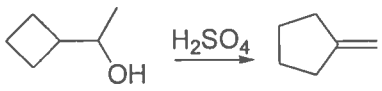
   c. How would you synthesize the following ether from any alcohol and any alkyl halide? (5 pts)





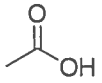
 Name_____

4) Write an arrow-pushing mechanism for the reaction shown below. (10 pts)



Note: this is one case where multiple successive rearrangements occur. This is only likely when each individual rearrangement increases stability - expanding a 2° C+ from a 4-membered ring to a 5-membered, and then going from 2° to 3° C+.

5) Write the names of the following functional groups. (2 pts each)



Carboxylic acid

aldehyde

ketone

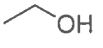
epoxide

alkene

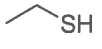
alkyne

ether

sulfide



alcohol

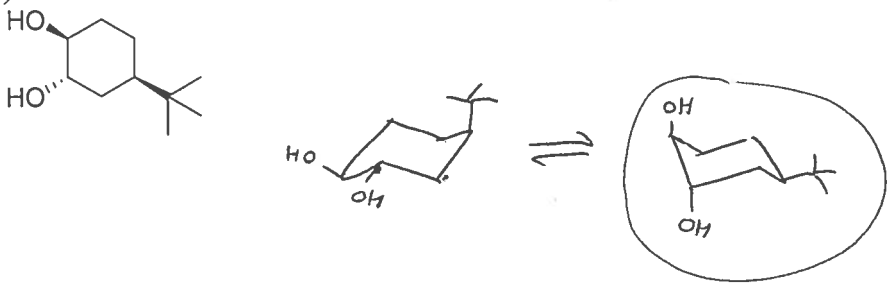


thiol or mercaptan.

 Name_____

6) Draw the following molecules in **both** chair conformations, and circle the most stable. (5 pts each)

a.



b.

c.

7) For each of the following acid-base reactions, say whether the reactants or products are favored, and identify the HOMO and LUMO if each reaction were to take place. (3 pts each)

a. $HI + MeS^- \rightleftharpoons I^- + MeSH$

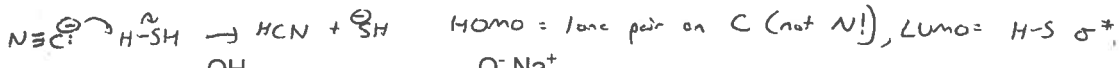
pKa = -10 pKa = 10-12 Product is favored

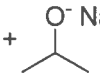
b. $CH_3COO^- + CH_4 \rightleftharpoons CH_3COOH + CH_3^-$

pKa = 60 pKa = 4.7 Reactants are favored.

c. $HSH + CN^- \rightleftharpoons HS^- + HCN$

pKa = 7.0 pKa = 9.4 Products are favored.

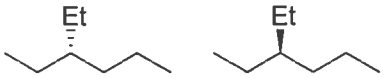


d. $NaH +$  $\rightleftharpoons H_2 +$ 

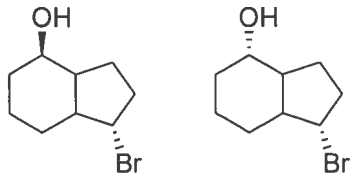
pKa = 16-18 pKa = 35 Products are favored.

 Name_____

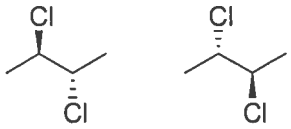
8) **Parts a – d:** Describe each of the following pairs of molecules as identical, enantiomers, diastereomers, or constitutional isomers. (2 pts per pair)

a. 

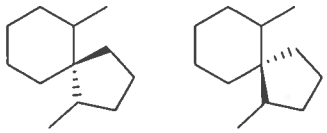
Identical (no stereocenters!)

b. 

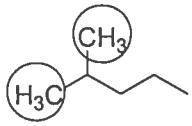
Diastereomers

c. 

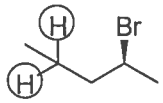
Identical (meso)

d. 
Enantiomers

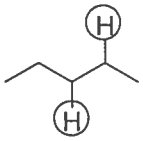
Parts e – g: Describe each of the following groups as homotopic, enantiotopic, diastereotopic, or constitutionally nonequivalent. (2 pts each)

e. 

Enantiotopic

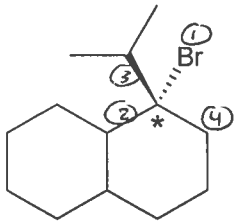
f. 

Diastereotopic

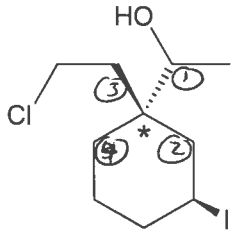
g. 

Constitutionally nonequivalent.

Parts h-j: Describe each molecule as R or S at the stereocenter labeled with a *. (2 pts each)

h. 

S

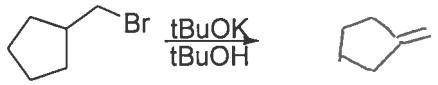
i. 

R

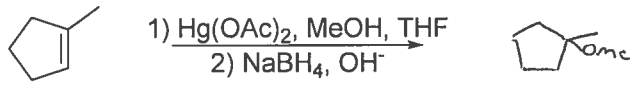
 Name_____

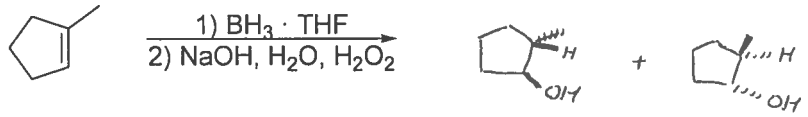
9) Predict the products of the following reactions, showing stereochemistry if necessary. If more than one stereoisomer is produced, show all compounds. (3 pts each)

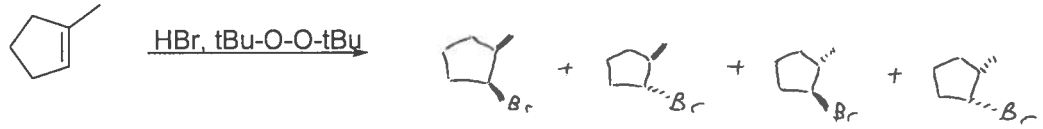
a. 

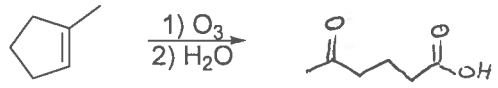
b. 

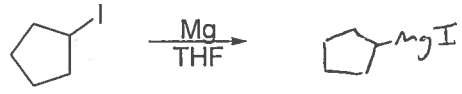
c. 

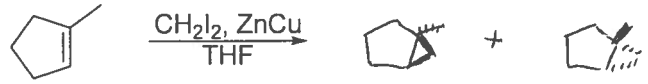
d. 

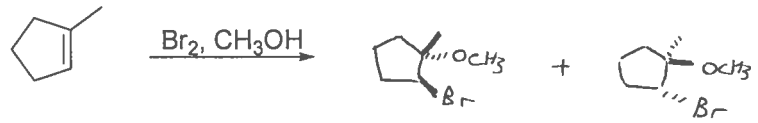
e. 

f. 

g. 

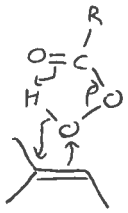
h. 

i. 

j. 

 Name_____

10) Extra credit! Write the mechanism for the following reaction. (10 pts extra credit)



or