

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.

Hydrogen 1 H (1.079)	Lithium 3 Li (6.941)	Boron 5 B (10.811)	Carbon 6 C (12.011)	Nitrogen 7 N (14.012)	Oxygen 8 O (16.000)	Fluorine 9 F (19.000)	Neon 10 Ne (20.180)
Magnesium 12 Mg (24.315)	Sodium 11 Na (22.989)	Aluminum 13 Al (26.982)	Phosphorus 15 P (30.973)	Sulfur 16 S (32.065)	Chlorine 17 Cl (35.453)	Argon 18 Ar (39.959)	Krypton 19 K (39.098)
Calcium 20 Ca (40.078)	Strontium 21 Sc (44.960)	Titanium 22 Ti (47.967)	Vanadium 23 V (50.942)	Chromium 24 Cr (51.966)	Manganese 25 Mn (54.938)	Iron 26 Fe (55.845)	Coobalt 27 Co (58.933)
Rubidium 37 Rb (85.464)	Yttrium 39 Y (88.902)	Zirconium 40 Zr (91.223)	Niobium 41 Nb (91.964)	Molybdenum 42 Mo (95.94)	Tantalum 43 Tc (101.07)	Ruthenium 44 Ru (101.07)	Rhenium 45 Rh (101.91)
Silver 47 Ag (107.87)	Ytterbium 48 Yb (131.291)	Rhenium 49 Re (161.966)	Rhenium 50 Ru (161.966)	Rhenium 51 Rh (162.966)	Rhenium 52 Rh (162.966)	Rhenium 53 Rh (162.966)	Rhenium 54 Xe (131.291)
Cesium 55 Cs (132.911)	Lanthanum 57 Lu (138.901)	Hafnium 71 Hf (174.07)	Tantalum 72 Ta (174.13)	Tungsten 73 W (180.55)	Rhenium 74 Re (182.71)	Rhenium 75 Os (183.21)	Rhenium 76 Ir (187.22)
Rhenium 77 Re (187.22)	Rhenium 78 Os (187.22)	Rhenium 79 Pt (190.28)	Rhenium 80 Au (191.97)	Rhenium 81 Hg (192.29)	Rhenium 82 Tl (194.94)	Rhenium 83 Pb (200.364)	Rhenium 84 Bi (201.364)
Rhenium 85 Po (213.191)	Rhenium 86 At (213.191)	Rhenium 87 Rn (222.191)					
Lanthanide series	La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb	Actinide series	Lanthanide series	Actinide series	Actinide series	Actinide series	Actinide series

Actinium 89 Ac (227)	Curium 90 Th (232.04)	Curium 91 Pa (231.04)	Curium 92 U (239.03)	Curium 93 Np (237)	Curium 94 Pu (241)	Curium 95 Am (243)	Curium 96 Cm (247)	Curium 97 Bk (247)	Curium 98 Cf (251)	Curium 99 Es (252)	Curium 100 Fm (251)	Curium 101 Md (254)	Curium 102 No (254)
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Average = 126.5

St Dev = 40.1

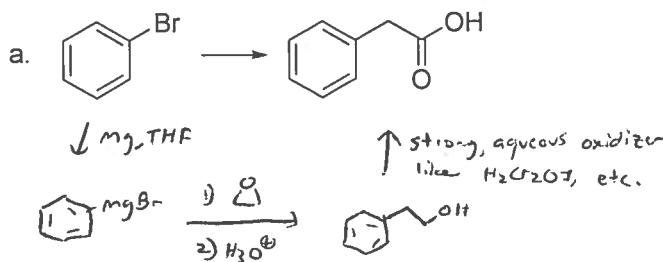
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Min = 16

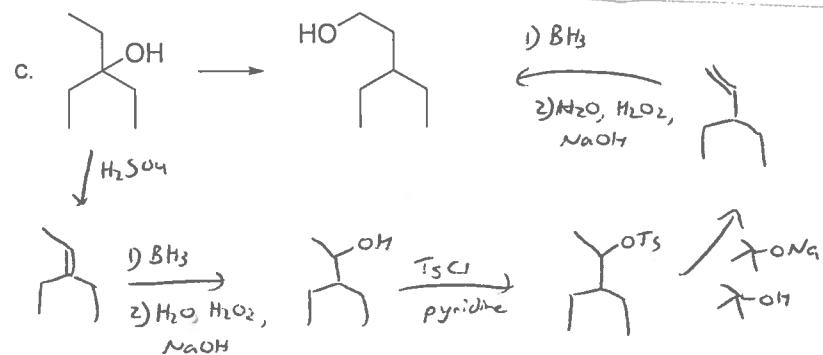
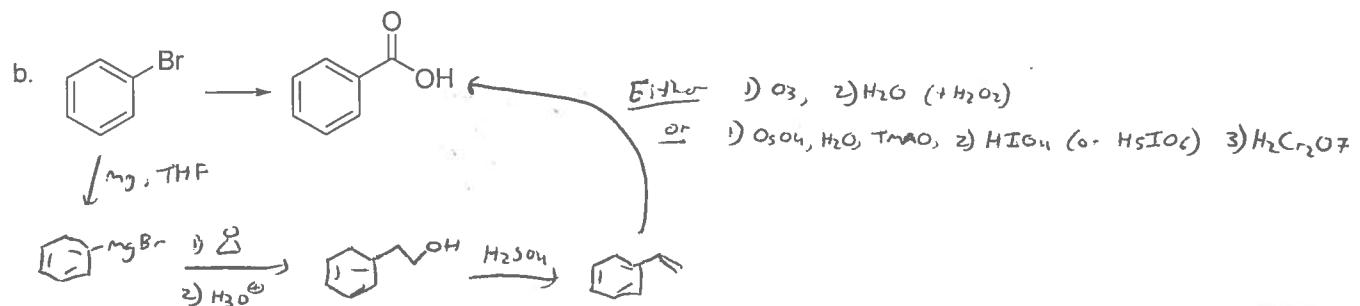
pKa Values

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

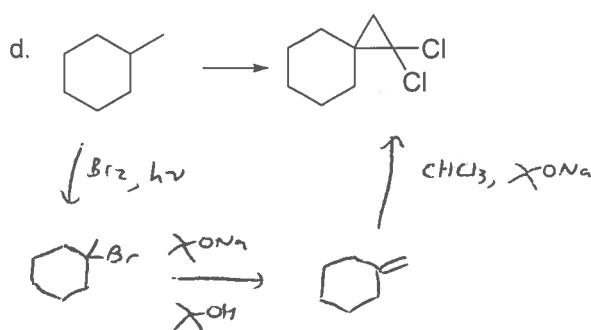
- 1) Find a way to synthesize the desired product from the given starting material. If more than one step is necessary, show the product of each step. Do not show mechanisms. (10 pts each)



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

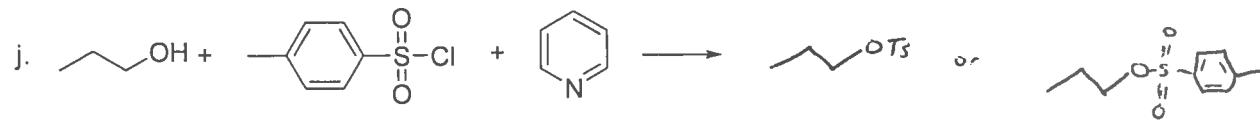
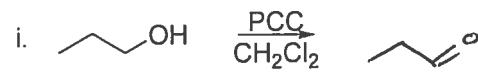
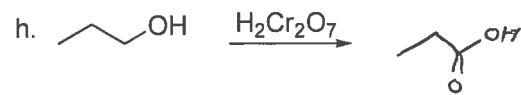
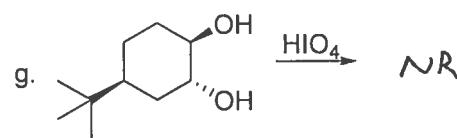
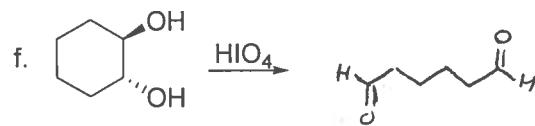
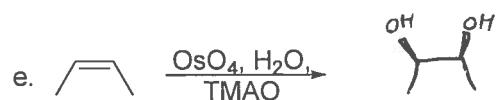
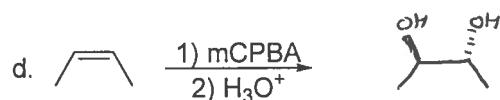
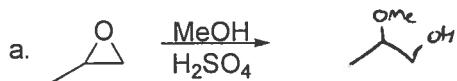


Note: either H2SO4 or tosylation/elimination is acceptable for the first elimination, but the second elimination must go by tosylation/elimination since it's anti-Zaitsev.



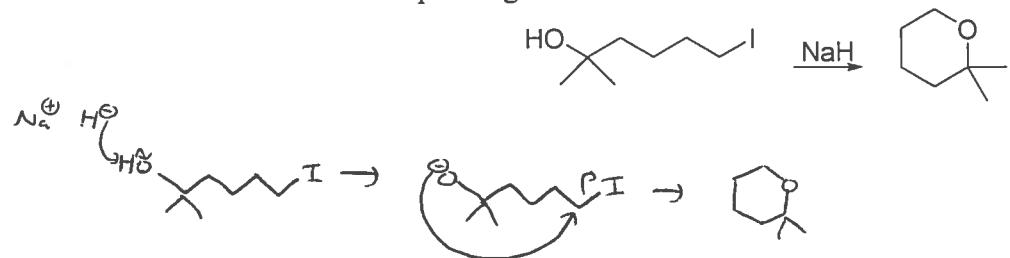
2) Predict the products of the following reactions. Show stereochemistry for parts d and e.

(4 pts each)

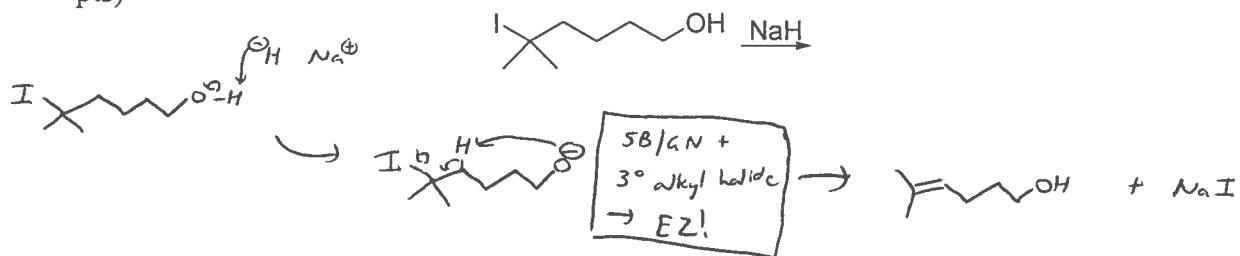


3) Williamson Ether Synthesis:

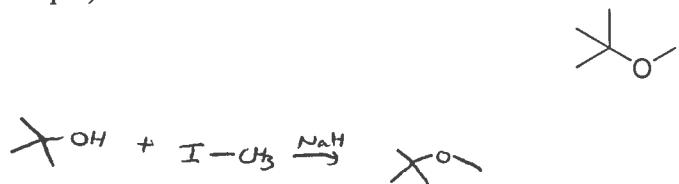
- a. Write an arrow-pushing mechanism for the reaction shown below. (4 pts)



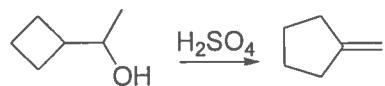
- b. Predict the product of the following reaction, and show a mechanism for its formation. (6 pts)



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

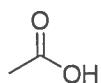


4) Write an arrow-pushing mechanism for the reaction shown below. (10 pts)



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

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



carboxylic acid



aldehyde



ketone



epoxide



alkene



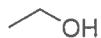
alkyne



ether



sulfide

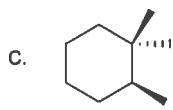
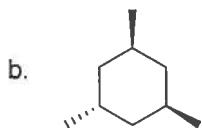
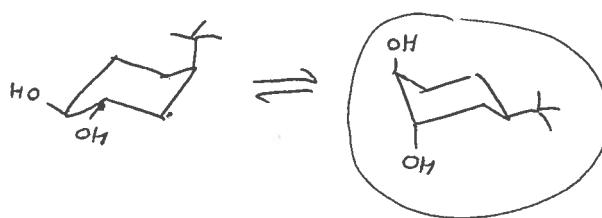
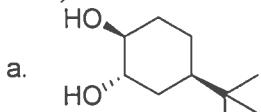


alcohol

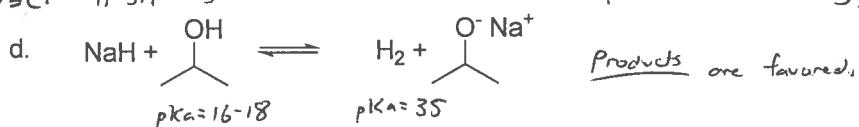
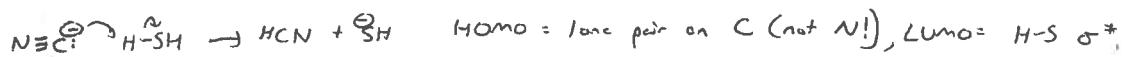
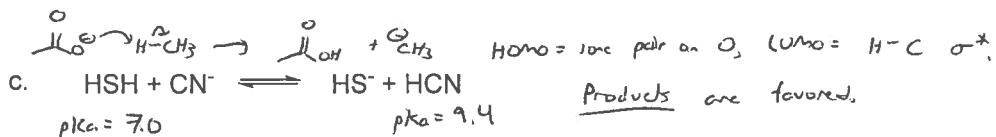
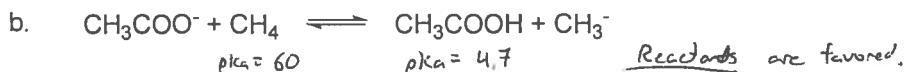
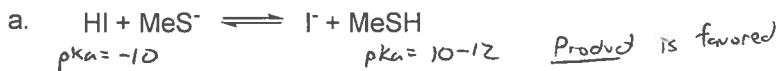


thiol or
mercaptan

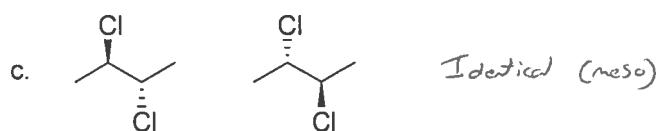
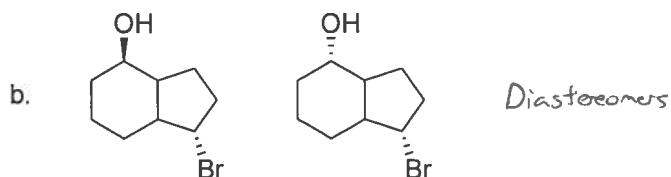
- 6) Draw the following molecules in **both** chair conformations, and circle the most stable. (5 pts each)



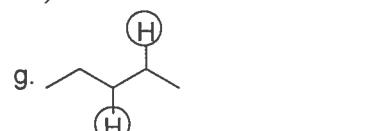
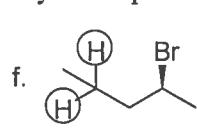
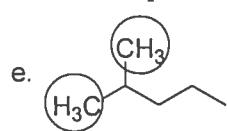
- 7) For each of the following acid-base reactions, say whether the reactants or products are favored, and identify the HOMO and LUMO if each reaction were to take place. (3 pts each)



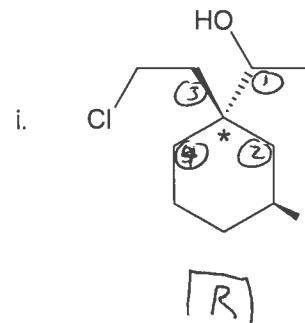
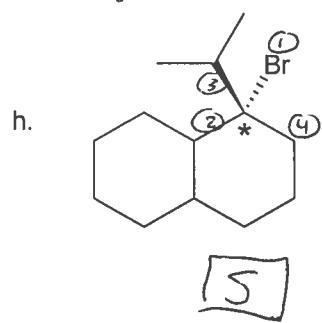
8) Parts a – d: Describe each of the following pairs of molecules as identical, enantiomers, diastereomers, or constitutional isomers. (2 pts per pair)



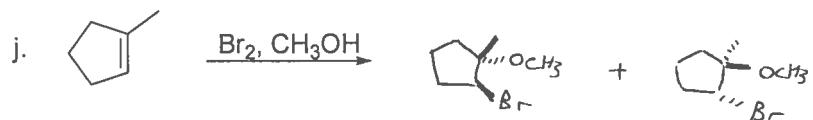
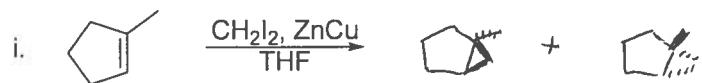
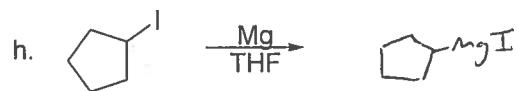
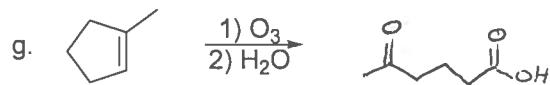
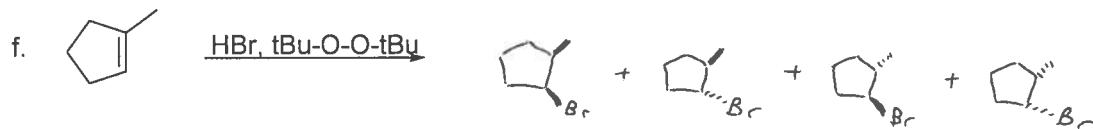
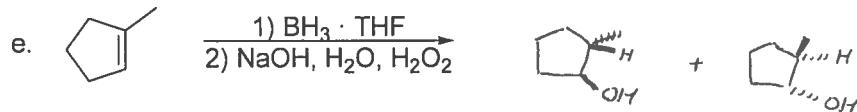
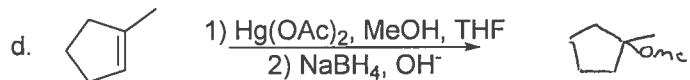
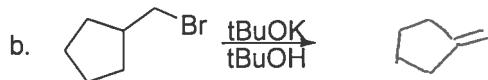
Parts e – g: Describe each of the following groups as homotopic, enantiotopic, diastereotopic, or constitutionally nonequivalent. (2 pts each)



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



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)



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

