

# CHEM 3311 (Richardson) Final Exam – May 11, 2017

Your Name \_\_\_\_\_

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

- Recitation Time  8:00 Wednesday w/ Josh Kamps  
 2:00 Wednesday w/ Josh Kamps  
 10:00 Thursday w/ Brendan Griffiths  
 11:00 Thursday w/ Brendan Griffiths  
 12:00 Friday w/ Brendan Griffiths

Question	Score	Out of
1		40
2		30
3		45
4		15
5		15
6		35
7		20
8		10 e.c.
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. 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 1.0079																			helium 2 He 4.0026						
lithium 3 Li 6.941	beryllium 4 Be 9.0122																			boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305																			aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078																			gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.90
rubidium 37 Rb 85.468	strontium 38 Sr 87.62																			indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
cesium 55 Cs 132.91	barium 56 Ba 137.33	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04					thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]					unennium 111 Uue [272]	unununium 112 Uub [277]	ununbium 113 Uub [283]	ununtrium 114 Uut [289]		

\* Lanthanide series

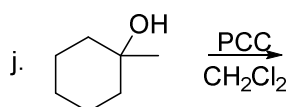
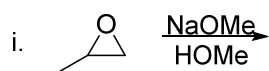
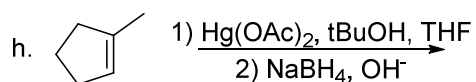
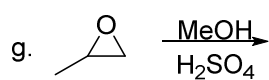
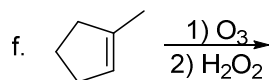
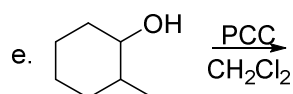
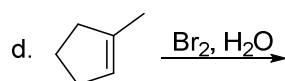
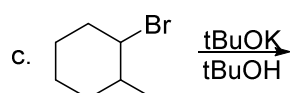
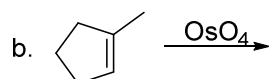
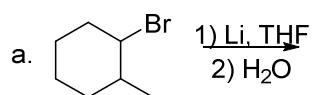
lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
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\*\* Actinide series

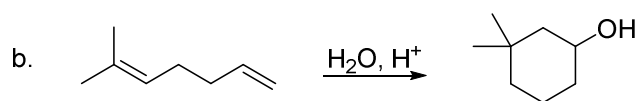
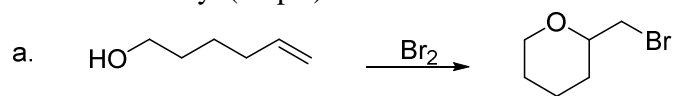
## pKa Values

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		

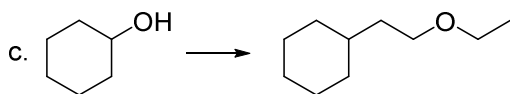
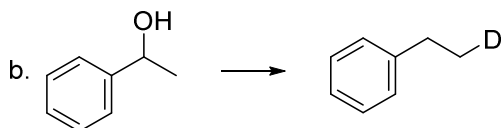
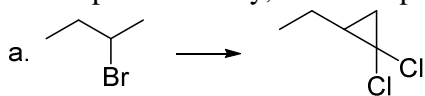
- 1) **Predict the product** of the following reactions, and **choose the appropriate descriptor** (reduction, oxidation, or neither) for what happens to the organic molecule during each reaction. You do not need to show stereochemistry. (40 pts)



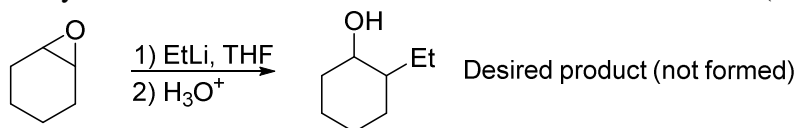
2) Show a reasonable arrow-pushing mechanism for these reactions, including stereochemistry where necessary. (30 pts)



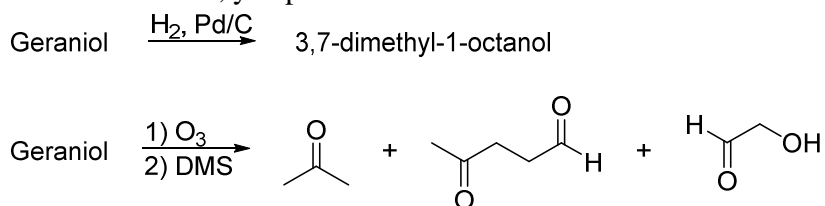
3) Find a way to synthesize the desired product from the given starting material. If more than one step is necessary, show the product of each step. Do not show mechanisms. (45 pts)



- 4) A student performed the reaction below, hoping to synthesize the desired product. What product was actually formed instead? Show a mechanism for its formation. (15 pts)



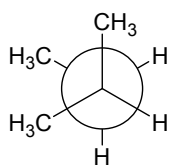
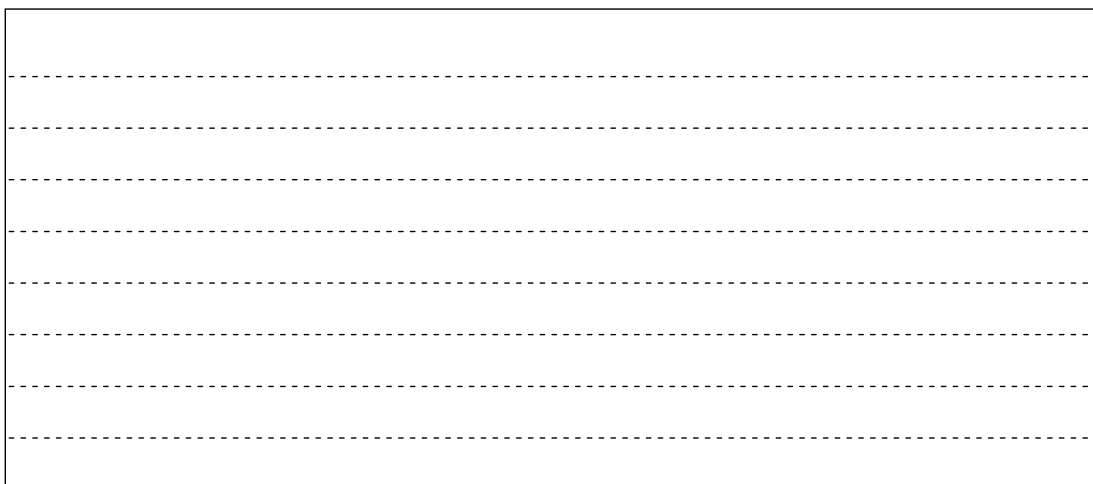
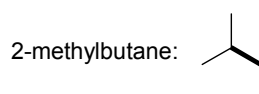
- 5) You have found a mysterious bottle in your lab bench labeled "Geraniol – C<sub>10</sub>H<sub>18</sub>O". In an attempt to discover its structure, you perform a few reactions and observe the following results.



What is the structure of geraniol? (15 pts)

- 6) The structure of 2-methylbutane is shown below. Sighting along the C2-C3 bond (shown in bold), show a Newman projection for the molecule for dihedral angles in increments of  $60^\circ$ . **Keep the front atom stationary and rotate the back atom clockwise.** For each conformation, plot these energy levels and create a conformational energy diagram. You do not need to calculate the exact energy for each level – a rough estimate is acceptable. (35 pts)

Interaction	Energy (kcal/mol)
H/H eclipsed	1
CH <sub>3</sub> /H eclipsed	1.15
CH <sub>3</sub> /CH <sub>3</sub> eclipsed	3.6
CH <sub>3</sub> /CH <sub>3</sub> gauche	0.67



Interactions:

2 x  
CH<sub>3</sub>/CH<sub>3</sub>  
gauche

Interactions:

Interactions:

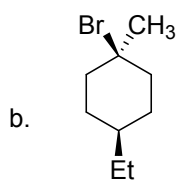
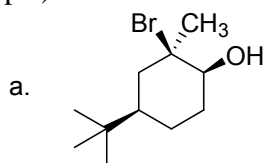
Interactions:

Interactions:

Interactions:

Interactions:

- 7) Draw the following molecules in **both** chair conformations, and circle the most stable. (20 pts)



- 8) Extra credit! Describe the following pairs of molecules as homomers, enantiomers, diastereomers, or constitutional isomers. (10 pts e.c.)

