

CHEM 3311 (Richardson) Final Exam – May 7, 2015

Your Name _____

Student ID _____

Recitation Time 12:00 Monday, 1:00 Monday,
11:00 Tuesday, 1:00 Tuesday,
12:00 Wednesday

Question	Score	Out of
1		20
2		20
3		30
4		30
5		30
6		20
7		20
8		10
9		20
10		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																				neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305																				argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078																				krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62																				xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *																			radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 * *																			
			scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	seelenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80			
			yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	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			
			lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	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]			
			lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununium 111 Uuu [273]	unbibium 112 Uub [277]		ununquadium 114 Uuq [289]							

* Lanthanide series

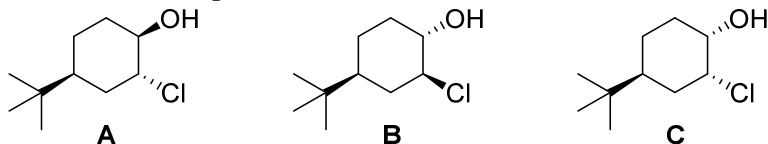
lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 151.96	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
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]	mendeleevium 101 Md [258]	nobelium 102 No [259]

** Actinide series

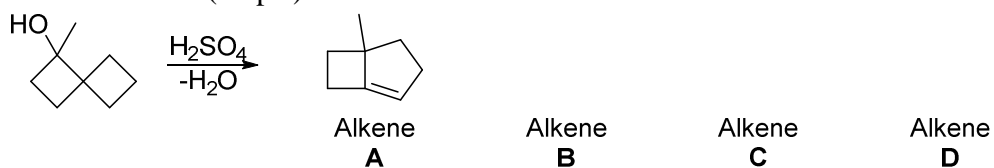
pKa Values

HI	-10	CH ₃ COOH	4.7	Phenol (PhOH)	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		

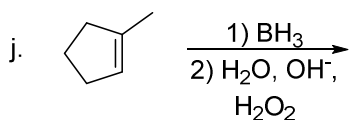
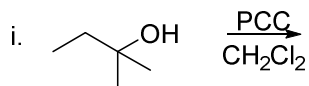
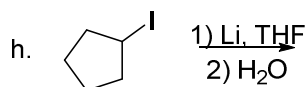
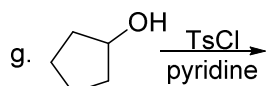
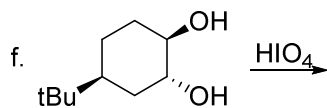
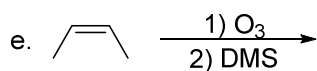
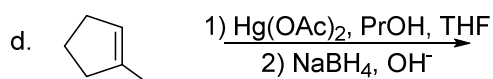
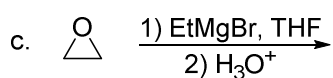
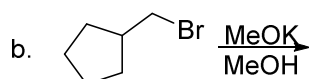
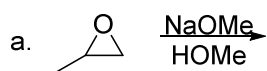
- 1) The three compounds below were reacted with NaH in an attempt to form a neutral product. One reacted very quickly, one reacted very slowly, and one did not react at all. Which is which? Show the product that each compound formed, or write NR if no reaction occurred. (20 pts)



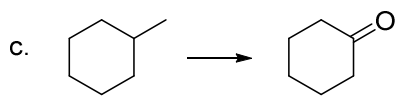
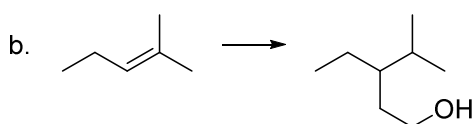
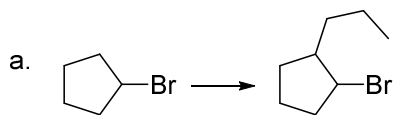
- 2) The reaction conditions shown below produces a mixture of four different alkenes. Show the structures of these alkenes (one has already been provided), and show the mechanism for the formation of alkene A. (20 pts)



3) **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. If no reaction occurs then write NR. (30 pts - 3 pts each)



4) 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. (30 pts - 10 pts each)



6) Rank each group of molecules by increasing heat of formation and explain the reason for the ordering in under twenty words per group. (20 pts)

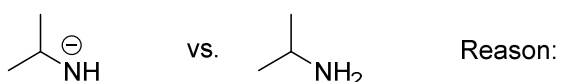
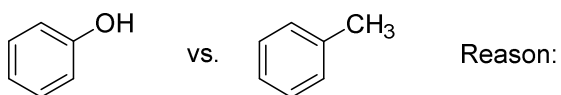
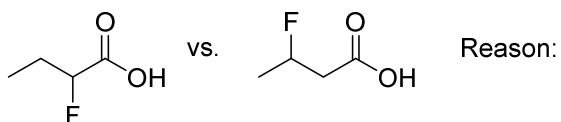
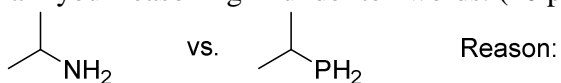
a. Methylcyclopentane, cyclohexane, 1,1-dimethylcyclobutane

b. *cis*-2-butene, *trans*-2-butene, 1-butene

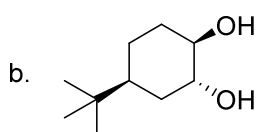
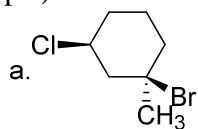
c. Hexane, propane, butane

d. *cis*-2-hexene, 2,2-dimethylbutene, 2-methyl-2-pentene

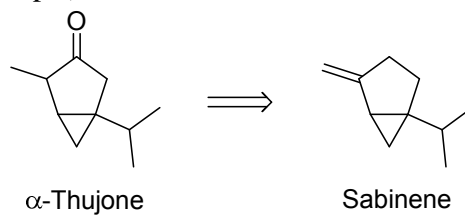
7) For each pair of compounds shown below, select the more acidic of the two compounds and explain your reasoning in under ten words. (20 pts)



- 8) Draw the following molecules in **both** chair conformations, and circle the most stable. (10 pts)



- 9) α -Thujone is a monoterpene that was once believed to be responsible for the psychedelic effects of absinthe. Although it is typically isolated directly from wormwood, it can also be synthesized from similar precursors, including sabinene. Show the steps necessary to do this, ignoring stereochemistry. (20 pts)



- 10) Extra credit! In the previous problem, there was one step where three different elimination products could potentially form, but two of those products were disfavored. What are these products, and why is each of them disfavored? (10 pts extra credit)