

CHEM 3311 (Richardson) Third Exam – Nov. 27, 2018

Your Name: _____

Student ID: _____

- Recitation (check one) O 10:00 Mon (Shafer Soars)
 O 11:00 Mon (Matthew Farmer) O 1:00 Mon (Lacey Wayment)
 O 2:00 Mon (Shaofeng Huang) O 3:00 Mon (Shaofeng Huang)
 O 9:00 Tue (Lacey Wayment) O 10:00 Tue (Josh Kamps)
 O 12:00 Tue (Josh Kamps) O 2:00 Tue (Lauren Bodkin)
 O 3:00 Tue (Lauren Bodkin) O 4:00 Tue (Matthew Farmer)

Question	Score	Out of
1		15
2		20
3		20
4		10
5		10
6		10
7		15
8		10 e.c.
Total		100

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	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	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80	rubidium 37 Rb 85.468	strontium 38 Sr 87.62	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
cesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	wolfram 74 W 183.84	reynoldsium 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]	francium 87 Fr [223]	radium 88 Ra [226]	89-102 * *	lawrencium 103 Lr [263]	rutherfordium 104 Rf [261]	dubnium 105 Db [263]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [265]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununium 111 Uuu [272]	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 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
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]

* * Actinide series

pKa Values

HI	-10	CH ₃ COOH	4.7	ArOH	10	HC≡CH	26
HBr	-8	HN ₃	4.7	RSH	10-12	H ₂	35
HCl	-6	H ₂ S	7.0	H ₂ O	15.7	NH ₃	36
H ₃ O ⁺	-1.7	NH ₄ ⁺	9.3	ROH (R=alkyl)	16-18	H ₂ C=CH ₂	45
HF	3.2	HCN	9.4	O=C-CH (α H)	9-25	CH ₄	60

- 1) For each of the following pairs of reactions, circle the one that would be faster at S_N2 and explain why in under ten words. If both are equal, do not circle an option. (15 pts; 3 pts each)



- 2) Structure and reactivity. For parts b. and c., if a reaction forms a racemic mixture that contains the target compound plus its enantiomer, that is an acceptable answer. (20 pts total)

- a. Draw each of the following compounds. (2 pts each)

(1R,2R)-2-methylcyclopentanol

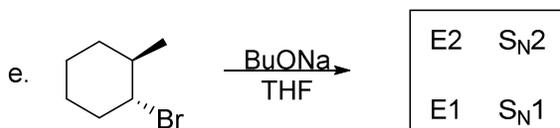
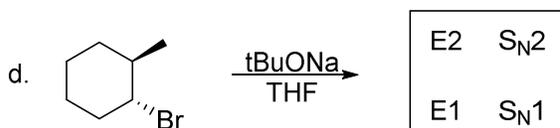
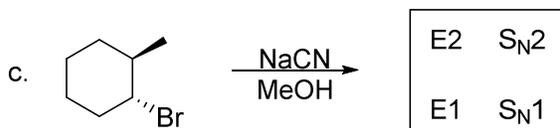
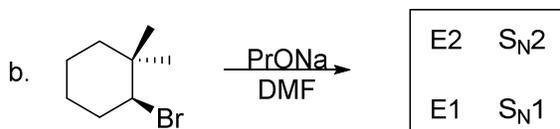
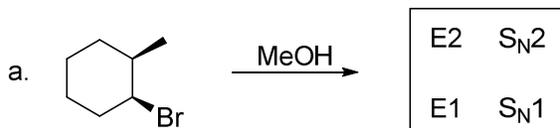
1-methylcyclopentanol

(1R,2S)-2-methylcyclopentanol

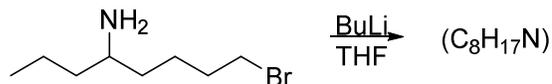
(R)-2-butanol

- b. Which of these can be formed as the only major product of hydroboration-oxidation on any alkene of your choice? Show the overall reaction for their formation from this alkene. (6 pts)
- c. Which of these can be formed as the only major product of oxymercuration-reduction on any alkene of your choice? Show the overall reaction for their formation from this alkene. (6 pts)

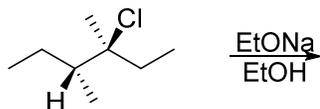
- 3) For each of the reactions shown below, **circle the mechanism(s)** you would expect to see, if any, and **draw the product(s)**. If a product has stereocenters, show its configuration using wedges and dashes. If two stereoisomers are formed, show both of them. If an elimination occurs, show only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



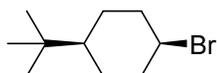
- 4) Show the product of this reaction and the mechanism for its formation. (10 pts)



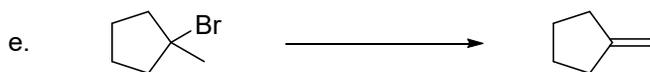
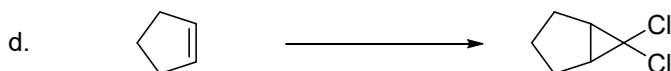
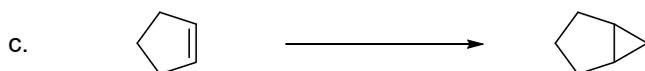
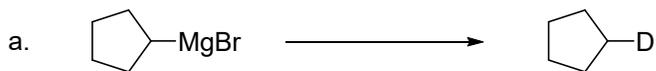
- 5) Predict the product of the reaction below, including E/Z stereochemistry. Explain the stereochemical outcome in under thirty words, but with as many structures as you need. (10 pts)



- 6) One of these molecules undergoes E2 elimination much faster than the other. Circle the faster molecule and explain why it is faster in under thirty words, but with as many structures as you need. (10 pts)



7) On each arrow, show the reagents needed to accomplish each reaction. In each case, the target product should be the major product of the reaction. (15 pts – 3 pts each)



8) Extra credit! In your lab, you have found a mysterious bottle labeled “Compound **A** - achiral alkyl halide $C_{10}H_{17}Br$.” In an attempt to discover its structure, you react it with KOH in ethanol and form two products (**B** and **C**), each with formula $C_{10}H_{16}$. Compound **A** rapidly undergoes solvolysis in aqueous ethanol. Ozonolysis of **A** followed by treatment with DMS gives $(CH_3)_2C=O$ (acetone) as one of the products plus an unidentified halogen-containing material. Catalytic hydrogenation of either **B** or **C** gives a mixture of both *trans*- and *cis*-1-isopropyl-4-methylcyclohexane. Compound **A** reacts with one equivalent of Br_2 to give a mixture of two separable compounds, **D** and **E**, both of which are achiral. Finally, ozonolysis of **B** followed by treatment with aqueous H_2O_2 gives acetone and compound **F**, shown below. Draw compounds **A** through **E**. (10 pts extra credit)

