

CHEM 3311 (Richardson) Third Hour Exam – April 18, 2017

Your Name

Key

Student ID

Recitation Time (check one)

- ☐ 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		15
2		15
3		9
4		16
5		25
6		20
7		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 1.00794																		Helium 2 He 4.00260																																							
Lithium 3 Li 6.941		Beryllium 4 Be 9.0122																																																							
Sodium 11 Na 22.990		Magnesium 12 Mg 24.305																																																							
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 65.38		Gallium 31 Ga 69.723		Germanium 32 Ge 72.63		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 127.6		Iodine 53 I 126.91		Xenon 54 Xe 131.29																							
Cesium 55 Cs 132.91		Barium 56 Ba 137.33		57-70 * Lanthanum 57 La 138.91 Cerium 58 Ce 140.12 Praseodymium 59 Pr 140.91 Neodymium 60 Nd 144.24 Promethium 61 Pm 144.91 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 173.05		Lanthanum 71 Lu 174.97		Cerium 72 Hf 178.49		Praseodymium 73 Ta 180.95		Neodymium 74 W 183.84		Promethium 75 Re 186.21		Samarium 76 Os 190.23		Europium 77 Ir 192.22		Gadolinium 78 Pt 195.08		Terbium 79 Au 196.97		Dysprosium 80 Hg 200.59		Holmium 81 Tl 204.38		Erbium 82 Pb 207.2		Ytterbium 83 Bi 208.98		Lanthanum 84 Po 209		Cerium 85 At 210		Promethium 86 Rn 222																					
Francium 87 Fr 223		Radium 88 Ra 226				Actinium 89 Ac 227		Thorium 90 Th 232		Protactinium 91 Pa 231		Uranium 92 U 238		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		Lawrencium 103 Lr 262		Rutherfordium 104 Rf 261		Dubnium 105 Db 262		Seaborgium 106 Sg 266		Bohrium 107 Bh 264		Hassium 108 Hs 277		Meitnerium 109 Mt 268		Darmstadtium 110 Ds 271		Roentgenium 111 Rg 272		Copernicium 112 Cn 285		Livermorium 114 Lv 293		Tennessine 115 Ts 294	

* Lanthanide series

- Actinide series

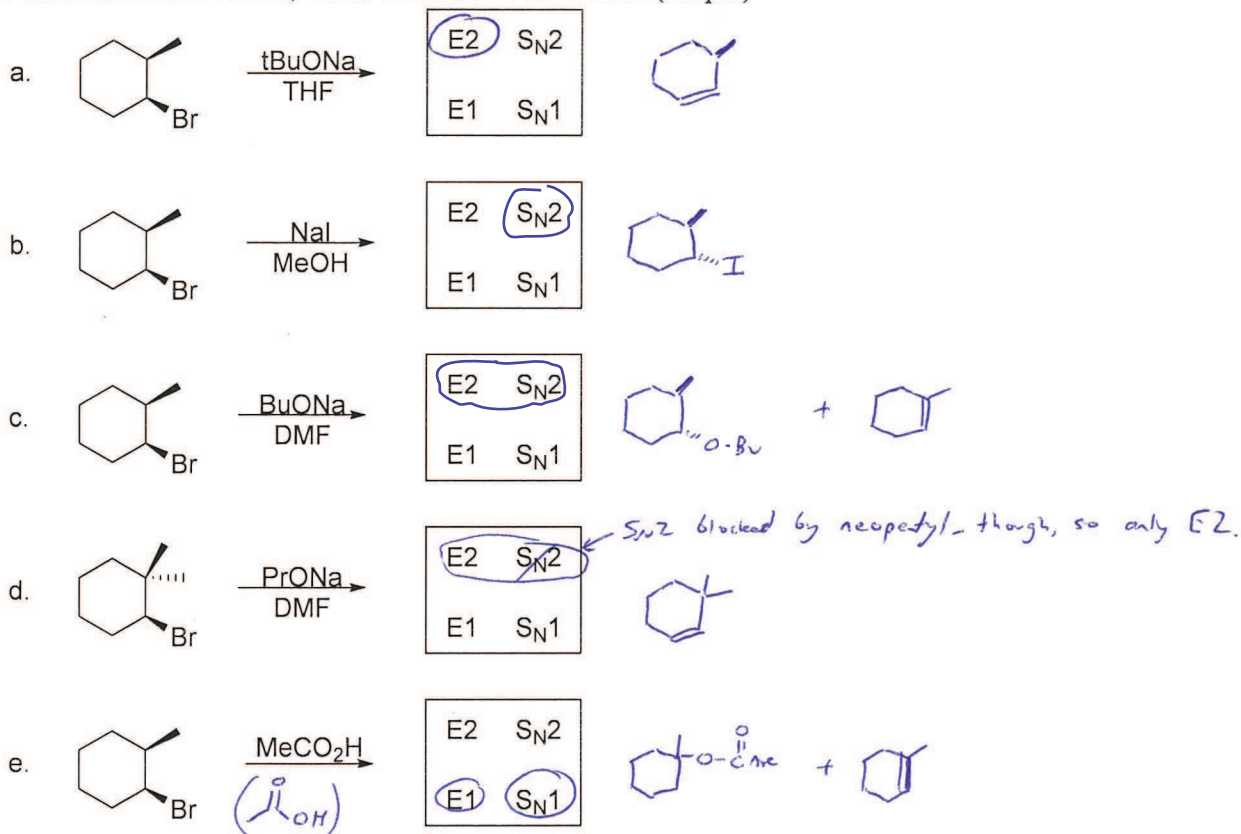
57 La lanthanum	58 Ce cerium	59 Pr praseodymium	60 Nd neodymium	61 Pm promethium	62 Sm samarium	63 Eu europium	64 Gd gadolinium	65 Tb terbium	66 Dy dysprosium	67 Ho holmium	68 Er erbium	69 Tm thulium	70 Yb ytterbium
71 Lu lutetium	72 Hf hafnium	73 Ta tantalum	74 W tungsten	75 Re rhenium	76 Os osmium	77 Ir iridium	78 Pt platinum	79 Au gold	80 Hg mercury	81 Tl thallium	82 Pb lead	83 Bi bismuth	84 Po polonium
89 Ac actinium	90 Th thorium	91 Pa protactinium	92 U uranium	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium

pKa Values

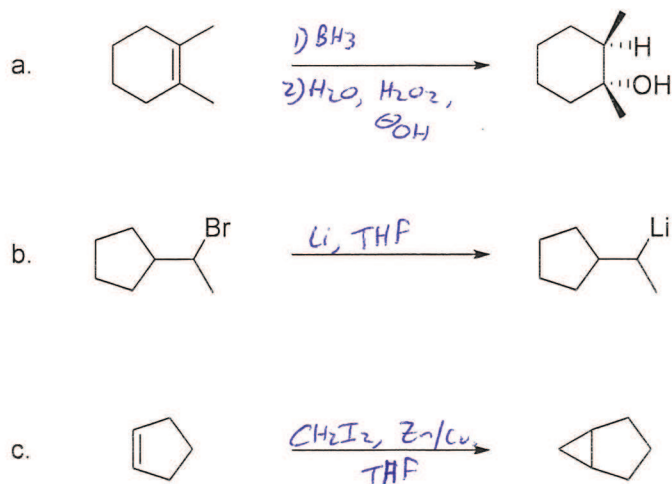
HI	-10	CH ₃ COOH	4.7	ArOH	10	H ₂	35
HBr	-8	HN ₃	4.7	RSH	10-12	NH ₃	36
HCl	-6	H ₂ S	7.0	H ₂ O	15.7	H ₂ C=CH ₂	45
H ₃ O ⁺	-1.7	NH ₄ ⁺	9.3	ROH (R=alkyl)	16-18	CH ₄	60
HF	3.2	HCN	9.4	HC≡CH	26		

Average: 81.8
St. Dev: 16.2
Max: 110
Min: 44

- 1) 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. (15 pts)



- 2) Each of these reactions can be done in a single-step synthesis. On each arrow, show the reagents needed to accomplish each one. In each case, the target product should be the only major product of the reaction. (15 pts)



- 3) For each of the following groups of molecules, circle the one with the highest boiling point and explain why it is higher in under ten words. (9 pts)

a. 1,6-hexanediol; 1,4-dimethoxybutane; 3-propoxy-1-propanol

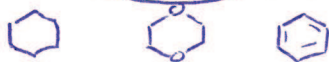


More OH groups = more H-bonding

1 pt for circle

2 pts for explanation

b. cyclohexane; dioxane; benzene



More dipoles = stronger intermolecular forces

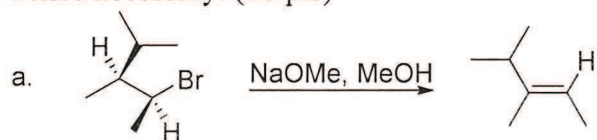
c. 2,5-dimethylhexane; octane; 2,2,3,3-tetramethylbutane



More surface area = stronger intermolecular forces

- 4) Show a reasonable arrow-pushing mechanism for these reactions, including stereochemistry where necessary. (16 pts)

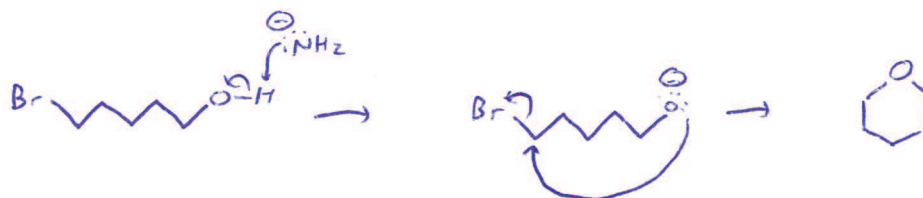
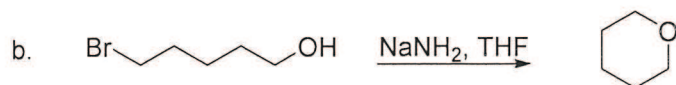
8 pts each



Redraw as antiplanar



-4 if stepwise

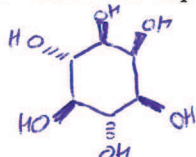


-3 if Br leaves first

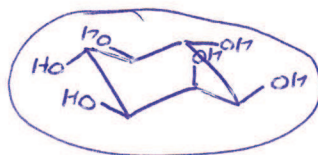
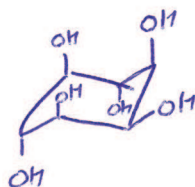
-4 if one step.

- 5) Inositol, or 1,2,3,4,5,6-cyclohexanehexol, is a chemical compound with formula $C_6H_{12}O_6$. Inositol has nine different possible stereoisomers. One specific stereoisomer of inositol, *myo*-inositol, is a sugar alcohol that serves several important biological purposes and is also commonly used as a stand-in for cocaine in movies. Its IUPAC name is *cis*-1,2,3,5-*trans*-4,6-cyclohexanehexol (this indicates that the OH groups on carbons 1,2,3, & 5 are all on the same face of the ring as each other, and the OH groups on carbons 4 & 6 are on the other face). Answer these questions about the molecule. (25 pts total)

a. Draw the top-down view of *myo*-inositol, including stereochemistry. (5 pts)



b. Draw both chair conformations of *myo*-inositol and circle the more stable one. (12 pts)

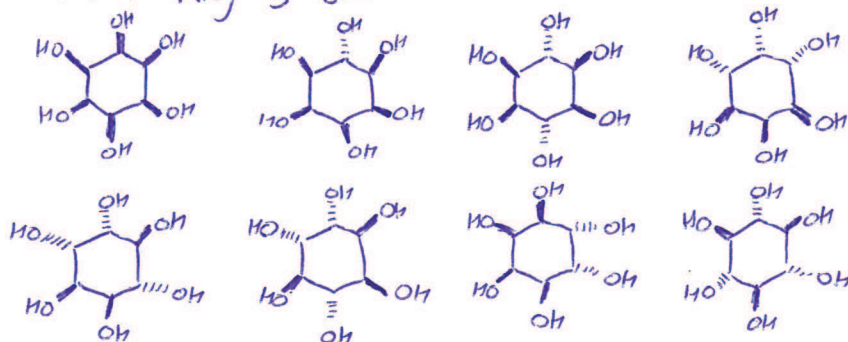


Structures: 5 pts each
Stability: 2 pts

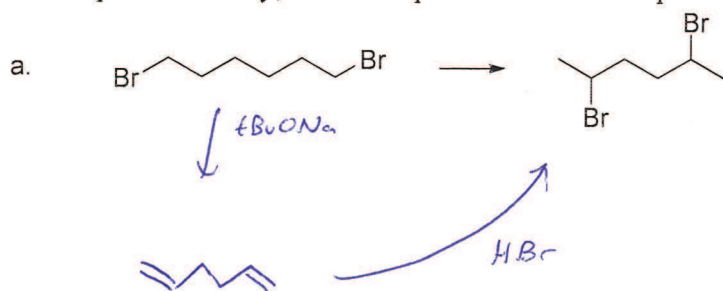
c. *myo*-Inositol is very soluble in water for an organic molecule. What intermolecular force is responsible for this property? (3 pts)

Hydrogen bonding

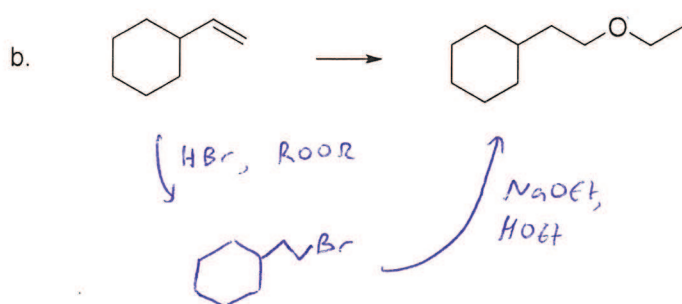
d. Draw five other distinct stereoisomers of inositol. Do not show any duplicate structures. (5 pts) Any 5 of:



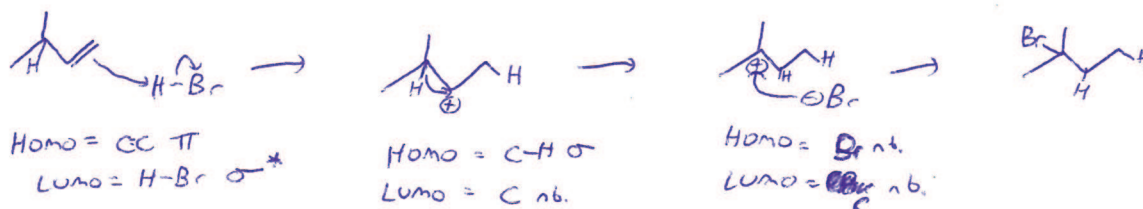
- 6) Find a way to synthesize the desired product from the given starting material. If more than one step is necessary, show the product of each step. Do not show mechanisms. (20 pts)



-4 for using ROOR in 2nd step



- 7) Extra credit! Draw the mechanism for the reaction of 3-methyl-1-butene with HBr (showing the major product only), and identify the HOMO and LUMO of each step. (10 pts e.c.)



For each step: 1 pt for arrows, 1 for HOMO, 1 for LUMO
1 pt for correct structure.