

CHEM 3311 (Richardson) First Hour Exam – February 9, 2016

Your Name _____

Student ID _____

- Recitation Time O 3:00 Monday w/ Blaine McCarthy
 (check one) O 11:00 Tuesday w/ Thomas Carey
 O 1:00 Wednesday w/ Garrett Cairo
 O 8:00 Thursday w/ Blaine McCarthy
 O 3:00 Thursday w/ Garrett Cairo

Question	Score	Out of
1		20
2		15
3		12
4		8
5		21
6		12
7		12
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.

hydrogen 1 H 1.0079															helium 2 He 4.0026			
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 65.39	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	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906	niobium 41 Nb 92.906
cesium 55 Cs 132.91	barium 56 Ba 137.33																	
francium 87 Fr [223]	radium 88 Ra [226]	57-70 *	lutetium 71 Lu [175]	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	wolfram 74 W 183.84	reinerium 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]
		89-102 * * *	lawrencium 103 Lr [260]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [265]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununilium 111 Uuun [272]	ununium 112 Uuun [272]		ununquadium 114 Uuq [289]				

* Lanthanide series

** Actinide 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]

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		

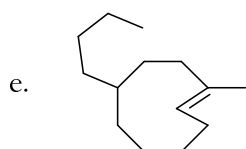
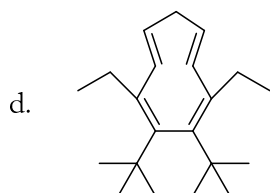
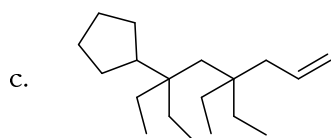
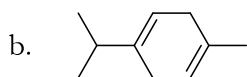
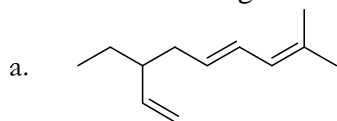
1) Molecular Orbitals (20 pts total)

- a. Helium, being a noble gas, is well-known for its unwillingness to form bonds to other atoms. Draw an MO diagram for the hypothetical He_2 molecule, being sure to name each orbital and fill in electrons correctly. (10 pts)

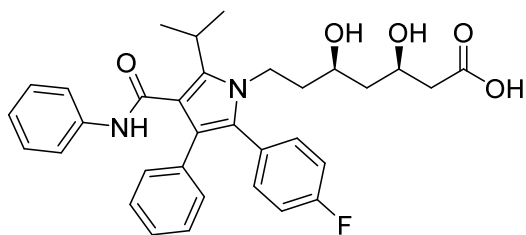
- b. What is the bond order between the two helium atoms in this molecule? (5 pts)

- c. In twenty words or less, explain why He_2 does not exist. (5 pts)

2) Name the following structures. You do not need to use E/Z descriptors. (15 pts)



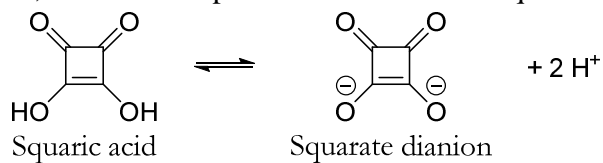
3) Lipitor, shown below, is a statin used to lower cholesterol and is the best-selling pharmaceutical of all time. Which of the listed functional groups does Lipitor contain? Circle all that apply. (12 pts)



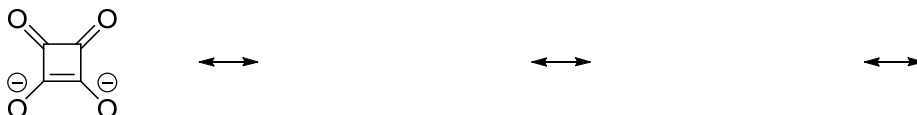
Alkyl halide	Ketone	Amide	Amine	Aromatic ring
Alcohol	Ether	Ester	Aldehyde	Carboxylic acid

- 4) Draw all the cycloalkanes with formula C_4H_7Br , using bond-line structures. Be careful not to repeat any structures. You only need to show connectivity – no stereochemistry or bold/dashed bonds are necessary. (8 pts)

- 5) Squaric acid, shown below, can lose two protons to become the squarate dianion.

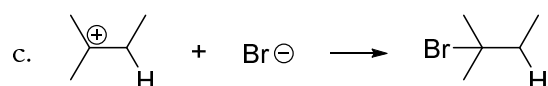
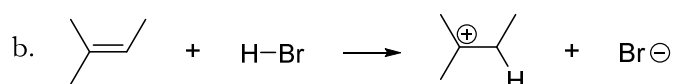
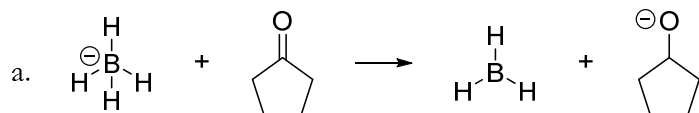


- a. Draw three other resonance forms for the squarate dianion. Use valid arrow-pushing to show the movement of electrons. (5 pts each)



- b. What is the average bond order for each C-O bond in this structure? (3 pts)
- c. What is the average bond order for each C-C bond in this structure? (3 pts)

6) Complete each arrow-pushing mechanism and identify each reactant as a nucleophile, electrophile, acid, or base. (12 pts)



7) For each of the following reactions, does the equilibrium favor the reactants or products? (12 pts)

