

CHEM 3311 (Richardson) First Exam – Sep. 25, 2018

Your Name: Key

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		12
2		16
3		24
4		18
5		12
6		18
Total		

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															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 22.9897	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 65.38	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	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					
francium 87 Fr [223]	radium 88 Ra [226]	* * 89-102	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]					

* 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

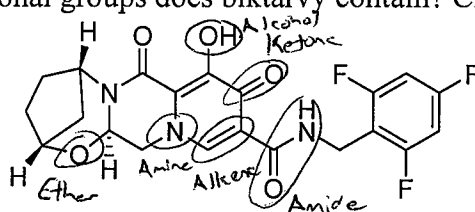
actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]
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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

Average: 74.8
 St. Dev: 16.1
 Max: 98
 Min: 7

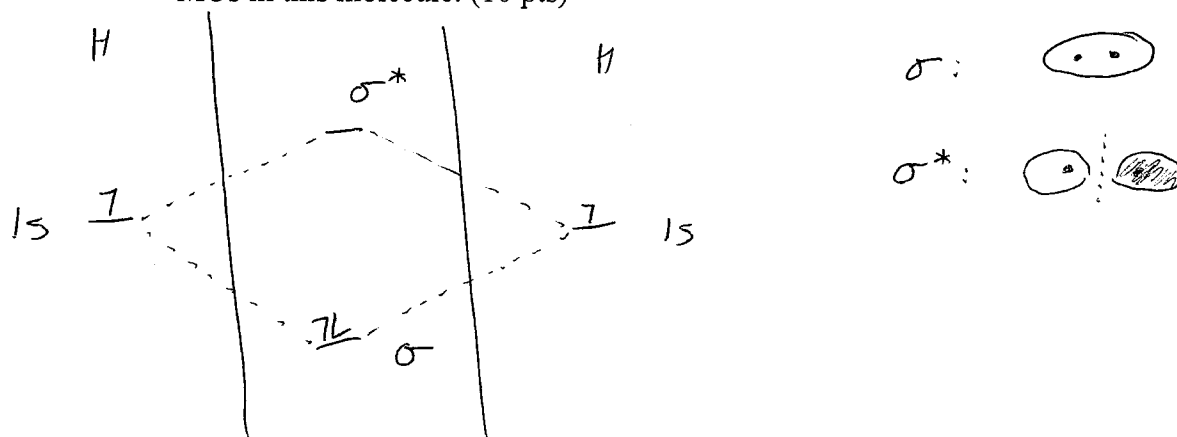
- 1) Biktarvy, shown below, is a new drug that is being investigated for the treatment of HIV. Which of the listed functional groups does biktarvy contain? Circle all that apply. (12 pts)



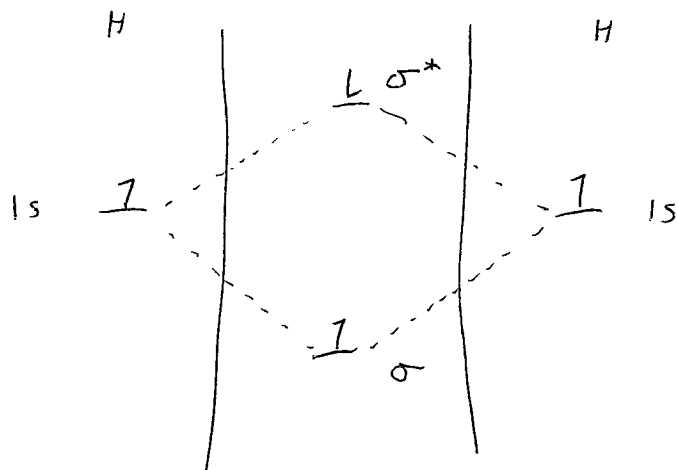
<u>Alcohol</u>	Aldehyde	<u>Alkene</u>	<u>Amide</u>	<u>Amine</u>
Acid anhydride	Carboxylic acid	Ester	<u>Ether</u>	<u>Ketone</u>

- 2) Molecular Orbital Diagrams (16 pts total)

- a. Draw an MO diagram for a molecule of hydrogen gas, H₂. Also draw the shapes of all MOs in this molecule. (10 pts)



- b. When the hydrogen molecule absorbs a photon of light, an electron can jump from the bonding MO to the antibonding MO. Draw the MO diagram after this happens, and explain why this leads to the breaking of the bond between hydrogen atoms in 30 words or less. (6 pts)

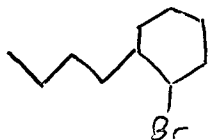


Bond order is $(1-1)/2 = 0$,
 so no bond exists now.

3) The following compounds were named incorrectly. Complete these steps for each one: (24 pts total)

- Draw the skeletal structure (2 pts per problem)
- Write the correct IUPAC name (4 pts per problem)
- Write the degrees of unsaturation (2 pts per problem)

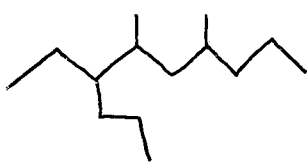
a. 1-(2-bromocyclohexyl)butane



1-bromo-2-butylcyclohexane

1 deg. unsat.

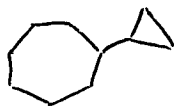
b. 4,6-dimethyl-3-propylnonane



4-ethyl-5,7-dimethyldecane

0 deg. unsat

c. 1-cycloheptyl-cyclopropane

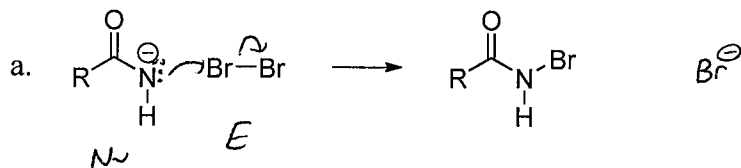


Cyclopropylcycloheptane

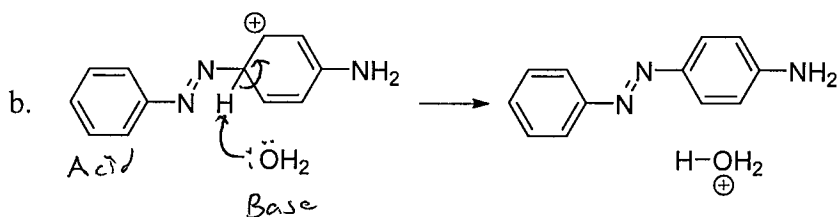
2 deg. unsat.

4) For the following reactions, complete these steps: (18 pts total)

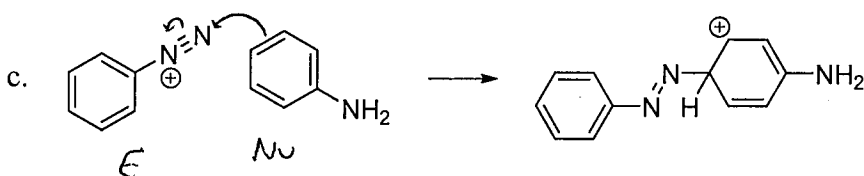
- add arrows to show the movement of electrons (2 pts per problem)
- classify each species as either an acid, base, nucleophile, or electrophile (2 pts per problem). Please use the labels “nucleophile” and “electrophile” only for things that are NOT acting as acids/bases.
- identify the HOMO and LUMO for each reaction (2 pts per problem)



HOMO: LP on N
LUMO: Br-Br σ^*

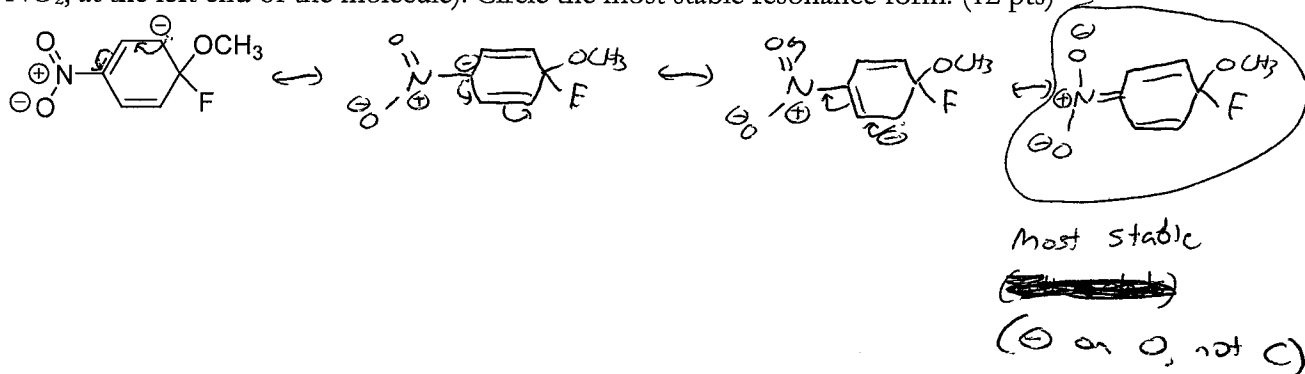


HOMO: LP on O
LUMO: H-C σ^*



HOMO: C=C π
LUMO: N=N π^*

5) Draw all reasonable resonance forms for this molecule, including valid arrow-pushing to convert each form into the next. (Ignore any forms where the **only** difference is within the nitro group, NO_2 , at the left end of the molecule). Circle the most stable resonance form. (12 pts)



- 6) Draw the structure of 1-bromopropane. Sighting along the bond between carbon 1 and carbon 2 (as numbered by IUPAC), show a Newman projection for the molecule's conformations for dihedral angles in increments of 60° , starting with both the bromine and carbon 3 pointed directly up. **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, so long as the relative ordering of levels is correct. (18 pts)

Interaction	Energy (kcal/mol)
H/H eclipsed	1
Me/H eclipsed	1.15
Br/H eclipsed	1.75
Br/Me eclipsed	4
Me/Br gauche	1

