

CHEM 3311 (Richardson) First Hour Exam – February 10, 2015

Your Name KEY

Student ID _____

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

Question	Score	Out of
1		5
2		20
3		25
4		15
5		15
6		20
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 1.008																	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 32.06	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 47.887	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 72.64	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	Sr 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	Te 52 Te 127.6	Iodine 53 I 126.90	Xenon 54 Xe 131.29						
Cesium 55 Cs 132.91	Ba 56 Ba 137.33	* 57-70	Lanthanum 57 La 138.91	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	Pt 78 Pt 195.08	Au 79 Au 196.97	Hg 80 Hg 200.59	Tl 81 Tl 204.38	Pb 82 Pb 207.2	Bi 83 Bi 208.98	Po 84 Po [209]	At 85 At [210]	Rn 86 Rn [222]					
Francium 87 Fr [223]	Ra 88 Ra [226]	* *	Lr 103 Lr [260]	Rf 104 Rf [261]	Db 105 Db [262]	Sg 106 Sg [263]	Bh 107 Bh [264]	Hs 108 Hs [265]	Mt 109 Mt [266]	Uun 110 Uun [267]	Uuu 111 Uuu [268]	Uub 112 Uub [269]											

* Lanthanide series

Lanthanum 57 La 138.91	Ce 58 Ce 140.12	Pr 59 Pr 140.91	Nd 60 Nd 144.24	Pm 61 Pm [145]	Sm 62 Sm 150.36	Eu 63 Eu 151.96	Gd 64 Gd 157.25	Tb 65 Tb 158.93	Dy 66 Dy 162.50	Ho 67 Ho 164.93	Er 68 Er 167.26	Tm 69 Tm 168.93	Yb 70 Yb 173.05
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* Actinide series

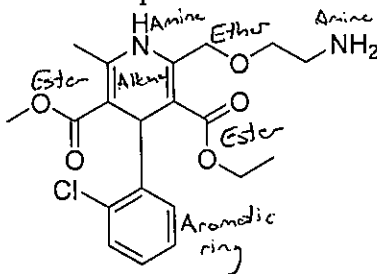
Actinium 89 Ac [227]	Th 90 Th 232.04	Pa 91 Pa 231.04	U 92 U 238.03	Np 93 Np [237]	Pu 94 Pu [244]	Am 95 Am [243]	Cm 96 Cm [247]	Bk 97 Bk [247]	Cf 98 Cf [251]	Es 99 Es [252]	Fm 100 Fm [257]	Md 101 Md [258]	No 102 No [259]
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pKa Values

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		

Average = 70.9
St. Dev = 14.8
Max = 97
Min = 29.5

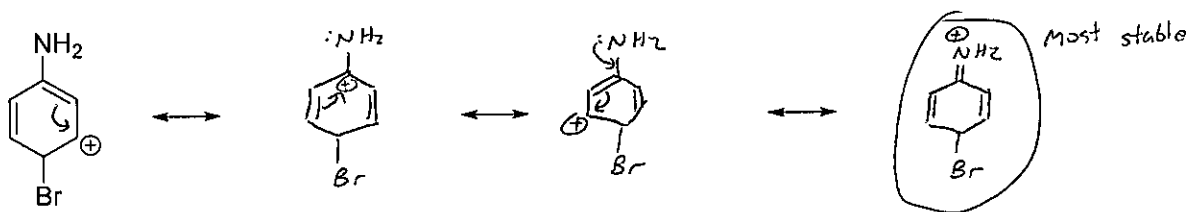
- 1) Amlodipine, shown below, is used to prevent chest pain and lower blood pressure. Which of the listed functional groups does Amlodipine contain? Circle all that apply. (5 pts)



Aldehyde	Ketone	Amide	<u>Amine</u>	<u>Aromatic ring</u>
Alcohol	<u>Ether</u>	<u>Ester</u>	<u>Alkene</u>	Carboxylic acid

- 2) Resonance (20 pts total)

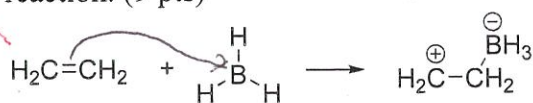
- a. Draw three other resonance forms for the molecule shown below. Use valid arrow-pushing to show the movement of electrons. (5 pts each)



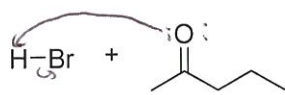
- b. Of these four total resonance forms, one of them is more stable – the form where every atom has a filled octet. Circle this resonance form. (5 pts)

3) Acids and bases (25 pts total)

- a. Complete each arrow-pushing mechanism and identify the HOMO and LUMO of each reaction. (9 pts)



HOMO: C=C π
LUMO: empty orbital (nonbonding) on B

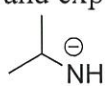


HOMO: lone pair (nonbonding) on O
LUMO: H-Br σ^*

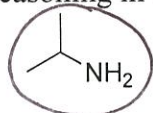


HOMO: lone pair (nonbonding) on O
LUMO: CH₃-Br σ^*

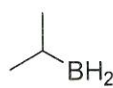
- b. For each pair of compounds shown below, select the more acidic of the two compounds and explain your reasoning in ~~ten~~ words or fewer. (2 pts each)



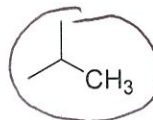
vs.



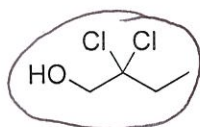
Reason: Charge effect: more \oplus charge or less \ominus charge = more acidic.



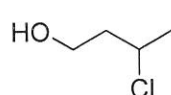
vs.



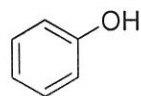
Reason: Element effect: within a row of periodic table, more EN = more acidic.



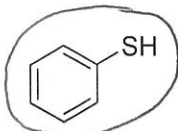
vs.



Reason: Inductive effect: more electronegative groups nearby = more acidic.

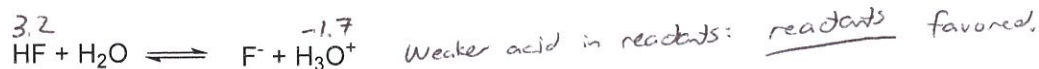
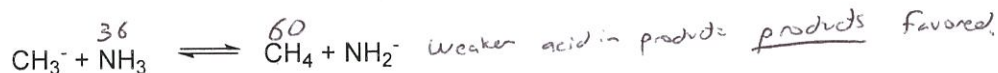
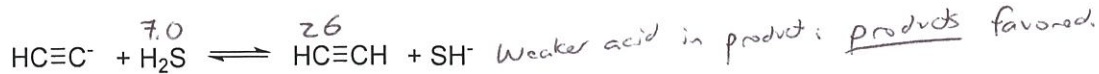
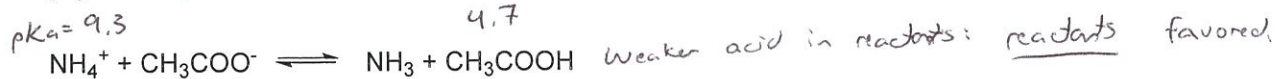


vs.



Reason: Element effect: larger atom = longer bond = more acidic.

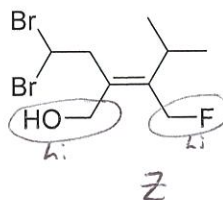
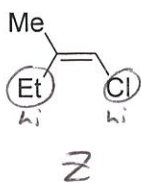
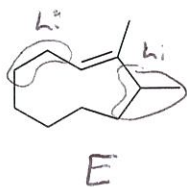
- c. For each of the following reactions, does the equilibrium favor the reactants or products? (2 pts each)



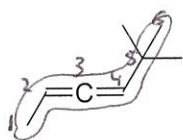
25

4) Nomenclature and stereoisomers (15 pts total)

a. Assign an E or Z descriptor to the following molecules. (2 pts each)

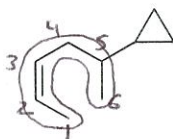


b. Name the following structures. Include E/Z descriptors where appropriate. (3 pts each)

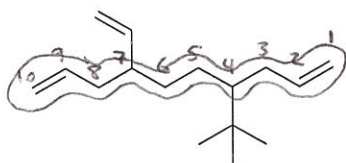


Name: 5,5-dimethyl-2,3-hexadiene

Not E or Z, but we didn't specifically cover stereochem for these so full points for any or no stereochem.

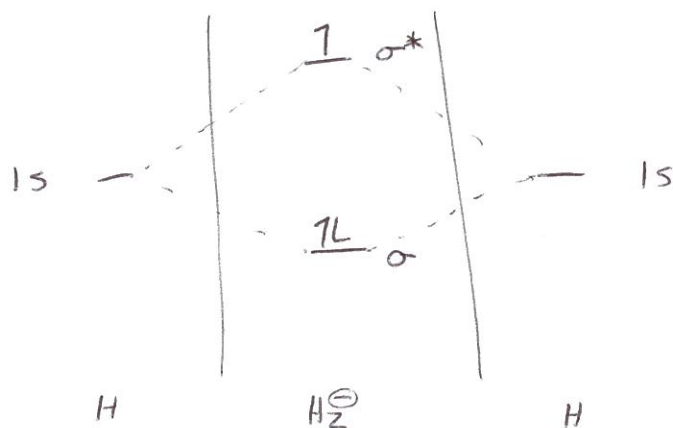


Name: (Z)-5-cyclopropyl-2-hexene



Name: 4-tert-butyl-7-vinyl-1,9-decadiene

5) Molecular Orbitals (15 pts total)

a. Draw an MO diagram for the H_2^- ion (note the negative charge on this ion). (10 pts)

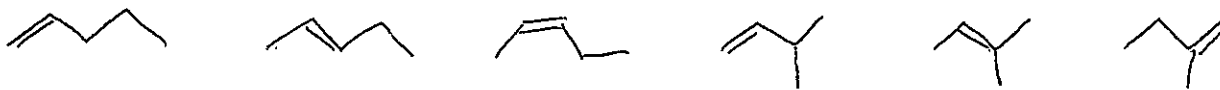
b. What is the bond order between the two hydrogen atoms in this ion? (5 pts)

of e^- in antibonding = 1
 # of e^- in bonding = 2

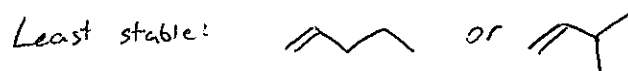
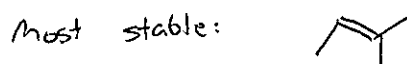
$$\frac{(2-1)}{2} = \left(\frac{1}{2}\right)$$

6) Alkene structure and stability (20 pts)

- a. Using skeletal structures, draw every alkene with the formula C_5H_{10} . If a structure has different E/Z stereoisomers possible, show both of them. (2 pts each)



- b. Out of the alkenes you drew for part (a), which is the most stable? Which is the least stable? (4 pts)



- c. How many degrees of unsaturation do each of the structures you drew for part (a) have? (4 pts)

Saturated hydrocarbon = C_nH_{2n+2} or C_5H_{12} for S_{C_5} .
 C_5H_{10} is missing 1 pair of Hs \rightarrow 1 degree of unsaturation,
 regardless of structure.