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

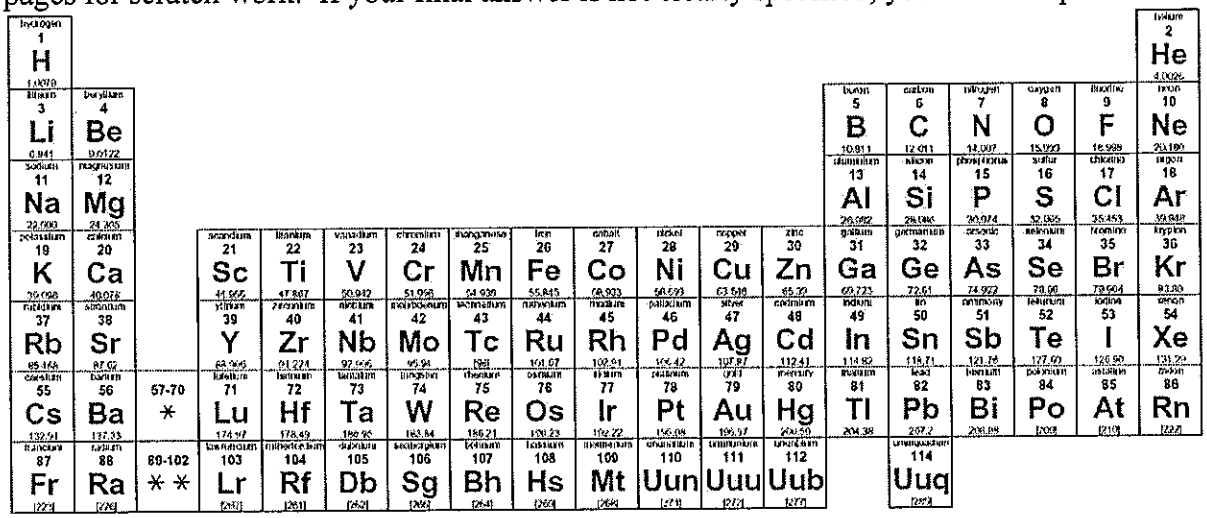
Your Name KEY

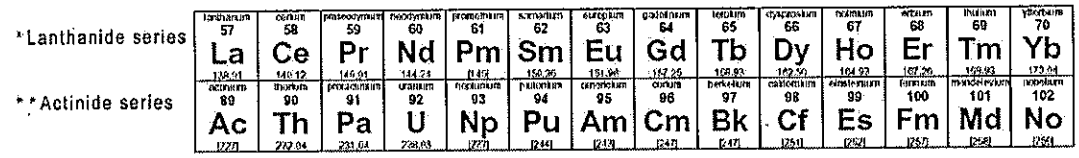
Student ID

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.





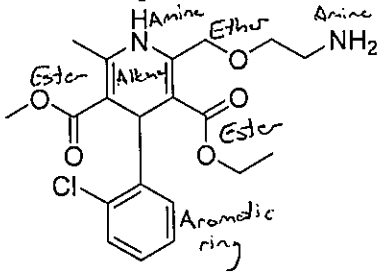
pKa Values

HI	-10	CH_3COOH	4.7	Phenol	10	H_2	35
HBr	-8	HN_3	4.7	RSH	10-12	NH_3	36
HCl	-6	H_2S	7.0	H_2O	15.7	$H_2C{=}CH_2$	45
H_3O^+	-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

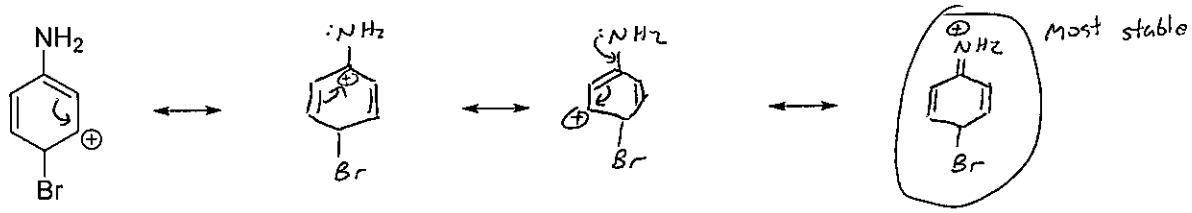
 Name_____

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	(Amine)	(Aromatic ring)
Alcohol	(Ether)	(Ester)	(Alkene)	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)



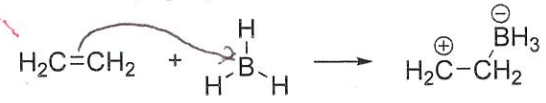
   b. Of these four total resonance forms, one of them is more stable – the form where every atom has a filled octet. Circle this resonance form. (5 pts)

 Name_____

3) Acids and bases (25 pts total)

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

3pts each



HOMO: C=C π

LUMO: empty orbital (nonbonding) on B

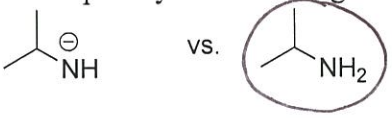
HOMO: Lone pair (nonbonding) on O

LUMO: H-Br σ*

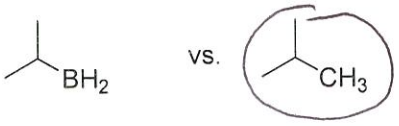
HOMO: Lone pair (nonbonding) on O

LUMO: CH_3-Br σ*

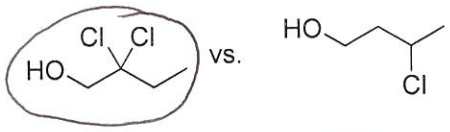
b. For each pair of compounds shown below, select the more acidic of the two compounds and explain your reasoning in ten 15 words or fewer. (2 pts each)



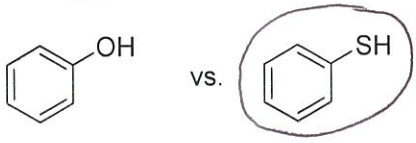
Reason: Charge effect: more ⊕ charge or less ⊖ charge = more acidic.



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



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



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)

pKa = 9.3 4.7

$NH_4^+ + CH_3COO^- \rightleftharpoons NH_3 + CH_3COOH$ Weaker acid in reactants: reactants favored.

7.0 26

$HC\equiv C^- + H_2S \rightleftharpoons HC\equiv CH + SH^-$ Weaker acid in product: products favored.

36 60

$CH_3^- + NH_3 \rightleftharpoons CH_4 + NH_2^-$ Weaker acid in product: products favored.

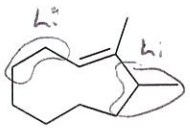
3.2 -1.7

$HF + H_2O \rightleftharpoons F^- + H_3O^+$ Weaker acid in reactants: reactants favored.

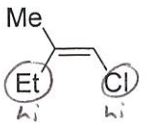
25

 Name_____

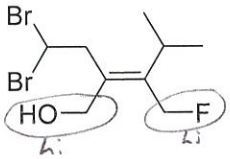
4) Nomenclature and stereoisomers (15 pts total)
   a. Assign an E or Z descriptor to the following molecules. (2 pts each)



E

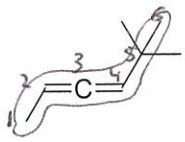


Z



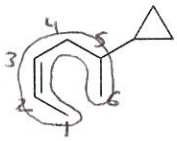
Z

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

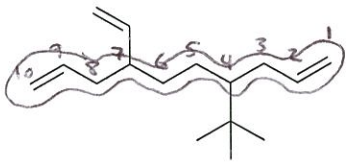


Name: 5,5-dimethyl-2,3-hexadiene

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

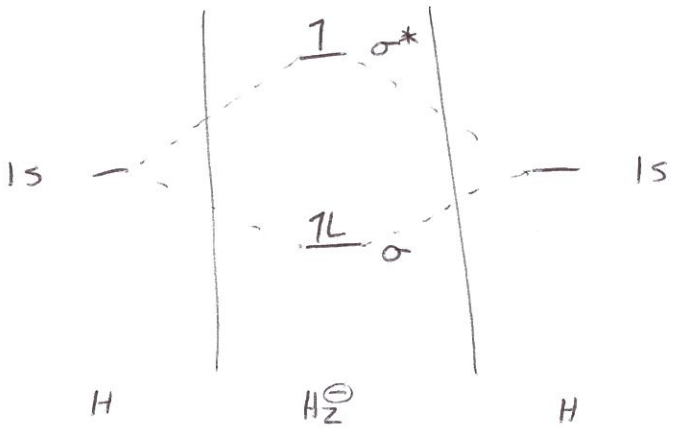


Name: (Z)-5-cyclopropyl-2-hexene



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)

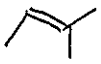
# of e⁻ in antibonding = 1
# of e⁻ in bonding = 2

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

 Name_____

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)

Most stable: 

Least stable:  or 

   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 5 Cs.

C_5H_{10} is missing 1 pair of Hs → 1 degree of unsaturation, regardless of structure.