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

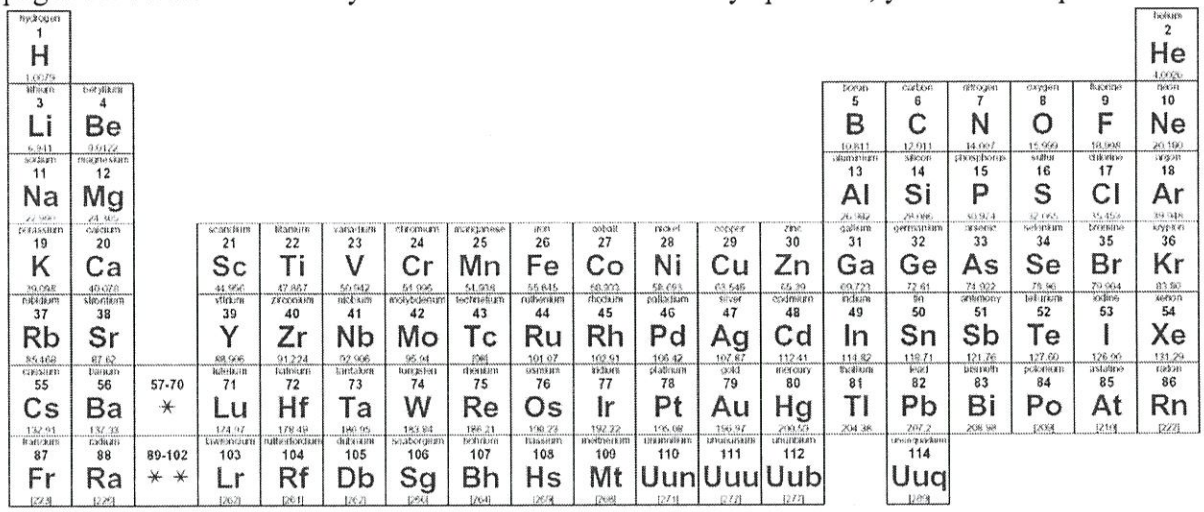
Your Name KEY

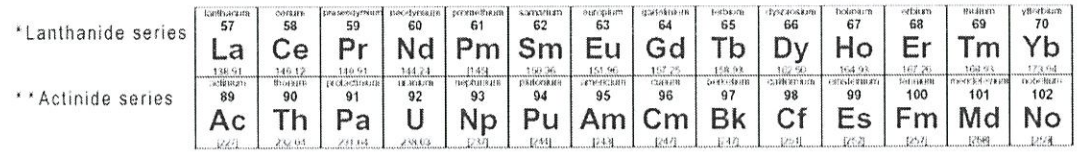
Student ID _____

Recitation Time (check one)
- O 3:00 Monday w/ Blaine McCarthy
- 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.





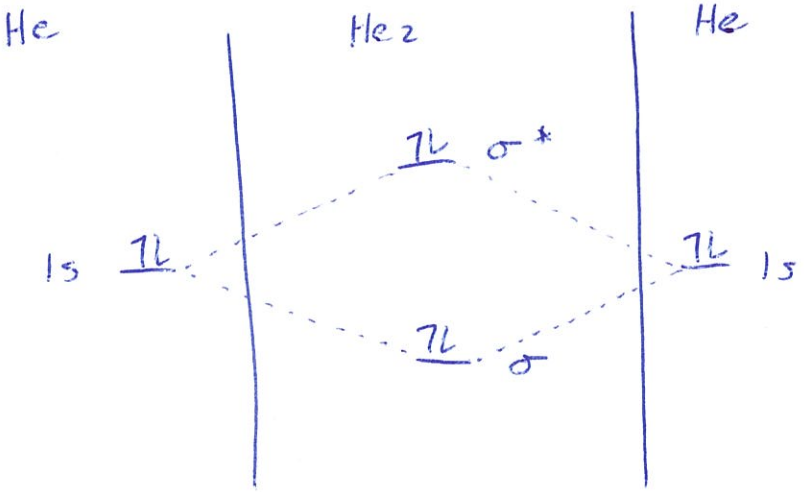
pKa Values

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: 76.6
St. Dev: 14.5
Max: 95
Min: 17.5

 Name_____

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)



-2 for not adding e⁻ properly
-5 for making up orbitals
-2 for wrong # of e⁻
-1 for labeling σ or σ* wrong

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

$\frac{(2-2)}{2} = 0$

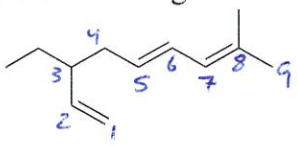
   c. In twenty words or less, explain why He_2 does not exist. (5 pts)

The bond order is zero because the bonding & antibonding MOs are equally full, so there's no energy benefit.

-1 for filled "odd," not "dud"

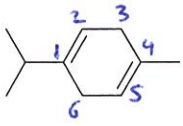
 Name_____

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

a. 

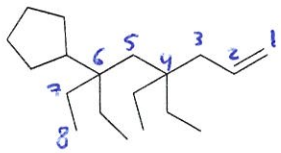
3-ethyl-8-methyl-1,5,7-~~trien~~nonatriene

(or 3-ethyl-8-methylnona-1,5,7-triene)

b. 

1-isopropyl-4-methyl-1,4-cyclohexadiene

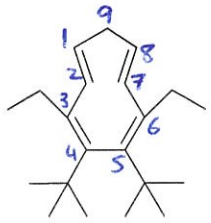
(or 1-isopropyl-4-methylcyclohexa-1,4-diene)

c. 

6-cyclopentyl-4,4,6-triethyl-1-octene

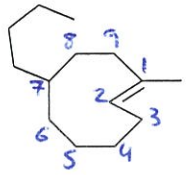
(or 6-cyclopentyl-4,4,6-triethyloct-1-ene)

3 pts each.
-2 for wrong parent chain
-1 for wrong numbering
-1 for wrong sub groups wrong
-1 for bad alphabetizing
-1 for wrong suffix

d. 

4,5-di-tert-butyl-3,6-diethyl-1,3,5,7-cyclononatetraene

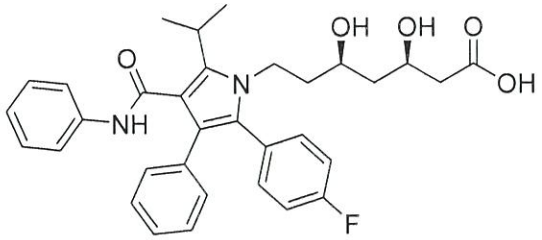
(or 4,5-di-tert-butyl-3,6-diethylcyclonona-1,3,5,7-tetraene)

e. 

7-butyl-1-methylcyclononene

(or 7-butyl-1-methylcyclonon-1-ene)

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. (~~6~~ 12 pts)



2 pts each
(-2 for each wrong choice)

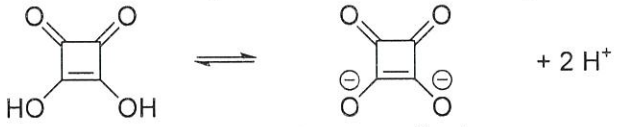
Alkyl halide	Ketone	Amide	Amine	Aromatic ring
Alcohol	Ether	Ester	Aldehyde ~~Alkene~~	Carboxylic acid

 Name_____

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)

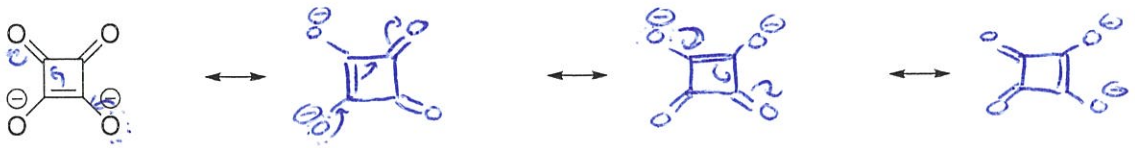
2 pts each

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



Squaric acid 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)



For each form: 3 pts for structure, 2 pts for arrows to get there.

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

$\frac{(2+2+1+1)}{4} = 1\frac{1}{2}$ for each C-O bond (they're all equivalent)

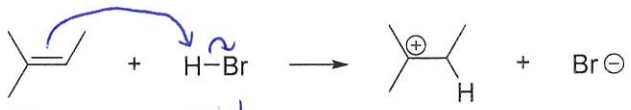
c. What is the average bond order for each C-C bond in this structure? (3 pts)

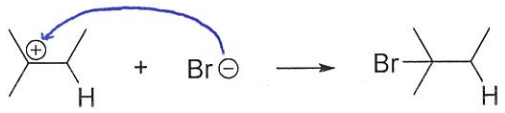
$\frac{(2+1+1+1)}{4} = 1\frac{1}{4}$ for each C-C bond (they're all equivalent)

 Name_____

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

a. 

b. 

c. 

For each: 2 pts for labels, 1 pt for arrows

-0.5 if 2 labels applied to same molecule.

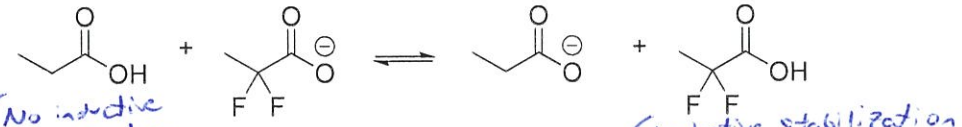
7) For each of the following reactions, does the equilibrium favor the reactants or products? (12 pts)

a. $HC{\equiv}C^{\ominus} + H_2O \rightleftharpoons HC{\equiv}CH + HO^{\ominus}$

($pK_a = 15.7$) ($pK_a = 26$)

weaker acid = Products more favored

For each: 4 pts

b. 

(No inductive stabilization → weaker acid) → Reactants more favored

(inductive stabilization → stronger acid)

c. 

(Smaller atom Weaker acid)

↓

Reactants more favored.

(Larger atom Stronger acid)