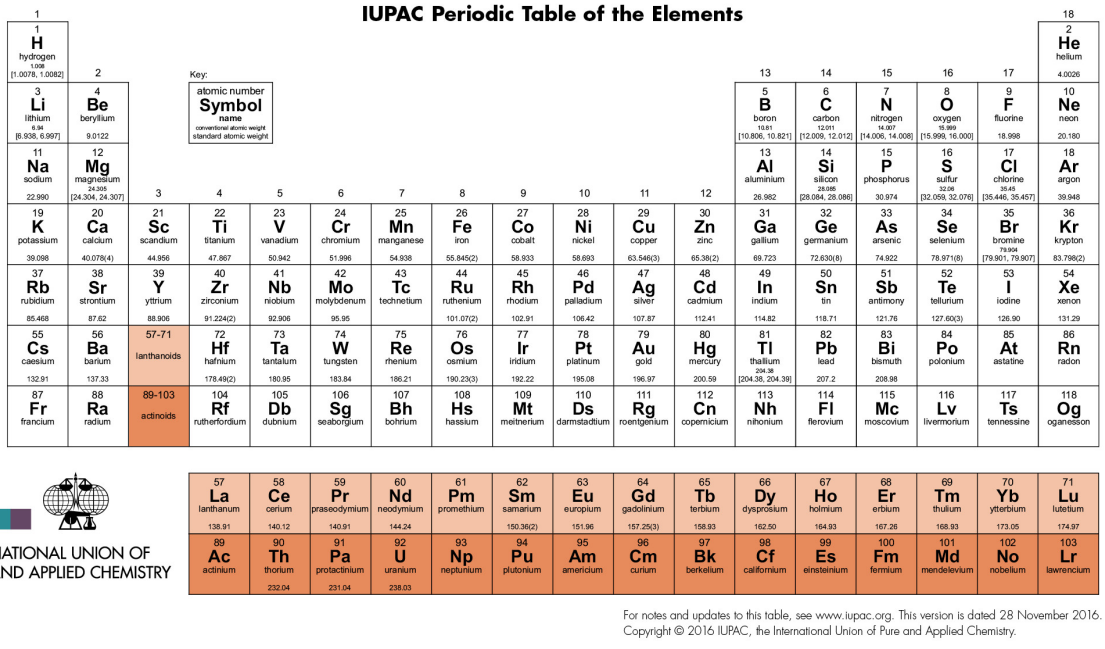
CH 334 Form A

First Midterm Exam Monday, October 16, 2017

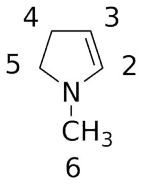
Name_____

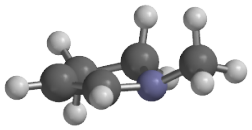
You may use model kits but no other material with chemical information without instructor approval.

Please do not use any electronic devices (calculators, phones, ipods, smart watches).



1. (24 points) 2-D and calculated 3-D structures for a molecule C_5H_9N is shown at the right. Carbon atoms are labeled numerically; the 3-D orientation is looking down the H-C2 bond vector.





a. Based on the structure, list the approximate atomic orbital hybridization of each of the following:

The methyl carbon:_____ Carbon 3:_____ The nitrogen:_____

b. Draw two proper, complete resonance structures for this molecule.

c. Based on your answers above, describe the components of the C2-N bond in terms of bond type (sigma, pi). You may use any descriptions or drawings you wish.

1. d. Based on the bond lengths shown below (and your prior answers) describe whether you think the C-N bonds in C_5H_9N are single, double or triple bonds and why.

Compound	C-N Bond Length
C2-N in C_5H_9N (shown above)	1.399 Å
C5-N in C_5H_9N (shown above)	1.473 Å
CH_3CH_2-NH_2	1.467 Å
$CH_3CH{=}NH$	1.266 Å
$CH_3C{\equiv}N$	1.149 Å

2. (9 points) Given the pK_as of protonated species shown below, predict the magnitude of K_{eq} for each of the following reactions ($K_{eq} >> 1$, $K_{eq} << 1$, or $K_{eq} \approx 1$)

a. $HC{\equiv}C^{\ominus}$ + NH_3 ⇌ $HC{\equiv}CH$ + $NH_2^{\ominus}$

$pK_a = 36$ $pK_a = 25$

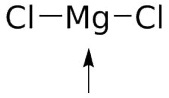
b. Br^- + CH_3OH ⇌ HBr + CH_3O^-

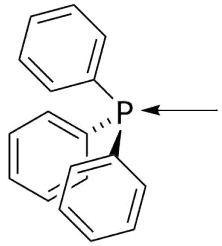
$pK_a = 15.5$ $pK_a = -9.0$

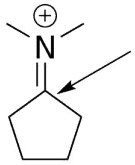
c.  + NH_3 ⇌  + NH_4^+

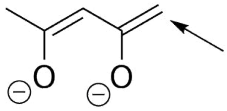
$pK_a = 4.75$ $pK_a = 9.3$

3. (15 points) Identify each atom highlighted with an arrow in the structures below as either nucleophilic (N) or electrophilic (E). (Label each as N or E.)









4. (12 points) Draw structures for each of the following compounds.

a. n-Hexane

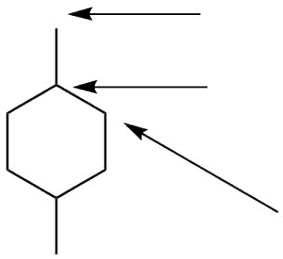
b. 3-methylheptane

c. 2-bromo-4-(1-propyl)nonane

5. (16 points) Using Newman projections, show the possible staggered rotamers of 3-methylpentane, looking down the C2-C3 bond. Rank them in order of stability. (Hint: draw 3-methylpentane and identify the bond down which you need to look.)

6. (24 points) Consider the free-radical halogenation of 1,4-dimethylcyclohexane (shown below in part a).

a. Label each of the different carbons as primary, secondary or tertiary.



b. Chlorination, as we know, is relatively nonselective. Draw all possible isomers for monochlorination of 1,4-dimethylcyclohexane (ignore cis/trans isomerism and other aspects of stereochemistry).

c. Bromination, on the other hand, tends to be more selective. Show the mechanistic propagation steps (including electron-pushing arrows) that illustrate selective formation of a single product from 1,4-dimethylcyclohexane.

Bond strengths (kcal/mol):

F-F	38
Cl-Cl	58
Br-Br	46
I-I	36
H-F	136
H-Cl	103
H-Br	87
H-I	71
CH_3-H	105
CH_3CH_2-H	101
$(CH_3)_2CH$-H	98.5
$(CH_3)_3C$-H	96.5
CH_3-F	110
CH_3-Cl	85
CH_3-Br	70
CH_3-I	57
CH_3CH_2-F	111
CH_3CH_2-Cl	84
CH_3CH_2-Br	70
CH_3CH_2-I	56
$(CH_3)_2CH$-F	111
$(CH_3)_2CH$-Cl	84
$(CH_3)_2CH$-Br	71
$(CH_3)_2CH$-I	56
$(CH_3)_3C$-F	110
$(CH_3)_3C$-Cl	85
$(CH_3)_3C$-Br	71
$(CH_3)_3C$-I	55