Exam 1 Summer 2016

Name Key Seat Number_____

Student ID_____

The exam consists of 10 questions worth 102 points on a total of 6 pages. It will be scored out of 100 points.

1. _____/10
2. _____/12
3. _____/8
4. _____/10
5. _____/12
6. _____/8
7. _____/10
8. _____/12
9. _____/8
10. _____/12

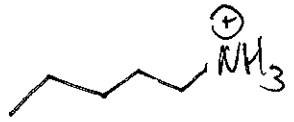
Total:

Regrading: All requests for regrades must be submitted in writing within 48 hours of the return of the exam. You must explicitly state what has been misgraded and why it is an error. The entire exam will be regraded, which could result in points being added or deducted overall.

1. (15pts) Draw each of the following molecules as a bond-line formula:

+1 +1 +1

a five carbon protonated amine

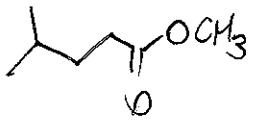


+1 +1

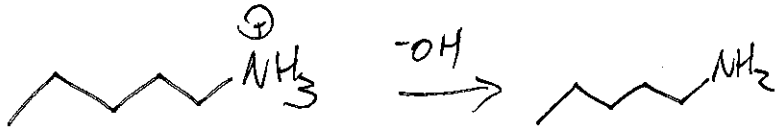
a cyclic, unsaturated hydrocarbon

+1 +1

a 6 carbon ester with a tertiary carbon



Which, if any, of the above molecules is a strong enough acid to react almost completely with NaOH? Explain how you chose the one(s) you chose.

+2 

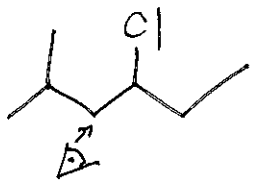
+2 no others

+2 explain based on pKa or stability principles

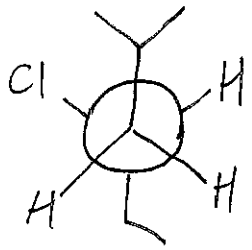
2. (10pts) Draw a bond-line structure for 4-chloro-2-methylhexane. Then draw the most stable Newman Projection of this compound around the C3-C4 bond.

Bond-line

+4



Newman Projection

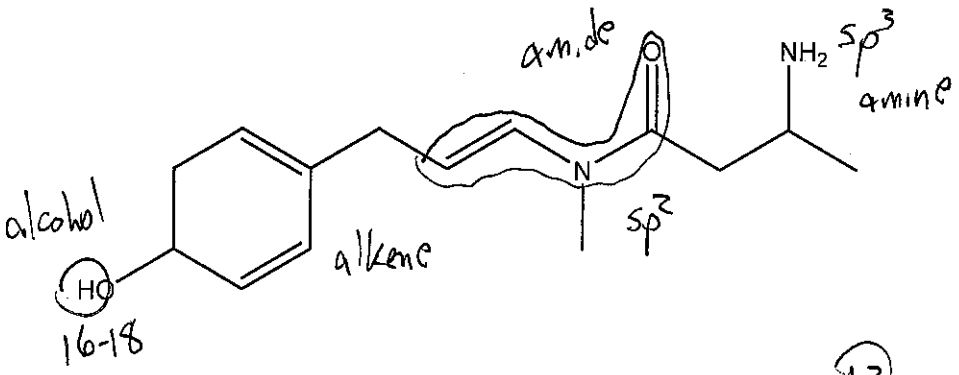


+2 structure

+2 staggered

+2 anti ethyl

3. (10pts) Answer the following questions using the molecule below.



A. On the structure, indicate the longest conjugated system. (+2)

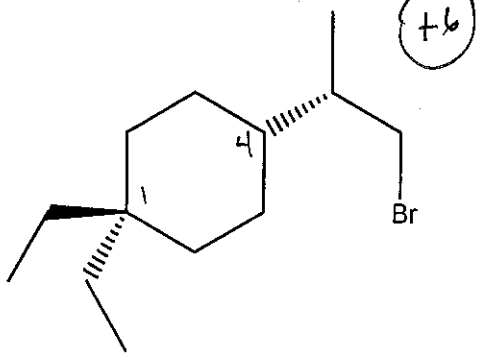
B. How many localized lone pairs are in this molecule? 5 (+2)

C. On the structure, label the hybridization of each nitrogen atom. (+2)

D. Label two functional groups on the molecule. (+2)

E. Circle the most acidic proton on the molecule, and give its pKa. (+2)

4. (12pts) Name the compound below, and then draw it in its most stable conformation.

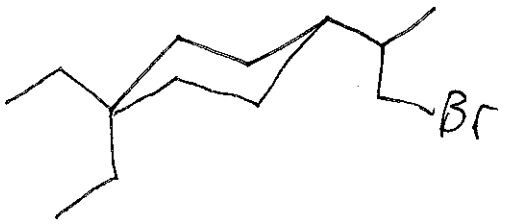


(+6)

4-(2-bromo-1-methylethyl)-1,1-diethylcyclohexane

(+2) (+1) (+1)

numbering (+1) αβ substituent (+1)

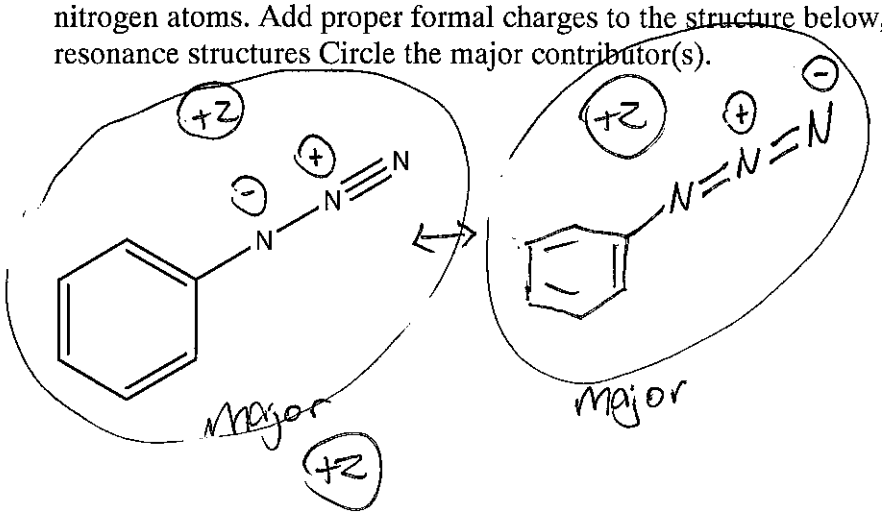


(+2) chair

(+2) equatorial group

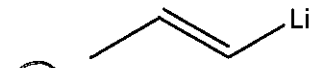
(+2) substituents in correct place

5. (8pts) The azide functional group, found in the molecule below, contains three adjacent nitrogen atoms. Add proper formal charges to the structure below, and draw three additional resonance structures Circle the major contributor(s).



+ 2 others

6. (6pts) Rank the following bases from strongest to weakest. Explain your answer using base stability principles.



+1 strongest

lone pair on sp^2 orbital

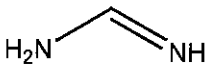
carbon hybrid orbital +2

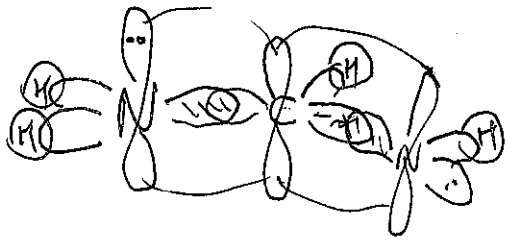
+2 dipole

weakest +1

lone pair on sp orbital and induction (dipole)

7. (10pts) Draw an orbital overlap picture of this compound. Use it to explain why one of the lone pairs is more reactive than the other.



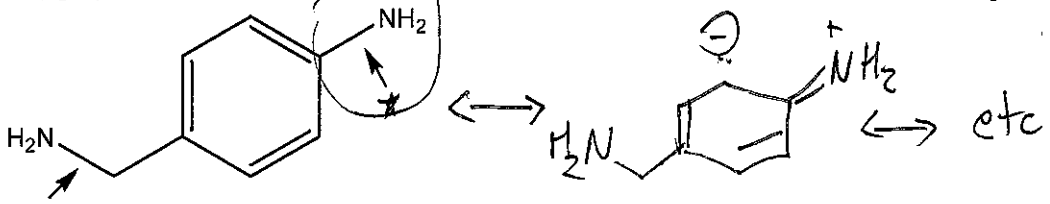


- all sp^2, p overlap +4
- geometries +2
- σ bonds +2
  use correct orbitals

Explain localized vs delocalized +2

+1

8. (4pts) One of the indicated bonds is much harder to rotate than the other. Explain.

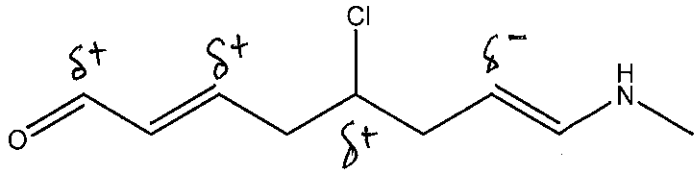


The indicated bond has double bond character or (resonance) explain with conjugation } +3

4

9. (6pts) In the molecule below, indicate all carbon atoms that are electron poor and electron rich.

+1 each



10. (12pts) Draw both chair flip structures of *trans* 1-*t*-butyl-3-ethylcyclohexane. If the 1,3-diaxial strain of an ethyl group is 7.6 kJ/mol and a t-butyl group is about 21 kJ/mol, indicate which is more stable. What is the difference in free energy of the two? What are the approximate percentages of each at equilibrium?

+4 chairs

+2 correct structure

more stable

1.8 Kcal

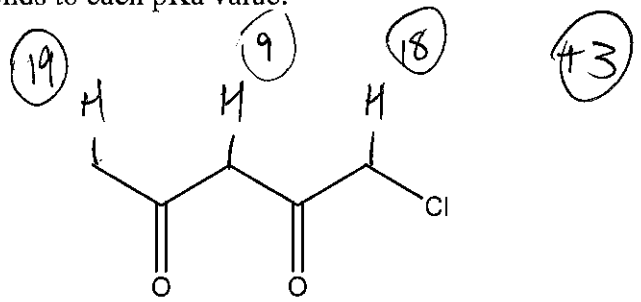
5.4 Kcal/mol

1.75 - 1.8 Kcal/mol +3

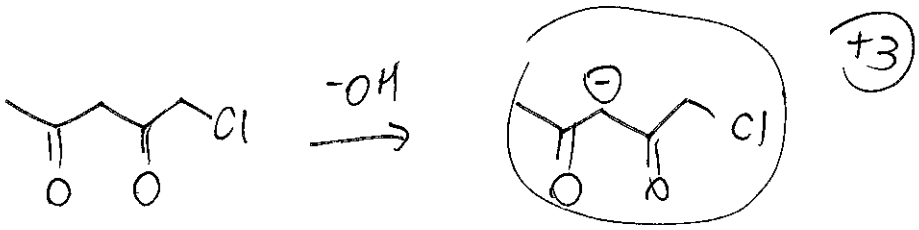
$\Delta G = 3.5$ Kcal/mol +4

Greater than 99% to 1% +2

11. (9pts) The pKa values of the three sets of protons in the compound below are 9, 18, and 19. Indicate which set corresponds to each pKa value.



Is NaOH a strong enough base to completely deprotonate this compound? If so, draw the product. If not, explain why.



Is $NaNH_2$ a strong enough base to completely deprotonate this compound? If so, draw the product. If not, explain why.