Chemistry 210
Winter Semester 1997
Examination #1

Prof. Rainer Glaser , University of Missouri—Columbia
Wednesday, February 19, 1997, in Ellis Auditorium, 8:40 - 9:30

featuring
Structure & Bonding and Alkanes & Structure Isomerism

Your Name:

Answer Key

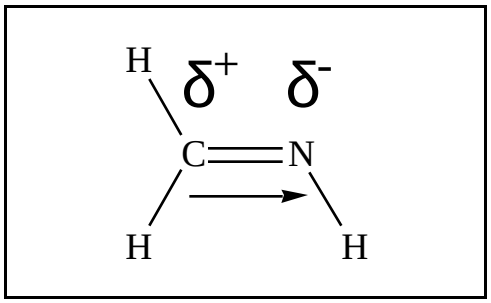
	Max.	Yours
Question 1	25	
Question 2	25	
Question 3	25	
Question 4	25	
Total	100	

Do not turn the page until advised to do so.

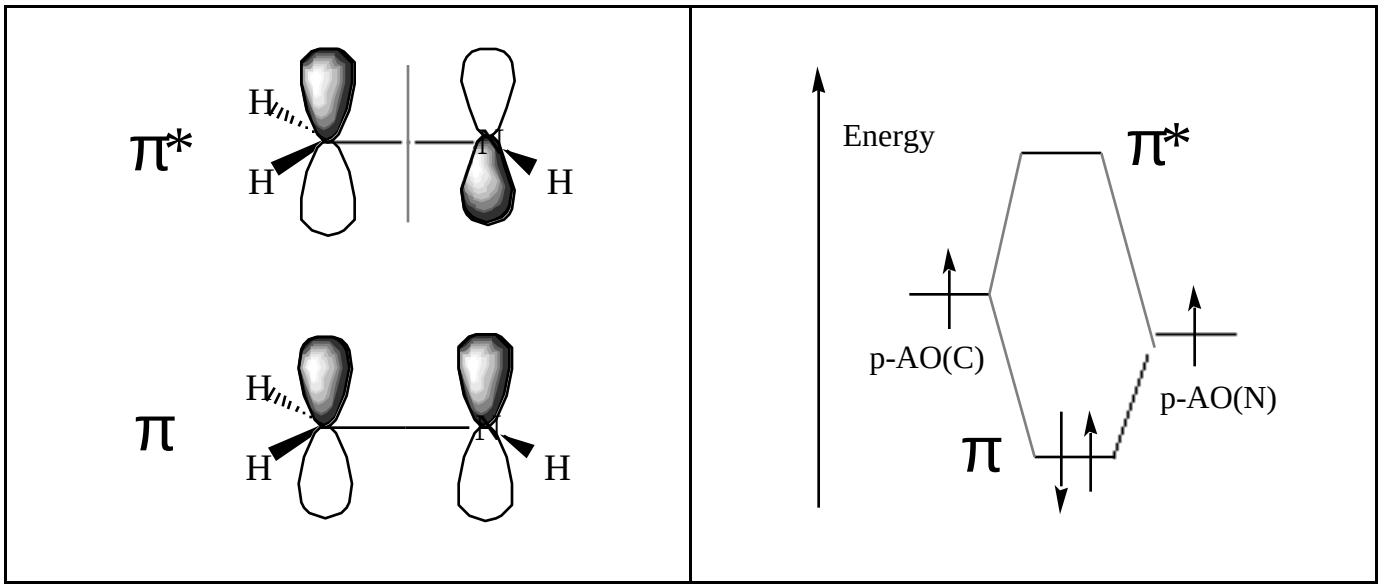
Question 1. Electronic Structure of Nitrogen and Carbon. (25 points)

(a) Electronic structure of atoms C and N. (6 easy pts)	**Carbon**	**Nitrogen**
Total number of electrons?	6	7
Number of valence electrons?	4	5
What shell **number** are the valence electrons in?	2	2
What is the **name** of that shell in Bohr's model?	L	L
(1 point each for this part) Electronegativity?	2.5	3.0

(b) Carbon and nitrogen form single bonds in alkylamines, double bonds in imines, and triple bonds in nitriles. Let's take a look at the **imine** drawn. Based on considerations of electro-negativity, indicate the partial charges on C and N and also indicate the polarity of the C=N double bond with an arrow (directed from the + pole to the - pole). (6 points)

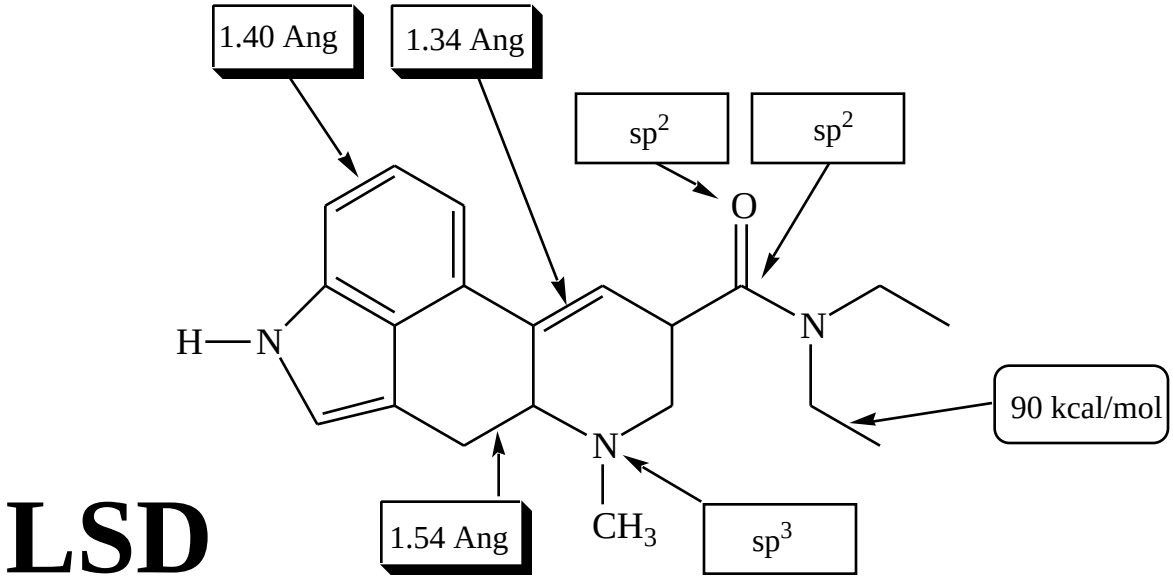


(c) Provide schematic drawings of the bonding and the anti-bonding π-MOs of the imine by completing the drawings on the left. Indicate nodes clearly. Complete the MO energy diagram on the right. Draw the MO levels, indicate which is π and which is π * and indicate occupations of AOs and MOs. (13 points)



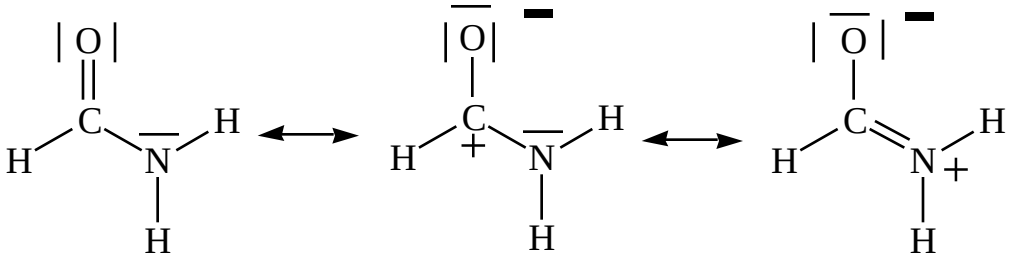
Question 2. Kekule Structures, Hybridization, Geometry, Bond Strength & Resonance. (25 points)

(a) The structure is shown of lysergic acid diethylamide, aka "LSD". Please provide the requested data for atom hybridization, bond length and homolytic bond dissociation energy. For bond lengths and dissociation energies also include the units in your answer. (13 pts. 2 lengths, 2.5 BDE, 1.5 hybrid.)



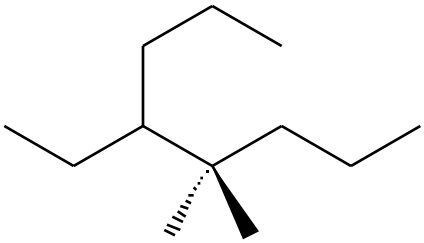
bond length | hybridization | bond diss. energy

(b) LSD is an "acid diethylamide" and the amide functional group -C(O)-NR- is of great significance in general. The simplest representative of all amides, the **formamide** is shown and you are asked to provide the three most important resonance forms for this molecule. Always show all lone pairs. (12 points)



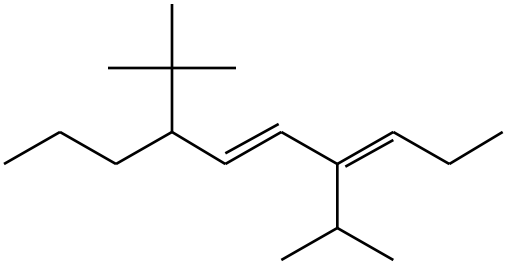
Question 3. Hydrocarbon Nomenclature including Descriptors for Conformers. (25 points)

(3 points)



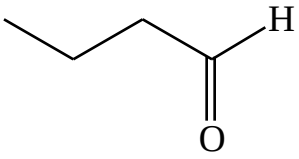
5-ethyl-4,4-dimethyl-octane

(4 points)



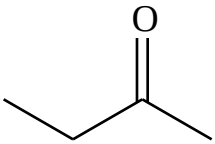
7-*tert*.-butyl-4-*iso*.-propyl-3,5-decadiene

(3 pts)



butanal

(3 pts)

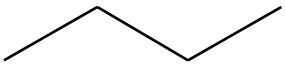


ethylmethylketone

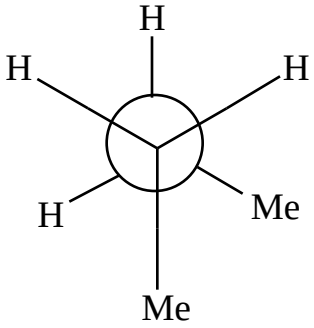
Condensed structural formula of *n*-butane. (2 pts)

$H_3C\text{-}CH_2\text{-}CH_2\text{-}CH_3$

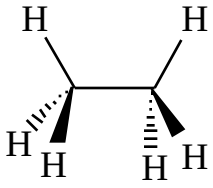
Bond line structure of butane. (2 pts)



Newman projection of *gauche* butane along the central C2-C3 bond. (4 pts)



Perspective drawing of *eclipsed* ethane. (4 pts)

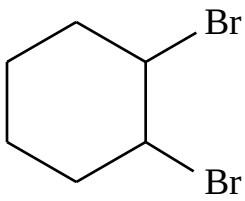


Question 4. Isomers and Double Bond Equivalents. (25 points)

Let's look at structural isomers of **$C_6H_6Br_2$**. In all cases, draw structural formulas. You may use condensed structural formulas so long as it is clearly indicated where all the hydrogens are.

(a) The double bond equivalent (DBE) of **C_6H_8** is __**3**_. The DBE is the number of H_2 molecules that needs to be added to obtain the corresponding *acyclic alkane* with formula C_nH_{2n+2}. The two Br atoms replace two H atoms and C_6H_8 and $C_6H_6Br_2$ have the same DBE. (3 pts for DBE).

(b) One mole of **$C_6H_6Br_2$** was treated with H_2 / Ni and the **addition of two mole of H_2** was observed.
Draw one possible structure of the **product**!
(4 points)

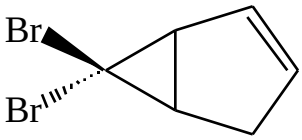


(c) Provide isomeric structures of **$C_6H_6Br_2$** that fulfill the constraints specified. (The constraints may well allow for several isomers. Just provide one that fits the constraint given.)

(3 4-pointers and 2 3-pointers as indicated)

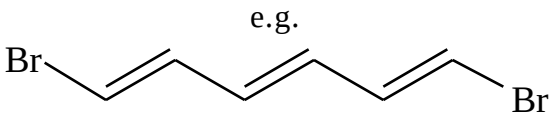
Bicyclic structure with a 5-membered ring. (3)

e.g.



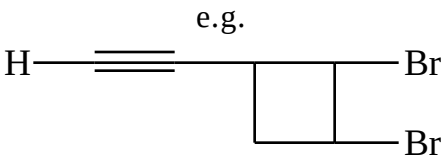
A **triene** without overall dipole moment. (4)

e.g.

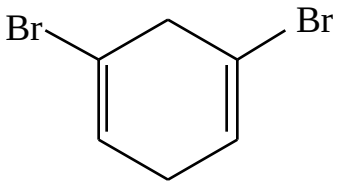


An **acetylene** without any primary C atoms. (4)

e.g.

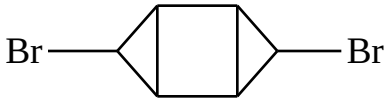


A **diene** molecule with isolated double bonds. (3)



e.g.

Draw a completely **saturated** molecule. (4)



The End is near. The End is near! The End is near. The End is near. **The End is here!!** Yahoo, back to the web!