CHEM 233, Fall 2017 Midterm #1 Ian R. Gould

COMPLETE THIS SECTION : Up to TWO POINTS will be removed for incorrect/missing information!

PRINTED **FIRST** NAME *Answer Key* PRINTED **LAST** NAME _____

NAME OF the Person on your **LEFT** (or **Empty** or **Aisle**) _____

NAME OF the Person on your **RIGHT** (or **Empty** or **Aisle**) _____

Class you are REGISTERED FOR (**onground or hybrid**) _____

The room where the students world **normally** take the test for your class, e.g. LS A-191 for onground and PS H-152 for hybrid, etc., **do NOT write DRC here**) _____

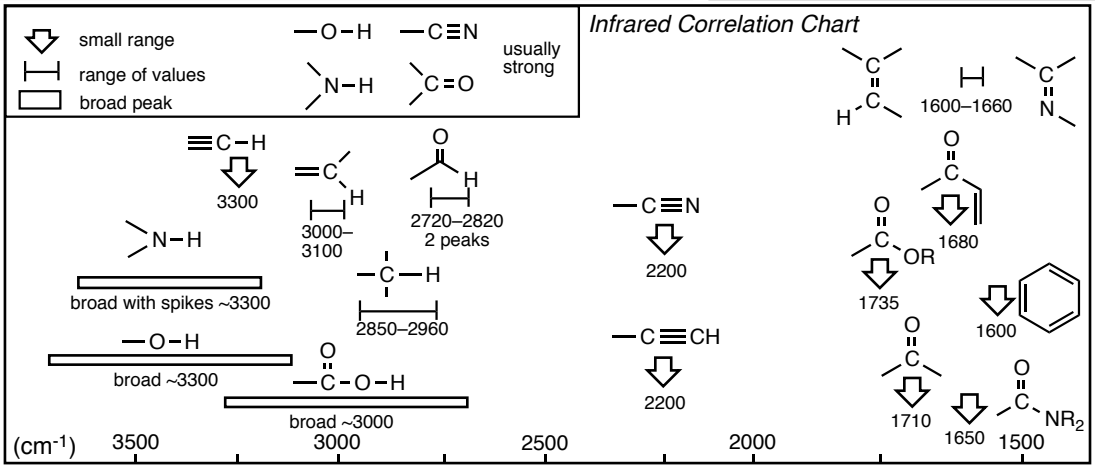
*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

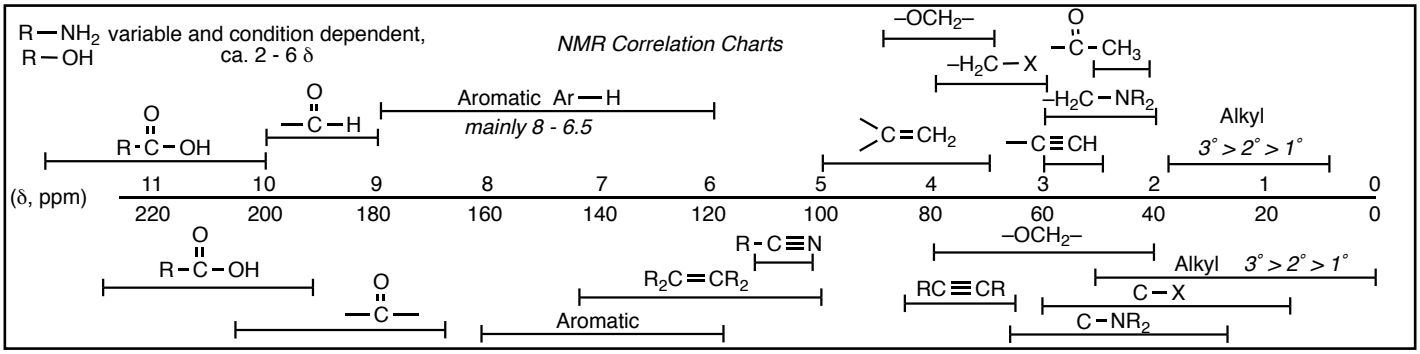
- *PRINT YOUR NAME ON EACH PAGE!*
- *READ THE DIRECTIONS CAREFULLY!*
- *USE BLANK PAGES AS SCRATCH PAPER*
  work on blank pages will not be graded...
- *WRITE CLEARLY!*
- *MOLECULAR MODELS ARE ALLOWED*
- *DO NOT USE RED INK*
- *DON'T CHEAT, USE COMMON SENSE!*

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn

Interaction Energies, kcal/mol

Eclipsing		Gauche	
H/H	-1.0	Me/Me	-0.9
H/Me	-1.4	Et/Me	-0.95
Me/Me	-2.6	i-Pr/Me	-1.1
Et/Et	-3.1	t-Bu/Me	-2.7





YOU MUST COMPLETE THIS PAGE WITH YOUR NAME
(EVEN THOUGH YOU ALREADY DID THIS ON THE COVER PAGE)
AND ALSO GIVE YOUR ASU OR POSTING ID NUMBER
WE NEED THIS NUMBER BECAUSE YOU WOULDN'T BELIEVE THE NUMBER OF STUDENTS WHOSE NAMES WE CAN'T READ!

PRINTED **FIRST** NAME **ANSWER** _____ *PRINTED* **LAST** NAME **KEY** _____ *ASU ID or Posting ID* _____

Points by question

1_____**/18**

2_____**/16**

3_____**/12**

4a_____**/2**

4b_____**/36**

4c_____**/10**

5_____**/10**

6_____**/12**

7_____**/27**

8_____**/16**

9_____**/16**

Points Removed for cover errors ____**/2**

Extra Credit_____**/5**

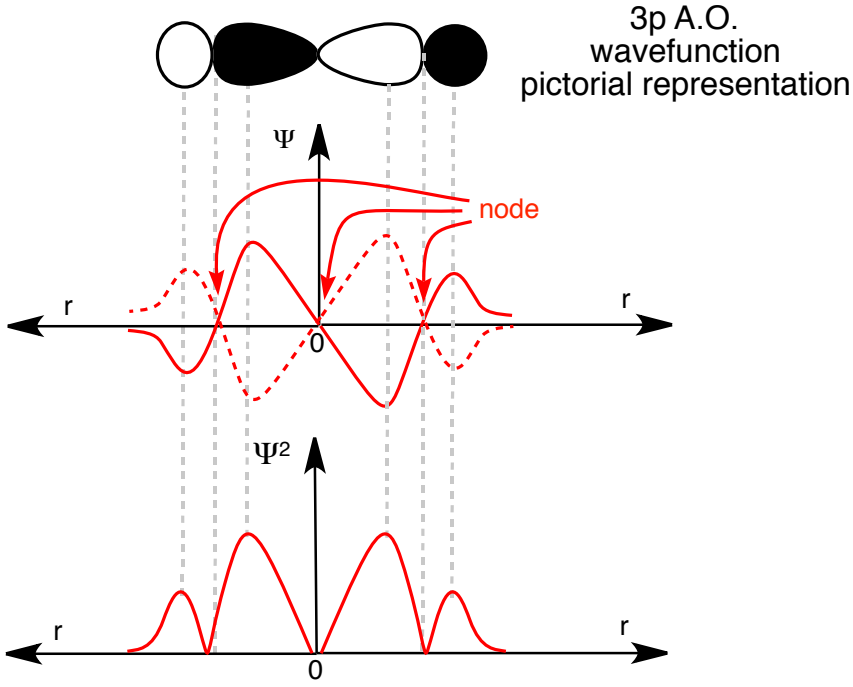
Total (incl Extra)_____**/175+5**

*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

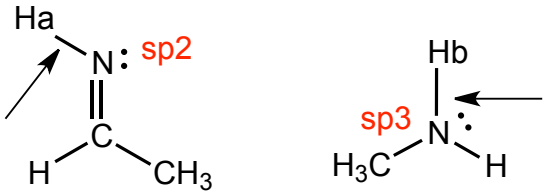
Question 1 (18 pts.) Here is a pictorial representation of the Ψ of a 3p atomic orbital.

a) Give a plot of the magnitude of the wavefunction (Ψ) versus distance from the nucleus, r, on the axes provided, **AND IDENTIFY ANY NODES ON THIS PLOT**

b) Give a plot of the magnitude of the wavefunction squared (Ψ^2) versus distance from the nucleus, r, on the axes provided

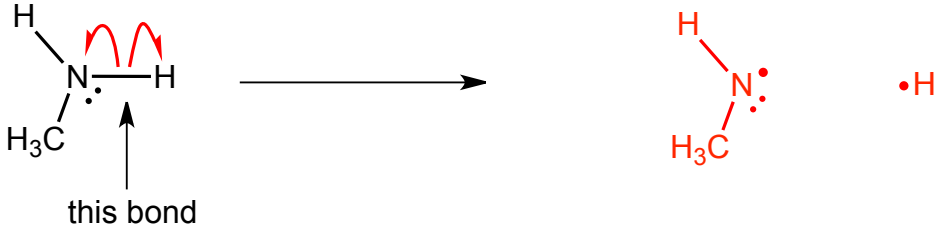


Question 2 (16 pts.) For the N-Ha and N-Hb bonds in the 2 structures below, explain which would have the LARGER bond dissociation energy (BDE) and give a BRIEF explanation that must include the term "energy of the electrons".



The N-Ha BDE is larger because the energy of the electrons in the bond are lower in energy because the bond is built using a N sp2 hybrid orbital insetad of an sp3 hybrid orbital as in N-Hb, the lower p character in the bonding M.O., the lower the energy of the electrons, the larger the BDE.

Question 3 (12 pts.) For homolytic dissociation of the N-H bond indicated below by the arrow, draw the curved arrow-pushing that describe bond breaking and give the product of bond breaking. Include all non-bonding electrons



Question 4 For the molecular formula C_5H_8

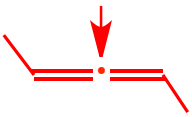
a) (2 pts.) Give the degrees of unsaturation

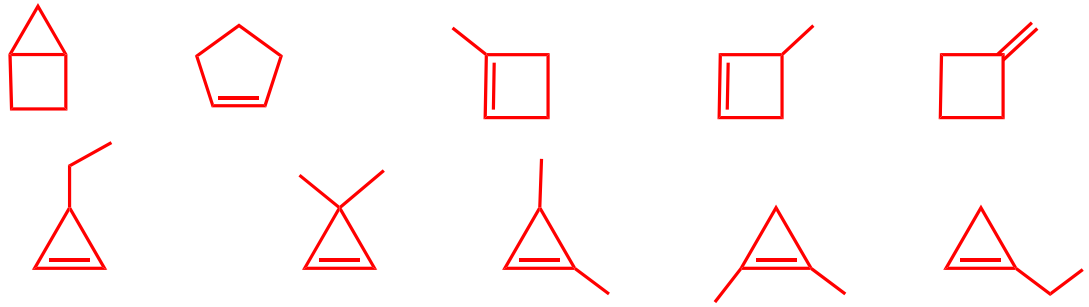
2 degrees of unsaturation

b) (36 pts.) Draw **SIX** structural isomers that obey the normal rules of valence for each atom. You can draw Lewis structures or line-angle structures (your choice).

here are several, there are more...

structures like this should be LINEAR at THIS sp hybridized carbon

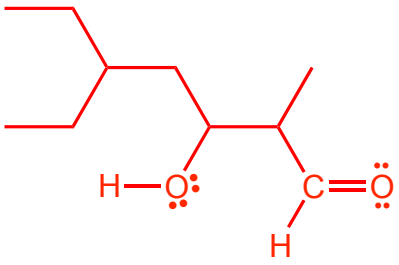




c) (10 pts.) Draw **ONE PAIR** of stereoisomers that obey the normal rules of valence for each atom for C_5H_8. You do NOT have to identiy cis- or trans-isomers. **DO NOT INCLUDE ANY STRUCTURES in part c) THAT WERE DRAWN AS PART OF YOUR ANSWER TO PART b) OF THIS QUESTION**

Question 5 (10 pts.) Convert the provided condensed formula into a line-angle structure (include all non-bonding electrons).

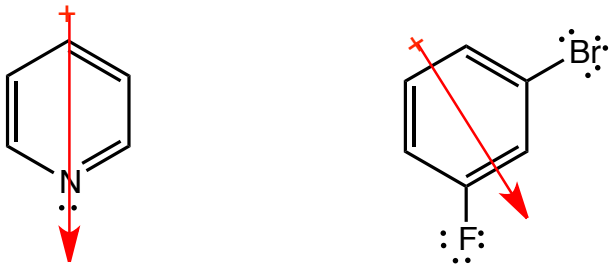
$(CH_3CH_2)_2CHCH_2CH(OH)CH(CH_3)CHO$



Extra Credit (5 pts.) In the "Organic Chemistry in Real Life" pages, anti-bonding molecular orbitals were described as playing an important role in which of the following

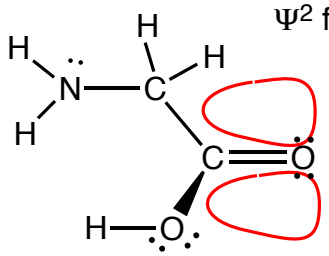
(color) burning hydrocarbons ATP energy conversion

Question 6. (12 pts). Indicate the direction of the MOLECULAR dipole moments in the following.



Question 7 (27 pts.) Shown below is the simplest amino acid, glycine, in its neutral form. For the orbitals indicated, draw directly ON TOP of the molecule either Ψ or Ψ^2 as requested (read the question carefully!) and **indicate the appropriate atomic orbitals that are involved**. For drawings of Ψ, **indicate ALL NODES**. For drawings of Ψ^2**, indicate all places where the probability of finding the electrons is zero.**

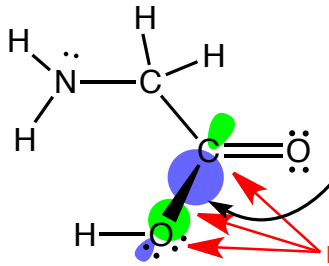
Ψ^2 for the carbon-oxygen π bonding orbital



carbon: p A.O.
oxygen: p A.O.

electron probability = zero

note that orbital is larger towards oxygen end because O is more electronegative than C. -2pts if this incorrect.

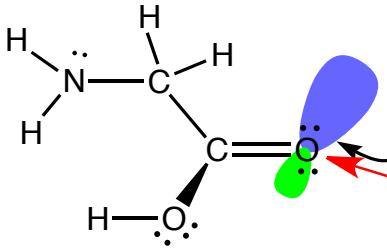


oxygen: sp^3 A.O.
carbon: sp^2 A.O.

Ψ for the carbon-oxygen σ* ANTI-bonding orbital

nodes

the orbital is larger towards carbon end because O is more electronegative than C and antibonding orbitals have opposite direction to bonding orbitals.

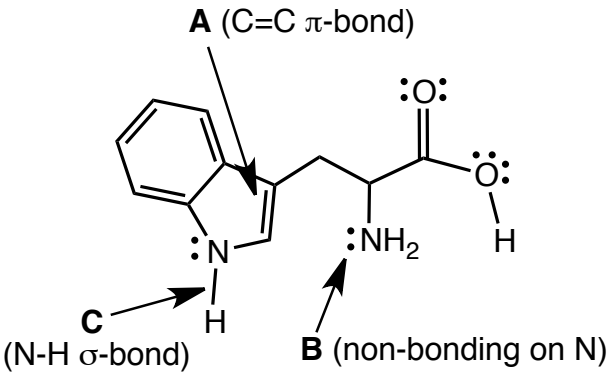


oxygen: sp^2 A.O

Ψ for the non-bonding electrons on oxygen

node

Question 8 (16 pts.) Rank the indicated pairs of electrons **A** - **C** in the essential amino acid tryptophan (shown in its neutral form) in order of increasing energy. Give a BRIEF explanation for your choice (all of the points are for the explanation, not the order)

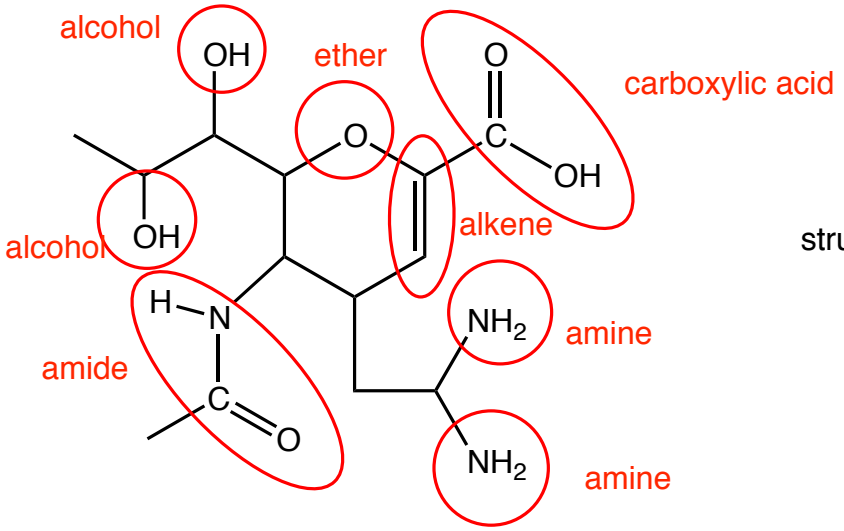


C < **A** < **B**

lowest energy — highest energy

electrons in sigma-bonds are lower in energy than those in pi-bonds since they are closer to the nuclei, non-bonding electrons are generally higher in energy than any bonding electrons because they are stabilized by a single nucleus only, compared to two nuclei for bonding electrons

Question 9 (16 pts.) Circle and identify all functional groups in the following structure, ignore alkyl groups. Indicate any amines, amides or alcohols as primary, secondary or tertiary, as appropriate. Non-bonding electrons are omitted in this structure for clarity.



structure based on that of Relenza - a flu drug