CHEM 3451 Tarek Sammakia Spring 2017 Exam 1

Name Answer Key

Periodic Table

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	La	Ha	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac															

Please sit with an empty seat between you and your neighbors.

Unless specifically asked, you do not have to draw mechanisms for reactions.

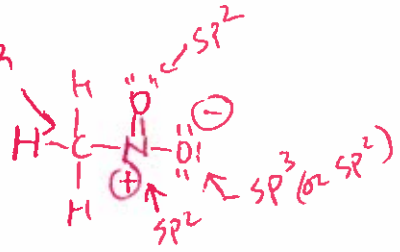
For full credit, any explanations you write should **be complete and grammatically-correct sentences**.

Feel free to ask questions about the questions, but **please don't ask questions about your answers**; I won't answer them and it distracts your neighbors.

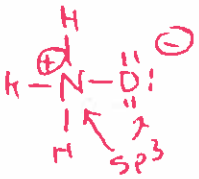
	Possible	Earned
Page 2	31	_____
Page 3	28	_____
Page 4	28	_____
Page 5	18	_____
Total	100	_____

1 For all the molecules shown below, please provide the following and note that the connectivity is as indicated in each formula. In other words, if I write H_3C, it means that there are three hydrogens attached to the carbon.
a) The Lewis structure including all lone pairs of electrons.
b) The hybridizaton for all the non-H atoms.
c) The formal charge for all non-H atoms (+, -, or 0 as appropriate). **Hint:** Even if there is not an overall charge in the molecule, there can be a formal charge on atoms. 21 points total

6 pts H_3CNO_2

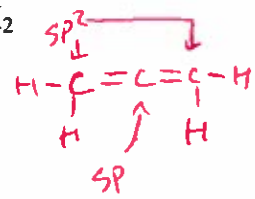


6 pts H_3NO

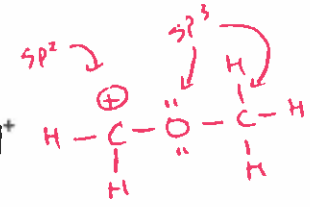


Struct 2 pts
Hybrid 2 pts
charge 2 pts

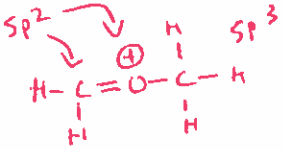
4 pts H_2CCCH_2



5 pts $[H_2COCH_3]^+$



OR



2) Please provide definitions for the terms provided below in one sentence. (10 pts).

- Electronegativity: The tendency of an atom in a molecule (or bond) to attract electrons towards itself

- Nucleophile: a species with a relatively high energy pair of electrons (or with a singly occupied orbital) that can attack an empty orbital

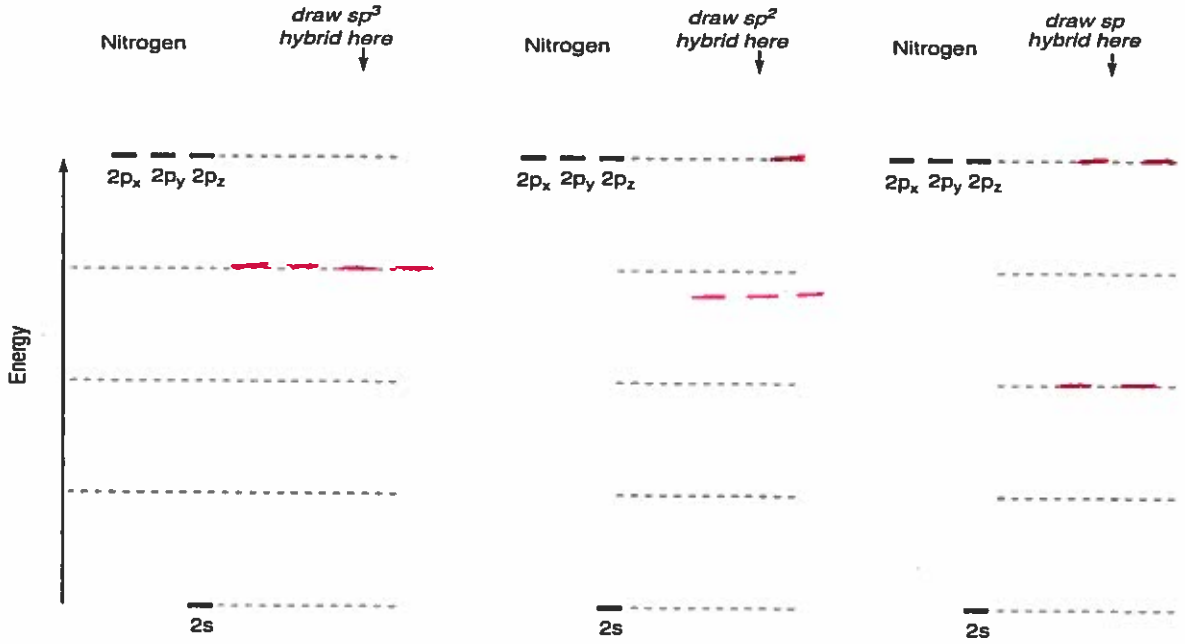
- Electrophile: a species with a relatively low E orbital that can be attacked by a pair of electrons (or by a single electron)

- Bonding molecular Orbital: The in-phase combination of two atomic orbitals on different atoms

- Antibonding molecular Orbital: The out-of-phase combination of two atomic orbitals on different atoms such that there is a node between the nuclei

Total pts this page:

3) Below are the orbital energies for nitrogen's valence shell orbitals.
a) Provide the energy diagram for all the orbitals of an sp^3 hybridized nitrogen
b) Provide the energy diagram for all the orbitals of an sp^2 hybridized nitrogen
c) Provide the energy diagram for all the orbitals of an sp hybridized nitrogen.
Hint: Your energy diagram should include a total of 4 orbitals in each case. Also, pay attention to the energies of all your orbitals and make sure they are lined up correctly with respect to the starting atomic orbitals and with respect to each other (the grid lines are provided to help you line-up the energies of your orbitals). (12 pts total)



4 a) Draw the 3-dimentional shape of a nitrogen sp hybrid orbital (I just want one orbital). Include the **sign of the wave function** in your drawing. (4 points)

b) How does the 3-dimentional size and shape of an oxygen sp hybrid differ from the nitrogen sp hybrid orbital? Explain this in one sentence. (3 points)

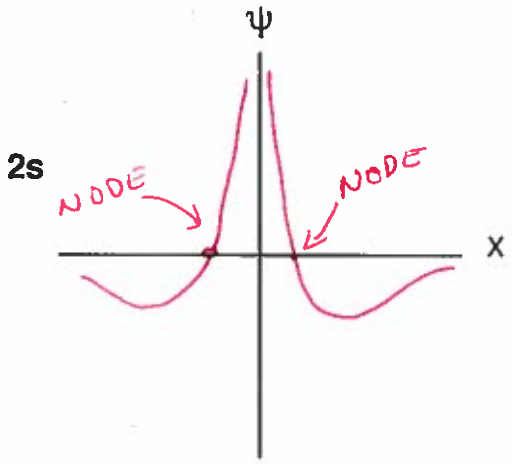
The oxygen sp^3 is smaller than the nitrogen sp^3

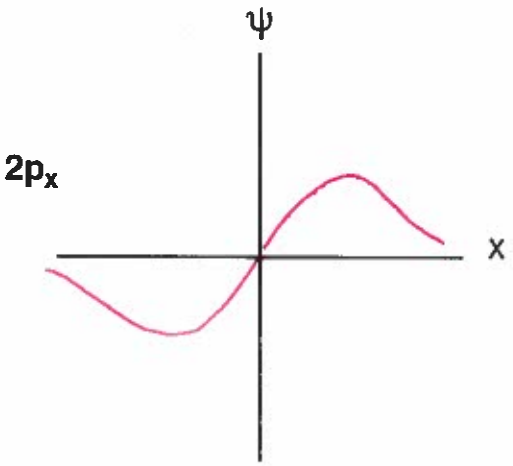
c) Are these molecular orbitals? Provide a **yes** or **no** answer and explain in one sentence. (4 pts)

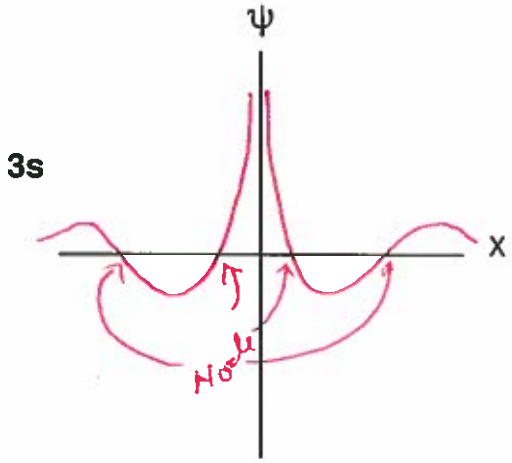
No. They are hybrid atomic orbitals that exist on an isolated atom.

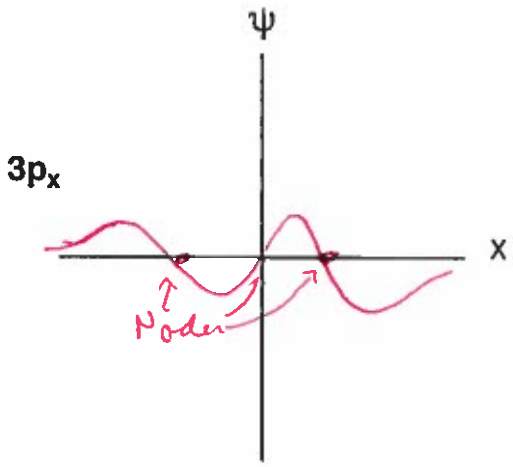
Total pts this page:

5) Draw ψ (i.e., the wave function) and show the presence of any nodes for the following orbitals (16 pts)









6) The Pauling electronegativity for hydrogen, boron, carbon, and oxygen are as follows: H = 2.2 ; B = 2.0 ; C = 2.5 ; O = 3.4. Four bonds are shown below: B-H, C-H; C-O; O-H.

a) Draw a "dipole arrow" (i.e., ⟷) to indicate the direction of the dipole for each bond (8 pts).

b) Which dipole is larger, B-H, C-H or C-O. Explain your answer in one sentence (4 pts).

the difference in electronegativity between C & O is the greatest, so the C-O bond is the most polarized

Total pts this page:

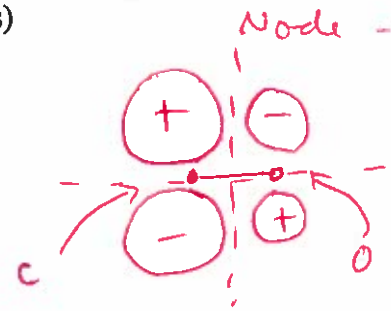
7) I provided three rules for writing reaction mechanisms. Provide them below (in any order you wish) and indicate if they are ever violated. (12 pts)

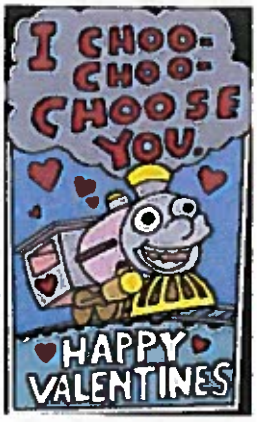
Rule 1 (can it be violated? **YES** or **NO**): Attack w/ electrons

Rule 2 (can it be violated? **YES** or **NO**): Electrons attack empty orbitals

Rule 3 (can it be violated? **YES** or **NO**): Break bonds towards the more electronegative atom

8) Draw the shape of the π* molecular orbital for a C-O bond. Pay attention to the **shape, sign, and size** of the lobes of your orbital and indicate with a dashed line the presence of any nodes and the **significance of those nodes** with respect to rendering the orbital an antibonding orbital. (6 pts)





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