# 2019 Spring Semester Quiz 2
## For General Chemistry I (CH101)

*Date: Apr 01 (Mon),    Time: 19:00 ~ 19:45*

| Professor Name | Class | Student I.D. Number | Name |
|---|---|---|---|
|  |  |  |  |

**1.** (Total 10 pts) **Choose the correct answer to complete each statement.** (2 pts for each correct sentence, –2 pts for wrong sentence, 0 pt for no answer.)

**(a) Ground state electron configuration of Chromium is ( [Ar] 3d⁴ 4s²   /  ⟨[Ar] 3d⁵ 4s¹⟩ ). (Atomic number of Chromium is 24.)**

**(b) Atomic N is ( ⟨paramagnetic⟩ /   diamagnetic ), and Molecular N₂ is ( paramagnetic   /   ⟨diamagnetic⟩ )**

**(c) Ionization energy of Aluminum is ( larger   / ⟨smaller⟩ ) than Magnesium.**

**(d) Bond length of C₂ is ( longer   / ⟨shorter⟩ ) than B₂.**

**(e) Angular momentum quantum number($l$) describing 2p$_z$ orbital is (   0   / ⟨1⟩ /   –1   / both 1 and –1 ).**

**2.** (Total 10 pts) **Identify the orbital for each given wavefunctions of an electron in a hydrogen atom. ($a_0 = 0.529 \times 10^{-10}$ m)**
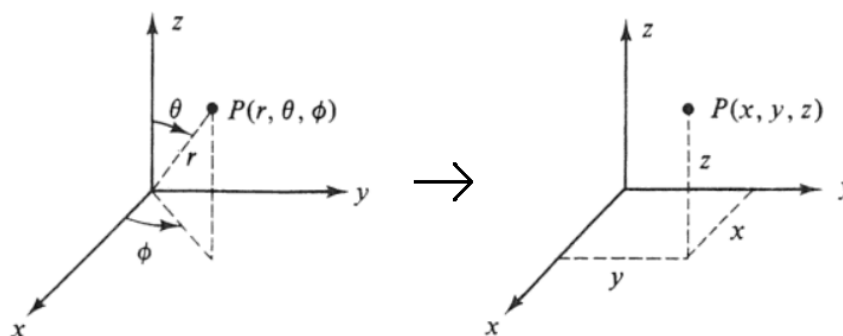
**(a)** (5 pts)  $\psi(r, \theta, \varphi) = \frac{1}{4\sqrt{2\pi}} \left(\frac{1}{a_0}\right)^{3/2} \left(2 - \frac{r}{a_0}\right) \ e^{-r/2a_0}$

**Answer : _____2s_____ (no partial point)**

**(b)** (5 pts)  $\psi(r, \theta, \phi) = \frac{1}{81\sqrt{2\pi}} \left(\frac{1}{a_0}\right)^{3/2} \left(\frac{r}{a_0}\right)^2 \ e^{-r/3a_0} \sin\theta \cos\theta \sin\phi$
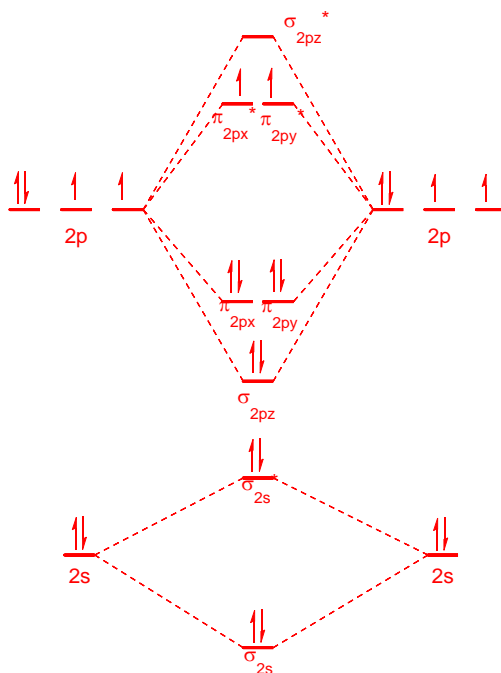
**Answer : _____3d$_{yz}$_____ (no partial point)**

**<Hint for Problem 2>**

**3.** (Total 10 pts) **Answer the question below.**

**(a)** (6 pts) **Draw the correlation diagram of the valence electron of $O_2$. Consider only 2s, 2p$_x$, 2p$_y$, and 2p$_z$ atomic orbitals. Consider O–O bond is parallel to z-axis. You should clearly note which atomic orbital contributes to molecular orbital. Also, you don't have to mention the symmetry(g, u) of orbitals.**
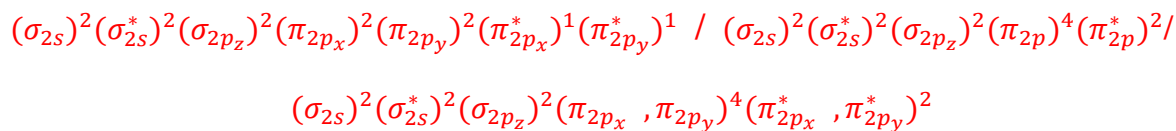


**<채점기준>**

**1. Proper MO order : +4 points (if wrong, 0 point)**

**2. Proper electron placement (Pauli / Hund / Aufbau) : +1 point**

**3. Proper labeling of MO : +1 point**

**(b)** (2 pts) **Using correlation diagram above, determine the ground-state valence electron configuration of the $O_2$ molecule.**

**All notation shown below are possible answers.**

$$(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p_z})^2(\pi_{2p_x})^2(\pi_{2p_y})^2(\pi_{2p_x}^*)^1(\pi_{2p_y}^*)^1 \ / \ (\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p_z})^2(\pi_{2p})^4(\pi_{2p}^*)^2/$$

$$(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p_z})^2(\pi_{2p_x},\pi_{2p_y})^4(\pi_{2p_x}^*,\pi_{2p_y}^*)^2$$

**If AO is not mentioned, -0.5 point.**

**If 1s orbital related MO mentioned, –0.5 point.**

**(c)** (2 pts) **Predict the bond length of $O_2$, $O_2^+$, and $O_2^-$.**

**Answer : (  $O_2^-$  ) > (  $O_2$  ) > (  $O_2^+$  )**

**4.** (Total 10 pts) **Calcium carbide, is a compound with the chemical formula of $CaC_2$. It is used for the industrial production of acetylene($C_2H_2$). It is the calcium salt of the carbide ion($C_2^{2-}$).**
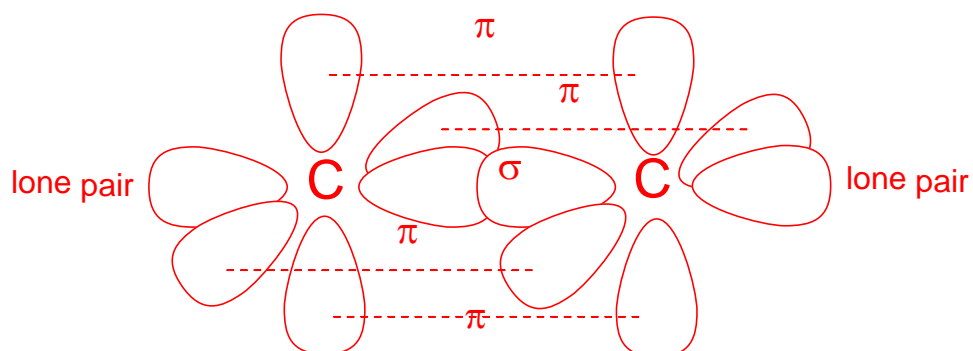**(a)** (2 pts) **Draw the Lewis diagram of carbide ion. Indicate formal charge of each atom.**

**(Hint : Consider the structure of acetylene($C_2H_2$) may help.)**

$$-1 \qquad -1$$
$$:C\!\!\equiv\!\!C:$$
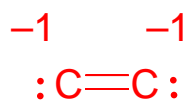
Proper Lewis diagram : +1 point

Proper Formal Charge : +1 point

**(b)** (4 pts) **Sketch a valence bond (VB) model of the carbide ion, showing the hybridization on the C atoms, the σ skeletal structure, lone pair electrons and π-bonding.**
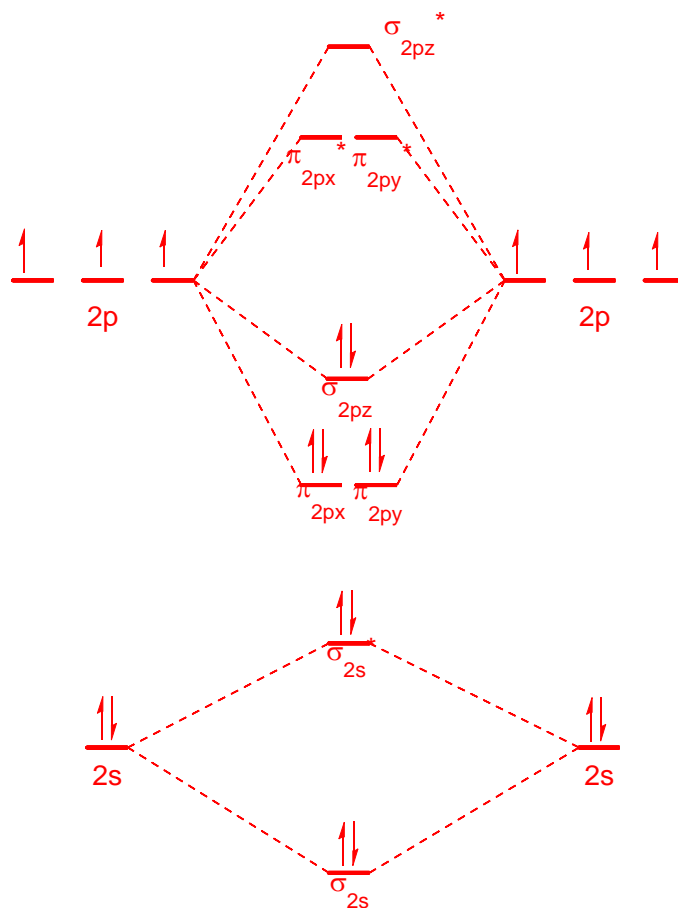


C is sp hybridized.

Proper drawing of orbital : +2 points

Correct mentioning of Hybridization : +1 point

Correct mentioning of Bond / Lone pair : +1 point

**(c) (4pts) Draw the correlation diagram of the valence electron of carbide ion to determine bond order. Consider only 2s, 2p$_x$, 2p$_y$, and 2p$_z$ atomic orbitals. Consider C–C bond is parallel to z-axis. You should clearly note which atomic orbital contributes to molecular orbital. Also, you don't have to mention the symmetry(g, u) of orbitals.**

**Example of orbital notation :** $\sigma^*_{2p_z}$

$\sigma^*_{2pz}$

$\pi^*_{2px}$  $\pi^*_{2py}$

2p                    2p

$\sigma_{2pz}$

$\pi_{2px}$  $\pi_{2py}$

$\sigma^*_{2s}$

2s                    2s

$\sigma_{2s}$

**Bond order : _____3_____**

**1. Proper MO order : +2 points (if wrong, 0 point)**

**2. Proper electron placement (Pauli / Hund / Aufbau) : +0.5 point**

**3. Proper labeling of MO : +0.5 point**

**4. Correct bond order : +1 point**