1a. Draw what the molecular orbital diagram would look like for Li₂. (The Atomic orbitals have been drawn for you). (1)

\[
\begin{array}{c|c}
2s & 2s \\
\hline
\end{array}
\]

1b. What is the bond order for Li₂? (1)

1c. Which compound is more stable Li₂ or Li₂⁻? (Explain) (1)

2. Rank the following in terms of increasing electron affinity and explain. (3)
Be⁻, N, O, N⁻, F, and C⁺

3. Calculate the approximate atomic radius of a neutral oxygen atom in the ground state. (4)

\[
r = \frac{n\varepsilon_0 h^2}{nm_e^2 Z_{eff}^2}
\]
\[
\begin{align*}
\varepsilon_0 (\text{permittivity}) &= 8.85 \times 10^{-12} \text{C}^2 \text{J}^{-1} \text{m}^{-1} \\
h &= 6.626 \times 10^{-34} \text{J} \cdot \text{s} \\
m_e &= 9.1 \times 10^{-31} \text{kg} \\
e &= 4.8 \times 10^{-19} \text{C} \\
n &= \text{valence shell number}
\end{align*}
\]
1. a) Fill in the empty MO diagram for He$_2$. Label the atomic orbitals and the bonding and anti-bonding MO. Be sure to include the correct number of electrons and the correct spin.

He$_2$

b) Calculate the bond order of He$_2$. Does the bond order indicate that He$_2$ is a stable compound?

2. The particle in a box problem can be extended into three dimensions. The energies of this model are given by the following equation:

\[ E_{x,y,z} = \frac{\hbar^2}{8m} \left( \frac{n_x^2}{L_x^2} + \frac{n_y^2}{L_y^2} + \frac{n_z^2}{L_z^2} \right) \]

In this equation, $n_x$, $n_y$, and $n_z$ are independent quantum numbers.

a) Five electrons are placed into a symmetrical, cubic ($L_x = L_y = L_z$) 3-D box. Draw an energy diagram of this system and fill the 5 electrons into the diagram. Indicate the amount of unpaired electrons. (HINT: find the lowest few energy levels)

Number of unpaired electrons:

b) Five electrons are now placed into a rectangular box. In this box, $L_x = L_y > L_z$. Draw an energy diagram of this system and fill the 5 electrons. Indicate the amount of unpaired electrons.

Number of unpaired electrons:
CHEM202
Quiz 4.3
20min
09/20/07

1. a) As we go across row 2 what patterns do we notice? How do these relate to the common trends found on the periodic table? Explain these again in terms of $Z_{\text{eff}}$ (1)

b) Now draw molecular orbital diagrams for $\text{H}_2$, $\text{H}_2^+$, $\text{H}_2^-$. What would the bond order be for these compounds? Now rank these compounds in terms of bond length? (3)

2. Calculate the approximate atomic radius of a neutral nitrogen atom in the ground state. (3)

$$r = \frac{m_e \alpha \hbar^2}{m_e e^2 Z_{\text{eff}}}$$

$\epsilon_0$ (permittivity) = $8.85 \times 10^{-12}$ C$^2$J$^{-1}$m$^{-1}$

$\hbar = 6.626 \times 10^{-29}$ Js

$m_e = 9.1 \times 10^{-31}$ kg

$\alpha = 1.6 \times 10^{-13}$ C

$n$ = valence shell number

3. Write down the complete electronic configuration of: (3)
   a) Iodine
   b) Cesium (Cs)
   c) Titanium (Ti)