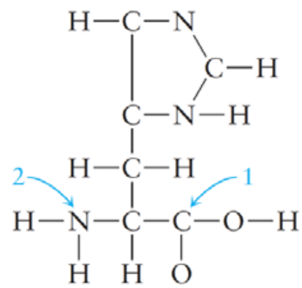
# Chemistry 204: Quiz #2

1. The following is a skeletal structure of the amino acid histidine. Complete the Lewis structure such that **all atoms have a formal charge of zero**, and answer the following question.




Which of the following best describes the hybridization around the carbon atom labeled 1 and the nitrogen atom labeled 2?

| | **Carbon atom (#1)** | **Nitrogen atom (#2)** |
|---|---|---|
| a) | $sp^3$ | $dsp^3$ |
| a) | $sp^2$ | $sp^2$ |
| b) | $sp^3$ | $sp^3$ |
| d) | $sp^3$ | $sp^2$ |
| e) | $sp^2$ | $sp^3$ |

2. Starch turns blue in the presence of iodine because of the formation of the triiodide ion ($I_3^-$). What is the hybridization of the center iodine in the triiodide ion?

a) $sp$ b) $sp^2$ c) $sp^3$ d) $dsp^3$ e) $d^2sp^3$

3. You are told that the shape around a specific atom in a molecule or ion is linear. From just this information, can you specify the hybridization of the atom?

a) No, a linear shape can result in two different hybridizations.
b) No, a linear shape can result in three different hybridizations.
c) No, a linear shape can result in five different hybridizations.
d) Yes, the atom must be *sp* hybridized.
e) It turns out the atom is not hybridized if the shape is linear.

4. Consider removing one electron from the $N_2$ molecule and one electron from the $O_2$ molecule. What is expected to happen to the bond lengths?

a) The bond lengths are expected to increase for both.
b) The bond lengths are expected to decrease for both.
c) The bond length is expected to increase when forming $N_2^+$ and to decrease when forming $O_2^+$.
d) The bond length is expected increase when forming $O_2^+$ and to decrease when forming $N_2^+$.

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5. Which of the following has the lowest ionization energy?

   a) $N_2$  b) $N_2^-$  c) O  d) $O_2$  e) $O_2^-$

6. You learned a long, long time ago that nitrogen, oxygen, and fluorine gases are all diatomic (written as $X_2$), and with Lewis structures you can determine the number of bonds and relative bond strengths. But what about removing an electron (resulting in $X_2^+$) or adding an electron (resulting in $X_2^-$)? Lewis structures do not help us determine what happens to the relative bond strengths. No fear – molecular orbital (MO) theory can!

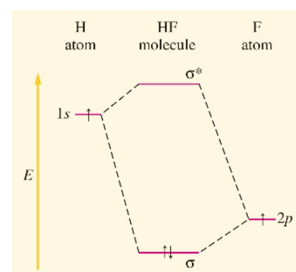
   a. Fill in the table below with $N_2$, $O_2$, and $F_2$ in the appropriate boxes – each molecule should be written twice; once for when an electron is removed, and once for when an electron is added. For example, we discussed in lecture that removing an electron from $H_2$ results in a weaker bond, so if I asked about $H_2$, you would write $H_2$ in the upper left box.

| | Weaker bond than $X_2$ | Stronger bond than $X_2$ |
|---|---|---|
| Removing an electron ($X_2^+$) | | |
| Adding an electron ($X_2^-$) | | |

   b. Use **MO energy-level diagrams** to **justify** your answers in the table in part a.

   c. One of the boxes in part a should be blank. Are there any homonuclear diatomic molecules ($X_2$; **not** an ion) that would be placed in that box? If yes, provide an example molecule with explanation. If not, explain why not, using the premises of MO theory.

   d. For $N_2$, $O_2$, and $F_2$, all bond strengths were greatly affected by both the adding and removing of an electron. It turns out that removing an electron from the HF molecule (resulting in $HF^+$) does not appreciably change the bond strength. A figure in the textbook (reproduced here) shows a partial MO energy level-diagram for the HF molecule (focusing only on the orbitals involved in bonding). **Sketch the complete MO energy-level diagram** (with **explanation**) for all valence electrons in H and F and **explain** why the bond strength does not change much.

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**KEY:**

MC: 1. e, 2. d, 3. b, 4. c, 5. e

6. See videos, lectures, and the textbook.