Question 1

MC101

How many nodes does the antibonding $\sigma^*$ orbital have in the N–H bond in the following molecule?

\[
\begin{array}{c}
\text{H} \\
\text{C} = \text{N}^* \\
\text{H} \\
\text{H}
\end{array}
\]

A : 0 nodes  
B : 1 node  
C : 2 nodes  
D : 3 nodes

Question 2

MCvsepr2

How many sp, sp$^2$ and sp$^3$ CARBONS ATOMS (ignore the oxygens) are there in the estrogen Mestranol (line-angle structure provided)?

\[
\begin{array}{c}
\text{Mestranol}
\end{array}
\]

\[
\begin{array}{c|c|c|c|c}
 & A & B & C & D \\
\hline
\text{# of sp} & 2 & 3 & 2 & 1 \\
\text{# of sp}^2 & 8 & 6 & 6 & 6 \\
\text{# of sp}^3 & 11 & 12 & 13 & 14 \\
\end{array}
\]
Question 3

MC10g

The three Lewis structures shown below, I, II and II, are incomplete since some of the atoms should have been assigned a formal charge. How many atoms for these structures IN TOTAL are missing a formal charge (add the number of missing charges in structure I to those in structure II to those in structure III)? All non-bonding pairs of electron are shown.

A  3 atoms total (over all 3 structures) are missing a formal charge
B  4 atoms total (over all 3 structures) are missing a formal charge
C  5 atoms total (over all 3 structures) are missing a formal charge
D  6 atoms total (over all 3 structures) are missing a formal charge

Question 4

MC10za

For the C-H bonds in methane, which best represents a plot of the magnitude of the wavefunction of the localized C-H $\sigma^*$-anti-bonding molecular orbital along the C-H internuclear axis (hint, draw a picture of the orbital on the indicated C-H bond and work from there, we did not do an example of this in class, work it out by analogy to similar plots we made for the atomic orbitals)

(the C and H on the horizontal axes provided represent the positions of the C and the H nuclei in the C-H bond)
Question 5
MC10q
What would you expect to be the order of INCREASING first ionization potential for the following four related 1-carbon structures? All non-bonding electrons and formal charges are included in all structures. The methyl cation, anion and methylene are all very reactive intermediates, methane itself is stable and represents the major component of natural gas.

```
1 methyl cation
H   H
H   H

2 methane
H   H
H   H

3 methyl anion
H   H
H   H

4 methylene

```

First ionization potential refers to the energy required to remove the first electron from a structure, i.e. the highest energy electron

A) \(4 < 2 < 3 < 1\)  
B) \(2 < 4 < 1 < 3\)  
C) \(3 < 4 < 2 < 1\)  
D) \(1 < 3 < 4 < 2\)

Question 6
MC10zb
Which best represents the \(\Psi^2\) for the C-C sigma bond in ethane, shown below? (the colors have no absolute meaning, when different colors are used they merely represent changes in phase that could equally well be represented by shading and non-shading)

```
H   C   C   H  ethane
H   H   H   H

```

```
A

H   H   H   H
H   C   C   H

B

H   H   H   H
H   C   C   H

C

H   H   H   H
H   C   C   H

D

H   H   H   H
H   C   C   H

```
Question 7
MC10z
Which best describes the $\Psi$ for the $\pi$-bonding molecular orbital in ethylene?

the colors blue and green have no particular significance, except that changes in a picture color mean the same thing as shading and non-shading

A
\begin{center}
\begin{tikzpicture}
  \draw (-0.5,0) -- (0.5,0);
  \draw (-0.5,0.5) -- (0.5,0.5);
  \draw (-0.5,-0.5) -- (0.5,-0.5);
  \draw (-0.1,0.1) -- (0.1,0.1);
  \draw (-0.1,-0.1) -- (0.1,-0.1);
  \draw (0,0) circle (0.2);
  \draw (0,0.2) circle (0.2);
  \draw (0,-0.2) circle (0.2);
  \draw (0.1,0.1) -- (0.1,-0.1);
  \draw (0.1,0.1) -- (0.1,0.5);
  \draw (0.1,-0.1) -- (0.1,-0.5);
  \draw (-0.1,0.1) -- (-0.1,0.5);
  \draw (-0.1,-0.1) -- (-0.1,-0.5);
  \draw (-0.1,0.1) -- (-0.1,0.5);
  \draw (-0.1,-0.1) -- (-0.1,-0.5);
\end{tikzpicture}
\end{center}

B
\begin{center}
\begin{tikzpicture}
  \draw (-0.5,0) -- (0.5,0);
  \draw (-0.5,0.5) -- (0.5,0.5);
  \draw (-0.5,-0.5) -- (0.5,-0.5);
  \draw (-0.1,0.1) -- (0.1,0.1);
  \draw (-0.1,-0.1) -- (0.1,-0.1);
  \draw (0,0) circle (0.2);
  \draw (0,0.2) circle (0.2);
  \draw (0,-0.2) circle (0.2);
  \draw (0.1,0.1) -- (0.1,-0.1);
  \draw (0.1,0.1) -- (0.1,0.5);
  \draw (0.1,-0.1) -- (0.1,-0.5);
  \draw (-0.1,0.1) -- (-0.1,0.5);
  \draw (-0.1,-0.1) -- (-0.1,-0.5);
  \draw (-0.1,0.1) -- (-0.1,0.5);
  \draw (-0.1,-0.1) -- (-0.1,-0.5);
\end{tikzpicture}
\end{center}

C
\begin{center}
\begin{tikzpicture}
  \draw (-0.5,0) -- (0.5,0);
  \draw (-0.5,0.5) -- (0.5,0.5);
  \draw (-0.5,-0.5) -- (0.5,-0.5);
  \draw (-0.1,0.1) -- (0.1,0.1);
  \draw (-0.1,-0.1) -- (0.1,-0.1);
  \draw (0,0) circle (0.2);
  \draw (0,0.2) circle (0.2);
  \draw (0,-0.2) circle (0.2);
  \draw (0.1,0.1) -- (0.1,-0.1);
  \draw (0.1,0.1) -- (0.1,0.5);
  \draw (0.1,-0.1) -- (0.1,-0.5);
  \draw (-0.1,0.1) -- (-0.1,0.5);
  \draw (-0.1,-0.1) -- (-0.1,-0.5);
  \draw (-0.1,0.1) -- (-0.1,0.5);
  \draw (-0.1,-0.1) -- (-0.1,-0.5);
\end{tikzpicture}
\end{center}

D
\begin{center}
\begin{tikzpicture}
  \draw (-0.5,0) -- (0.5,0);
  \draw (-0.5,0.5) -- (0.5,0.5);
  \draw (-0.5,-0.5) -- (0.5,-0.5);
  \draw (-0.1,0.1) -- (0.1,0.1);
  \draw (-0.1,-0.1) -- (0.1,-0.1);
  \draw (0,0) circle (0.2);
  \draw (0,0.2) circle (0.2);
  \draw (0,-0.2) circle (0.2);
  \draw (0.1,0.1) -- (0.1,-0.1);
  \draw (0.1,0.1) -- (0.1,0.5);
  \draw (0.1,-0.1) -- (0.1,-0.5);
  \draw (-0.1,0.1) -- (-0.1,0.5);
  \draw (-0.1,-0.1) -- (-0.1,-0.5);
  \draw (-0.1,0.1) -- (-0.1,0.5);
  \draw (-0.1,-0.1) -- (-0.1,-0.5);
\end{tikzpicture}
\end{center}

Question 8
MCvserpl
How many sp, sp$^2$ and sp$^3$ CARBONS ATOMS are there in Viagra? (look at the carbon atoms ONLY, ignore N, S, O etc)
(non-bonding electrons not shown for clarity)

\begin{center}
\begin{tabular}{l|cccc}
 & A & B & C & D \\
\hline
# of sp & 1 & 0 & 0 & 0 \\
# of sp$^2$ & 11 & 10 & 12 & 11 \\
# of sp$^3$ & 10 & 12 & 10 & 11 \\
\end{tabular}
\end{center}
QUESTION 9
There are NO INCORRECT answers to this question, ALL answers to this question will be considered correct for grading purposes.
What overall final grade do you expect to earn in this class?
A
B
C
D

QUESTION 10
There are NO INCORRECT answers to this question, ALL answers to this question will be considered correct for grading purposes.
How hard did you work on organic chemistry this week (not including watching/attending lectures)?
A  Very Hard
B  Hard
C  Somewhat Hard
D  Not very Hard this week