Question 1
MC10p

Which is the correct order of INCREASING first ionization potential for the following four molecules?

1 isopronanol (rubbing alcohol) 2 methane (swamp gas, really!) 3 trimethylamine (rotting fish smell!) 4 ethylene (the monomer of polyethylene)

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

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

Remember, electrons that are not in bonds are almost always higher in energy, thus molecules containing non-bonding electrons will have lower ionization potentials (it takes less energy to remove the non-bonding electrons to infinity)

Oxygen in more electronegative than nitrogen, thus the non-bonding electrons on ethanol are "held more tightly" than those on trimethylamine

Electrons in π-bonds are higher in energy (held less tightly by the nuclei) than electrons in σ-bonds, thus ethylene has a lower first ionization potential than methane

Actually, the ionization potentials for isopropylalcohol is only slightly lower than that for ethylene, which illustrates that non-bonding electrons on oxygen are very stabilized by electronegativity, and are often similar in energy to those in a simple carbon-carbon π-bond
Question 2
MC10k

The three Lewis structures below are incomplete in that the non-bonding electrons are missing. What is the TOTAL number non-bonding PAIRS of electrons that are missing from the three structures? (Add the number of missing electron pairs on nitromethane to the number missing on the amide anion to the number missing on ozone). ALL formal charges are included.

A 10 non-bonding PAIRS missing (20 total electrons)
B 11 non-bonding pairs missing (22 total electrons)
C 12 non-bonding pairs missing (24 total electrons)
D 13 non-bonding pairs missing (26 total electrons)

5 pairs here       2 pairs here       6 pairs here

non-bonding pairs indicated in RED
Question 3

Which of the following pictures best describes $\Psi^2$ for the $\sigma$-bonding molecular orbital associated with the carbon-nitrogen bond in the molecule shown.

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.

$\Psi^2$ for any wavefunction should contain NO phase information, so pictures with more than one color are clearly wrong. Structures B and D show the ATOMIC ORBITALS that are used to make the molecular orbitals.
Question 4
MC10s

Which of the following pictures best describes $\Psi$ for the $\pi^*$ ANTI-bonding molecular orbital in the molecule shown. (non-bonding electrons on N not included for clarity)

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.

$\Psi$ for any wavefunction should contain phase information, so pictures with only one color are clearly wrong. The antibonding M.O. has one more node than the bonding M.O.
Question 5
MCstruc5
Identify the following pairs of structures, I and II, as being structural isomers, stereoisomers, the same structure, or different structures with different molecular formulae

**pair I**

**pair II**

A I = structural isomers and II = the same

B I = the same and II = structural isomers

C I = different and II = stereoisomers

D I = stereoisomers and II = structural isomers

**pair I**
both have longest chain = 7 carbons, both have C=C at the C3-C4 position, BUT the -CH3 groups are on different sides of the C=C bond

**pair II**
both have longest chain = 7 carbons but the position of the C=C bond is different
Question 6
MC10q

Which represents the best picture of the $\Psi$ for the bonding molecular orbital between the carbon and the fluorine atom in the refrigerant Freon-11?

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

A $\Psi$ must properly indicate the phase information of the orbital, in this case by a change in color. Thus A and B are incorrect because there is simply no indicated change in phase. Fluorine is much more electronegative than carbon, thus the M.O. should be "larger" towards the fluorine "end" of the bond.
**Question 7**

MCdipole1

Which is the correct order of INCREASING molecular dipole moment?

A 1 < 2 < 3 ~ 4  
B 4 < 3 < 2 ~ 1  
C 4 ~ 3 < 1 < 2  
D 2 < 1 < 3 < 4

Bond dipoles that contribute to the Molecular dipoles are shown in red, the overall molecular dipole moment is shown in blue.

1  
2  
3  
4

compared to 1, the two extra dipoles "add", making a larger dipole moment than 1

all bond dipoles cancel, NO overall molecular dipole moment

all bond dipoles cancel, NO overall molecular dipole moment

represent bond dipole moments

represent overall molecular dipole moment, relative length of arrow corresponds roughly to relative magnitude of molecular dipole moment
Question 8

Identify the following three pairs of structures I, II and III as STEREOISOMERS, STRUCTURAL ISOMERS, THE SAME or DIFFERENT STRUCTURES with DIFFERENT Molecular Formulae

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>I = stereoisomers</td>
<td>II = structural isomers</td>
<td>III = the same</td>
</tr>
<tr>
<td>B</td>
<td>I = stereoisomers</td>
<td>II = stereoisomers</td>
<td>III = structural isomers</td>
</tr>
<tr>
<td>C</td>
<td>I = the same</td>
<td>II = the same</td>
<td>III = stereoisomers</td>
</tr>
<tr>
<td>D</td>
<td>I = stereoisomers</td>
<td>II = the same</td>
<td>III = stereoisomers</td>
</tr>
</tbody>
</table>

I flip

II bond rotate

III opposite sides

same side