Test 1, Summer 2009 ***Name ___ Answer Key_____***
Chemistry 211 ***60 points*** ***May 20, 2009***

Circle the best answer in bold*, or write short answers; be sure to address <u>all</u> parts of each question.*

1. (3) List <u>three</u> reasons why carbon is able to form so many compounds (over 30 million are known!).

   a. Carbon forms 4 strong bonds, including bonds to other C atoms
   b. Carbon can forms rings and long chains with other carbon atoms
   c. Carbon has three different geometries
   d. Carbon forms strong bonds to several other elements

2. (3) Circle the name of the American physicist who was responsible for developing the modern theory of covalent bonding in the early part of the 1900's and after whom the electron-dot structure was named:

   a. **Debye** b. **Einstein** c. **Lewis** d. **Pauling** d. **Heisenberg** e. **Schrödinger**

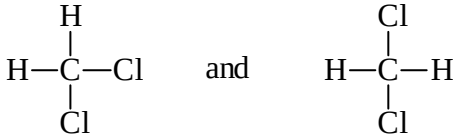
3. (3) A(n) **(orbital, antibonding M.O., shell, tetrahedron , vacuum)** is the space (including shape and orientation) in which there is a high probability of finding an electron.

4. (4) Name and summarize <u>two</u> of the three principles or rules followed in the process of distributing electrons into a set of atomic orbitals.

   a. Aufbau principle – electrons fill lower energy orbitals first, then higher energy orbitals
   b. Pauli exclusion principle – there can only be 2 electrons per orbital
   c. Hund's rule – electrons are distributed among equal energy (degenerate) orbitals before pairing up, before filling higher energy orbitals

5. (3) What experimental observation led to the notion of a tetrahedral arrangement of four single bonds around a carbon atom as opposed to a planar arrangement? Sketches may prove useful.

   Only one form of CH_2Cl_2 exists. If carbon had a square planar geometry, two forms would be possible:

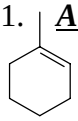
6. (3) In the process of forming ions, atoms gain or lose electrons in order to achieve a(n) **(pair, quartet, sextet, octet, dozen, gross, gazillion)** of electrons in the outermost shell.

7. (3) In 1916 G.N. Lewis first proposed the bonding in covalent substances to be due to a **(sticky, glued, shared, matched, double)** pair of electrons between bonded atoms.

8. (3) The bond length of a double bond is **(longer than, the same as, shorter than)** that of a single bond.

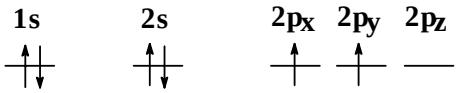
9. (3) The bond strength of a single bond is **(less than 1/3, exactly 1/3, more than 1/3)** that of a triple bond.

10. (5) Match the LETTER of the functional group name with the number of the structure on the board:

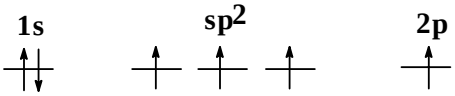
    1. ***A*** alkene 
    2. ***E*** alcohol CH_3OH
    3. ***F*** ether CH_3OCH_3
    4. ***M*** ester CH_3COCH_3
    5. ***J*** aldehyde CH_3CH

11. (4) Fill the electrons (as arrows) in the atomic orbital diagram for a carbon atom shown below, then show how hybridization occurs to form the hybrid orbitals used by carbon in ethene ($H_2C=CH_2$). Label <u>all</u> orbitals.

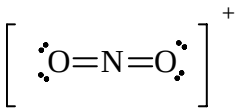
atomic orbital configuration of C:

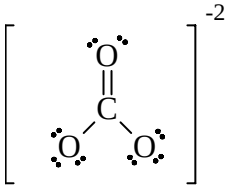


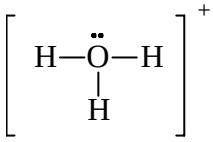
hybrid orbital configuration of C:



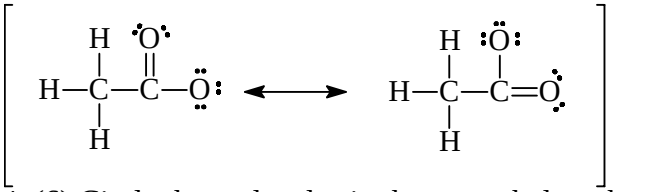
12. (9) For each of the following compounds or ions, indicate the <u>hybrid atomic orbitals</u> used by the central atom and the <u>(ideal) bond angles</u> about the central atom. <u>Name the geometry</u> about the central atom. (You should start by drawing an acceptable Lewis structure of each substance, but your Lewis structure itself will not be graded.)

NO_2^+  *sp, 180º, linear*

CO_3^{-2}  *sp^2, 120º, trigonal planar*

H_3O^+  *sp^3, 109.5º, trigonal pyramid*

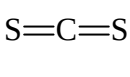
13. (4) Draw two acceptable Lewis structures for the acetate ion ($CH_3CO_2^-$). Comment on the relative lengths of the two carbon-oxygen bonds. Calculate the formal charge on the carbon that is attached to the two oxygens.

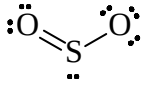


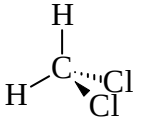
The carbon-oxygen bonds are <u>equal</u> in length.
The formal charge on C is zero.

14. (6) Circle the molecules in the group below that are <u>polar</u>. (you may want to draw a Lewis structure first, and predict the geometry, but those will not be graded)

CS_2 SO_2 CH_2Cl_2







15. (4) The pK_a of phenol is 9; the pK_a of ethyl acetate is 25. Which is more acidic? Could the conjugate base of phenol be used effectively to remove a proton from ethyl acetate?

Phenol is more acidic; No, its conjugate base is weaker than the conjugate base of ethyl acetate.