

NAME: \_\_\_\_\_  
STUDENT NUMBER: \_\_\_\_\_

SECTION: \_\_\_\_\_

**CHM 1045, 2001**  
**General Chemistry I. – Gelb**

Homework #11 (due 12/4/2001) Total: 10 points.

Read the questions carefully! You must **show your work** and use the correct number of significant figures in order to receive full credit for numerical problems. Remember to also put your name, number and recitation section on it! Attach additional sheets if necessary.

1. (1 point.) What hybridization scheme(s) is (are) acceptable for an atom having:

(a) A double bond

(b) A triple bond

(c) two double bonds

In each case, explain your answer and give an example.

2. (2 points.) Suggest an acceptable hybridization scheme expected for **every** atom (besides hydrogens) in each of the following:

(a)  $\text{CH}_4$

(b)  $\text{PF}_3$

(c)  $\text{SF}_6$

(d) benzene

(e)  $\text{NO}_2$

(f)  $\text{HCOOH}$  (formic acid)

(g) acetone

(h)  $\text{O}_2^{2-}$

3. (1 point.) Draw all the possible isomers of each of the following molecules.

(a)  $C_2H_2F_2$

(b)  $CHClBrF$

(c) difluorobenzene

4. (1 point.) Use trigonometry to calculate the tetrahedral angle to 8 significant figures (the text gives it as  $109.5^\circ$ , but this is only approximate.) (*Hint: remember that a tetrahedron can be drawn "inscribed" inside a cube.*)

5. (1 point.) Assume that the molecular orbital energy level diagram of Figure 10.27 (in your textbook) is applicable to heteronuclear diatomic molecules. For each of the following, predict the bond order and whether the molecule is paramagnetic or diamagnetic.

(a) CO

(b) OF

(c) NO<sup>-</sup>

(d) CN<sup>-</sup>

6. (1 point.) Draw molecular structures for each of the following:

(a) 3,4-dichlorotoluene

(b) 1,3,5-triphenylbenzene

(c) *para*-aminobenzoic acid (PABA, an ingredient in sunscreens.)

(d) hexaiodobenzene

7. (1 point.) The dipole moment of the diatomic molecule NaCl is 9.001 D, and the dipole moment of NaF is 8.156 D.

(a) Use these data to predict the bond-length of NaCl.

(b) Compare this with the prediction using ionic bond radii from Chapter 8. Consider that the NaCl bond is only partially ionic - use the ionic bond radii from Chapter 8 and the dipole moment given above to calculate the fractional charge on each atom.

(c) Repeat the above for NaF. Is NaF more or less ionic than NaCl ?

8. (2 points.) Multiple bonds.

(a) Compare the carbon-carbon single, double and triple bond energies in Table 9.1. Estimate the average energy of a single  $\pi$ -bond from these.

(b) Do the same for nitrogen-nitrogen  $\pi$ -bonds. What are the differences, if any, between the carbon and nitrogen cases?

(c) Write Lewis structures of  $C_2H_4$ ,  $N_2H_2$ ,  $C_2H_2$ , and  $N_2$ , and determine the hybridization of the central atoms in each case.

(d) Suggest an explanation for the differences between parts (a) and (b).