

**AP Chemistry Problem Set Chapters 8 & 9**

Name \_\_\_\_\_

Due: Tuesday, December 19<sup>th</sup>, 2006

30 points – 4 points for completion, 3 random essay problems will be graded, each worth 5 points. Each multiple choice must be answered (1 point each). Staple this sheet to the front of your essay responses.

**Multiple Choice.** Please indicate your multiple choice answers below.

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_ 5. \_\_\_\_\_

6. \_\_\_\_\_ 7. \_\_\_\_\_ 8. \_\_\_\_\_ 9. \_\_\_\_\_ 10. \_\_\_\_\_

1.  $\text{CCl}_4$ ,  $\text{CO}_2$ ,  $\text{PCl}_3$ ,  $\text{PCl}_5$ ,  $\text{SF}_6$  Which of the following does not describe any of the molecules above?  
(A) Linear (B) Octahedral (C) Square planar (D) Tetrahedral (E) Trigonal pyramidal

2. The melting point of  $\text{MgO}$  is higher than that of  $\text{NaF}$ . Explanations for this observation include which of the following?

- I.  $\text{Mg}^{2+}$  is more positively charged than  $\text{Na}^+$
- II.  $\text{O}^{2-}$  is more negatively charged than  $\text{F}^-$
- III. The  $\text{O}^{2-}$  ion is smaller than the  $\text{F}^-$  ion

(A) II only (B) I and II only (C) I and III only (D) II and III only (E) I, II, and III

3. Which ionic compound has the highest melting point?

(A)  $\text{KCl}$  (B)  $\text{K}_2\text{O}$  (C)  $\text{CaCl}_2$  (D)  $\text{CaO}$  (E)  $\text{CaBr}_2$ 

4. Of the following molecules, which has the largest dipole moment?

(A)  $\text{CO}$  (B)  $\text{CO}_2$  (C)  $\text{O}_2$  (D)  $\text{HF}$  (E)  $\text{F}_2$ 

5. Molecules that have planar configurations include which of the following?

- I.  $\text{BCl}_3$
- II.  $\text{CHCl}_3$
- III.  $\text{NCl}_3$

(A) I only (B) III only (C) I and II only (D) II and III only (E) I, II, and III

6. The electron-dot structure (Lewis structure) for which of the following molecules would have two unshared pairs of electrons on the central atom?

(A)  $\text{H}_2\text{S}$  (B)  $\text{NH}_3$  (C)  $\text{CH}_4$  (D)  $\text{HCN}$  (E)  $\text{CO}_2$ 

7. Which of the following molecules has a dipole moment of zero?

(A)  $\text{C}_6\text{H}_6$  (benzene) (B)  $\text{NO}$  (C)  $\text{SO}_2$  (D)  $\text{NH}_3$  (E)  $\text{H}_2\text{S}$ 

8. Types of hybridization exhibited by the C atoms in propene,  $\text{CH}_3\text{CHCH}_2$ , include which of the following?

- I.  $\text{sp}$
- II.  $\text{sp}^2$
- III.  $\text{sp}^3$

(A) I only (B) III only (C) I and II only (D) II and III only (E) I, II, and III

9. The  $\text{SbCl}_5$  molecule has trigonal bipyramid structure. Therefore, the hybridization of Sb orbitals should be:

(A)  $\text{sp}^2$  (B)  $\text{sp}^3$  (C)  $\text{dsp}^2$  (D)  $\text{dsp}^3$  (E)  $\text{d}^2\text{sp}^3$ 

10. Which of the following compounds is ionic and contains both sigma and pi covalent bonds?

(A)  $\text{Fe}(\text{OH})_3$  (B)  $\text{HClO}$  (C)  $\text{H}_2\text{S}$  (D)  $\text{NO}_2$  (E)  $\text{NaCN}$ **Essays:**

**#1 (1989 - #5)**

- (a) Draw a Lewis electron-dot structure for each of the molecules above and identify the shape of each.  
 (b) Use the valence shell electron-pair repulsion (VSEPR) model to explain the geometry of each of these molecules.

**#2 (1990 - #5)**

Use simple structure and bonding models to account for each of the following.

- (a) The bond length between the two carbon atoms is shorter in  $\text{C}_2\text{H}_4$  than in  $\text{C}_2\text{H}_6$ .  
 (b) The H - N - H bond angle is  $107.5^\circ$  in  $\text{NH}_3$ .  
 (c) The bond lengths in  $\text{SO}_3$  are all identical and are shorter than a sulfur-oxygen single bond.  
 (d) The  $\text{I}_3^-$  ion is linear.

**#3 (1992 - #9)**

Nitrogen is the central atom in each of the species given above.

- (a) Draw the Lewis electron-dot structure for each of the three species.  
 (b) List the species in order of increasing bond angle. Justify your answer.  
 (c) Select one of the species and give the hybridization of the nitrogen atom in it.  
 (d) Identify the only one of the species that dimerizes and explain what causes it to do so.

**#4. (1999 - #8)**

Answer the following questions using principles of chemical bonding and molecular structure.

Consider the carbon dioxide molecule,  $\text{CO}_2$ , and the carbonate ion,  $\text{CO}_3^{2-}$ .

- a. Draw the complete Lewis electron-dot structure for each species.  
 b. Account for the fact that the carbon-oxygen bond length in  $\text{CO}_3^{2-}$  is greater than the carbon-oxygen bond length in  $\text{CO}_2$ .

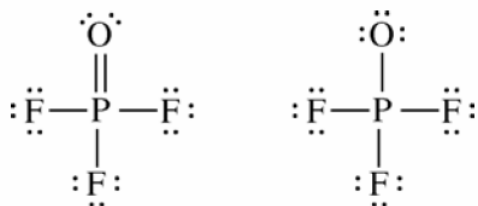
Consider the molecules  $\text{CF}_4$  and  $\text{SF}_4$ .

- a. Draw the complete Lewis electron-dot structure for each molecule.  
 b. In terms of molecular geometry, account for the fact that the  $\text{CF}_4$  molecule is nonpolar, whereas the  $\text{SF}_4$  molecule is polar.

**#5. (2005 - #6)**

Answer the following questions that relate to chemical bonding.

- a. Draw the complete Lewis structure (electron-dot diagram) for each of the following:  $\text{CF}_4$   $\text{PF}_5$   $\text{SF}_4$   
 b. On the basis of the Lewis structures drawn, answer the following questions about the particular molecule indicated.  
 (i) What is the F - C - F bond angle in  $\text{CF}_4$ ?  
 (ii) What is the hybridization of the valence orbitals of P in  $\text{PF}_5$ ?  
 (iii) What is the geometric shape formed by the atoms in  $\text{SF}_4$ ?  
 c. Two Lewis structures can be drawn for the  $\text{OPF}_3$  molecule, as shown below.



Structure 1

Structure 2

- (i) How many sigma bonds and how many pi bonds are in structure 1?  
 (ii) Which one of the two structures best represents a molecule of  $\text{OPF}_3$ ? Justify your answer in terms of formal charge.