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AP Chemistry – Hybrid Orbitals – 16

Name _____Per ___

1. What is the designation for the hybrid orbitals formed from each of the following combinations of atomic orbitals:

(a) one s and two p

(b) one s, three p, and one d

(c) one s, three p, and two d

2. List the characteristic bond angles associated with each hybrid orbital from question one:

(a)

(b)

(c)

3. What is the maximum number of hybrid orbitals that a Carbon atom can form? What is the minimum number? Explain.

4. What set of hybrid orbitals is used by the central atom in each of the following molecules and ions:

(a) $SiCl_4$

(b) HCN

(c) SO_3

(d) ICl_2^-

(e) BrF_4^-

5. If the valence atomic orbitals of an atom are sp hybridized, how many unhybridized p orbitals remain in the valence shell?

6. How many π bonds can the atom described in question 5 form?

7. How many σ and π bonds are generally part of a triple bond?

8. What type of rigidity do multiple bonds introduce into molecules?

9. The Nitrogen atoms in N_2 participate in multiple bonding, whereas those in Hydrazine, N_2H_4 do not. How can you explain this observation in light of the hybridization at the Nitrogen atoms in the two molecules?

10. Draw a single Lewis structure for SO_3, and determine the hybridization of the S atom.

11. Are there other equivalent Lewis structures for the molecule in question 10?

12. Would you expect SO_3 to exhibit delocalized π bonding? Explain.

13. Which of the following ions would you expect to be paramagnetic? O^+ , O^{2-} , N^{2-} , Li^+

14. The Lactic Acid molecule has the formula $CH_3CHOHCOOH$. Draw the Lewis structure for the molecule.
(a) How many σ and how many π bonds are in the molecule?
(b) Which CO bond is the shortest in the molecule?
(c) What is the hybridization of atomic orbitals around the carbon atom associated with the shortest CO bond?
(d) What are the approximate bond angles around each Carbon atom in the molecule?

15. Balance the following chemical equations:

a) $C_2H_5N + O_2 \Rightarrow CO_2 + H_2O + NO_2$

b) $TiCl_4 + H_2O \Rightarrow TiO_2 + HCl$

c) $NH_4NO_3 \Rightarrow N_2 + O_2 + H_2O$

d) $Ca_3P_2 + H_2O \Rightarrow Ca(OH)_2 + PH_3$

e) $Al(OH)_3 + HClO_4 \Rightarrow Al(ClO_4)_3 + H_2O$

f) $AgNO_3 + Na_2SO_4 \Rightarrow Ag_2SO_4 + NaNO_3$

g) $N_2H_4 + N_2O_4 \Rightarrow H_2O + N_2$

16. Convert these descriptions into balanced chemical equations:

a) When sulfur trioxide gas reacts with water, a solution of sulfuric acid forms.

b) Diboron trisulfide reacts violently with water to form boric acid and dihydrogen sulfide gas.

c) Phosphorus trihydride combusts in oxygen gas to form gaseous water and solid tetraphosphorus decoxide.

d) When solid mercury(II) nitrate is heated, it decomposes to form solid mercury(II) oxide, gaseous nitrogen dioxide and oxygen gas.

e) Copper metal reacts with hot concentrated sulfuric acid solution to form aqueous copper(II) sulfate, sulfur dioxide gas and water.

17. If Avogadro's number of pennies is divided equally among the 307 million people of the United States, how many dollars would each person receive? How does that compare to the national debt which is approximately 11.9 trillion dollars today?