SCH4U1

LEWIS STRUCTURES AND ORBITAL DIAGRAMS - ANSWERS

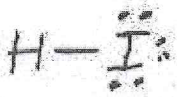
PART 1: Lewis Structures

Draw the Lewis Structure for each of the following compounds.

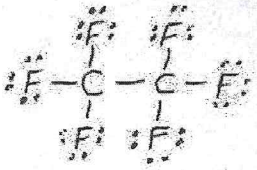
1) CS_2

2) BrCl

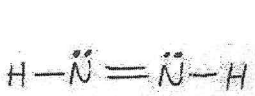
3) HI



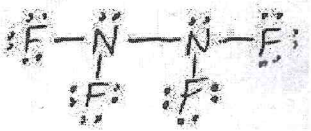
4) C_2F_6



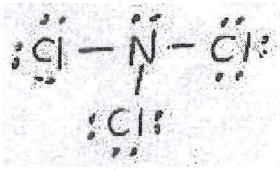
5) N_2H_2



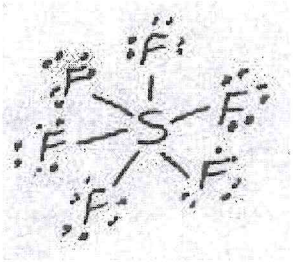
6) N_2F_4



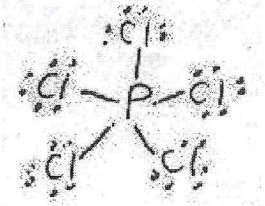
7) NCl_3



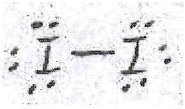
8) SF_6



9) PCl_5

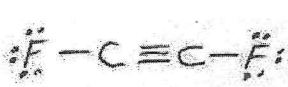


10) I_2

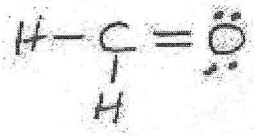


11) HCN

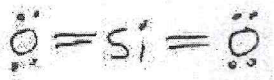
12) C_2F_2



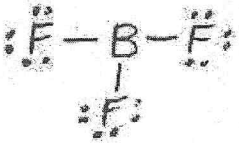
13) CH_2O



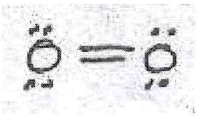
14) SiO_2



15) BF_3

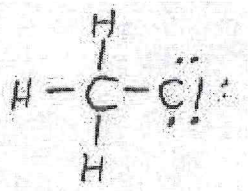


16) O_2

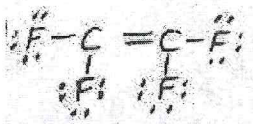


17) H_2S

18) CH_3Cl

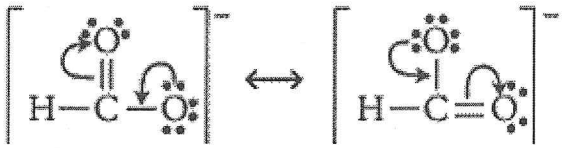


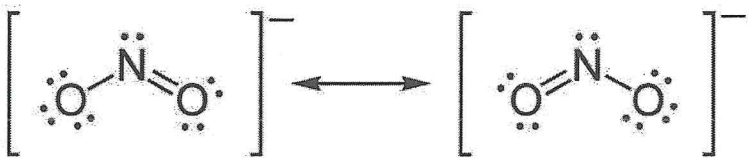
19) C_2F_4



20) C_2Br_2

Resonance Structures

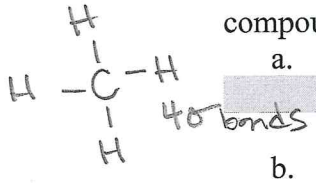




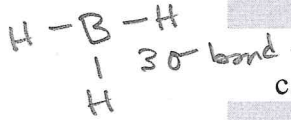
PART 2: Valence Bond Theory and Potential Energy Changes- ANSWERS

1. What atomic orbitals are available for bonding for each of the following atoms?
   a. H s orbital b. F p orbital
   c. S two p orbitals d. Br p orbital

2. Provide ground state and promoted state electron configurations for each of the following central atoms and indicate the type of hybridization involved when each atom forms a compound:

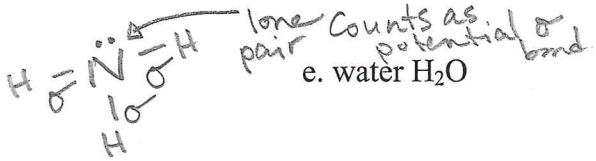


   a. carbon in CH_4 — ground state C: $1s^2 2s^2 2p^2$; promoted state C: $1s^2 2s^1 2p^3$; sp^3 hybridization (1+3 = 4σ)



   b. boron in BH_3 — ground state B: $1s^2 2s^2 2p$; promoted state B: $1s^2 2s^1 p^2$; sp^2 hybridization (1+2 = 3σ)

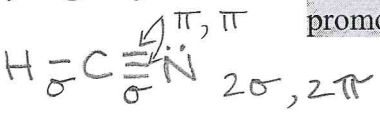
   c. beryllium in BeF_2 — ground state Be: $1s^2 2s^2$; promoted state Be: $1s^2 2s^1 p^1$; sp hybridization (1+1 = 2σ)



   d. ammonia NH_3 — ground state N: $1s^2 2s^2 2p^3$; promoted state N: $1s^2 2s^1 2p^4$; sp^3 hybridization

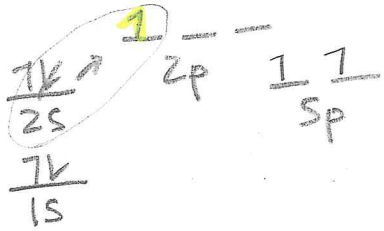
   e. water H_2O — ground state O: $1s^2 2s^2 2p^4$; promoted state O: $1s^2 2s^1 2p^5$; sp^3 hybridization

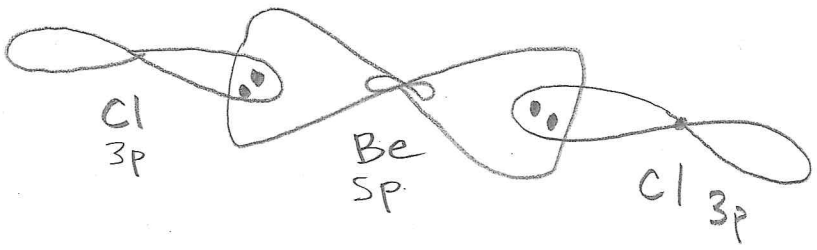
   f. hydrogen cyanide — ground state C: $1s^2 2s^2 2p^2$; promoted state C: $1s^2 2s^1 2p^3$; sp hybridization (1+1 = 2σ)



4. i. Draw the orbital representation for each of the following compounds
   ii. Draw the orbital shapes for the central atom and then include the overlapping orbitals forming the covalent bonds for each of the following molecules. For simplicity ignore filled orbitals that are not part of bonding. (Assume central atom is the only one that gets hybridized.

   a. $BeCl_2$ 



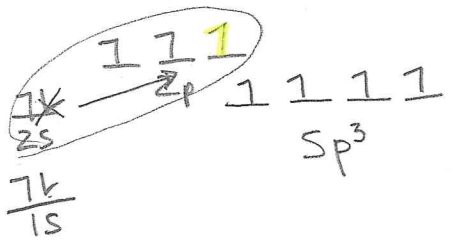


Be
Central atom.

Cl $1s^2 2s^2 2p^6 3s^2 3p^5$

b. CF_4

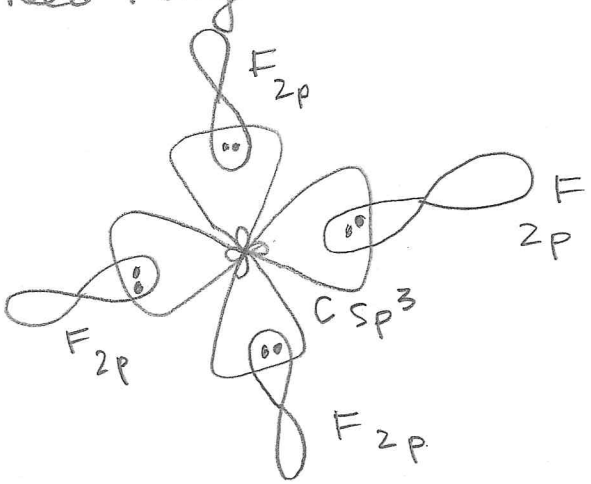
we need 4 single bonds



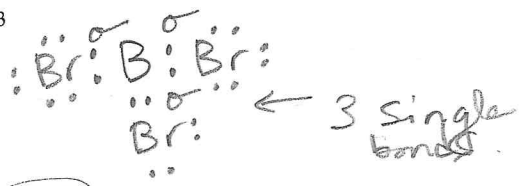
C

Central atom.

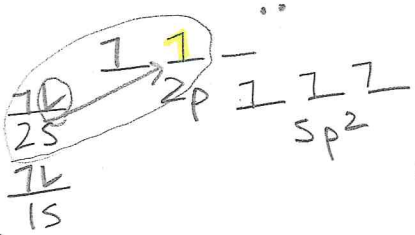
F $1s^2 2s^2 2p^5$



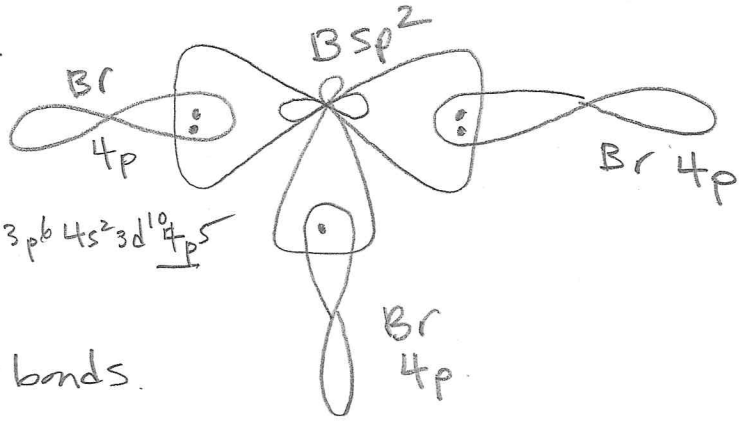
c. BBr_3



3 single bonds

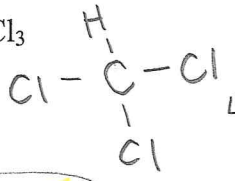


B

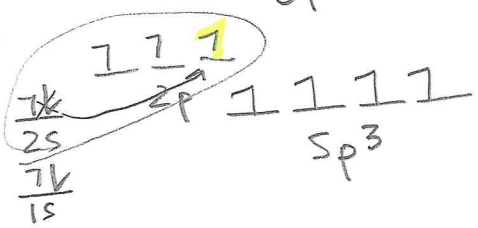


Br $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

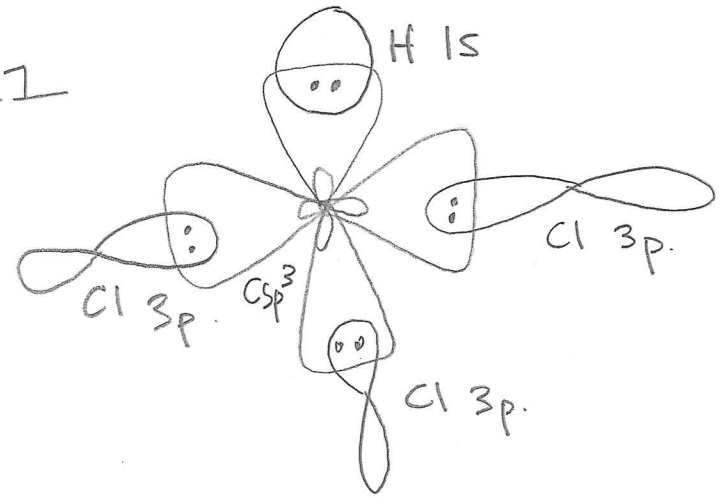
d. $CHCl_3$



4 σ bonds.



C

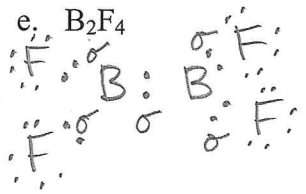


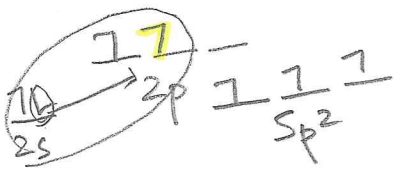
e. B_2F_4

6 e^-

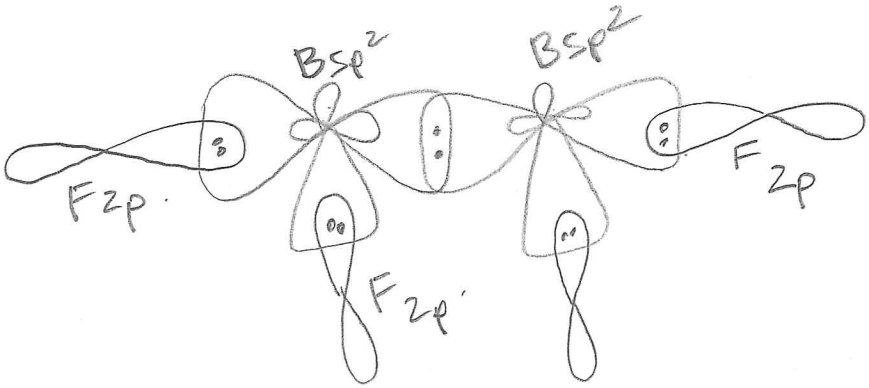
28 e^-

34 e^-



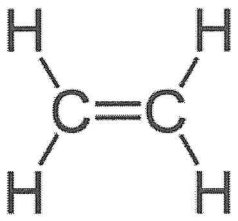


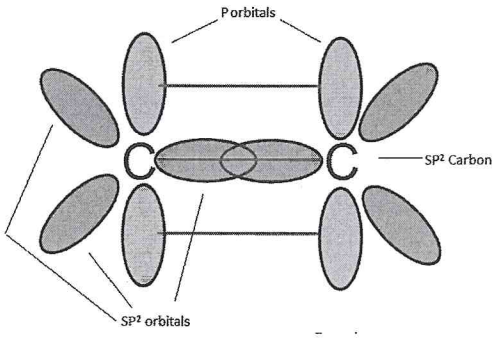
B



5. a) Draw a Lewis structure for ethane (C_2H_4)

b) Examine the diagram of the bonding orbitals in ethene (C_2H_4). Label each sigma and pi bond in the diagrams.





The red bond is a sigma bond, and the red orbitals shown will make a sigma bond with each hydrogen, for a total of 5 sigma bonds.
There is one pi bond, the blue.

FYI

Carbon atoms can form single, double and triple bonded molecules. However there is no experimental evidence for the existence of a quadruple C-C bond

The quadruple bond would have to much tension in the bond due to the four pairs of electrons all occupying a small area around the nucleus. It would create a bond situation that is so unstable it would not exist. You would have to have 1 sigma bond and 3 pi bonds. The p orbital that is parallel to the sigma bond could not reach around 180°.