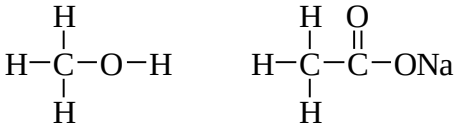
Chemistry 105, Chapter 7 Exercises

Types of Bonds

1. Using the periodic table classify the bonds in the following compounds as ionic or covalent. If covalent, classify the bond as polar or not.

   $MgBr_2$ CF_4 SiO_2 $CaNO_3$ HOF Br_2



Ionic Compounds

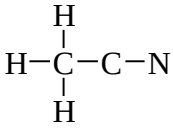
2. Complete and balance the following combination reactions showing the formation of an ionic compound.
   a. $Na + I_2 \rightarrow$
   b. $Mg + I_2 \rightarrow$
   c. $Fe + O_2 \rightarrow$ (for the product iron is +3)
   d. $Ca + N_2 \rightarrow$
   e. $Fe + S \rightarrow$ (for the product iron is +3)
   f. $Rb + N_2 \rightarrow$

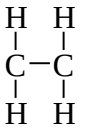
Lewis Structures

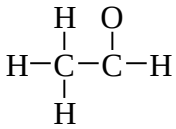
3. Write the Lewis structures for the following molecules and polyatomic ions. Unless otherwise noted, the first atom is the central atom.

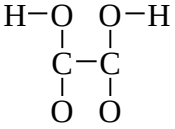
   a. NH_3
   b. CCl_4
   c. BrF_2^+
   d. $COCl_2$
   e. SCN^- (C is the central atom)
   f. CO
   g. HCO^+ (C is the central atom)
   h. CN^-
   i. XeF_2
   j. IO_2^-
   k. XeO_2F_2
   l. BF_3
   m. $SeBr_6$
   n. ICl_4^-
   o. SO_4^{2-}

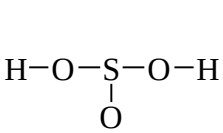
4. Draw Lewis structures (show all e- pairs) for the following species. The skeleton structure is shown. Multiple bonds may exist between bonded atoms.

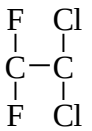




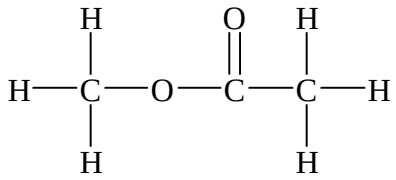


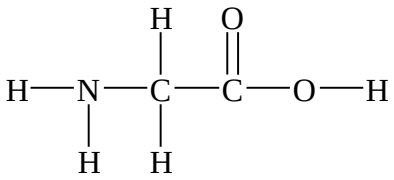


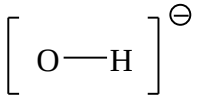


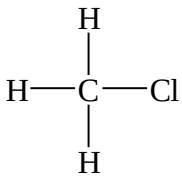


5. For the following compounds the correct number of bonds is shown. Supply the lone pairs of electrons.







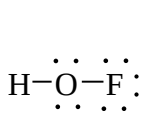


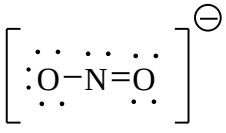
6. Draw resonance structures for the following.

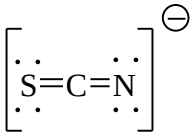
NO_2Cl (N is the central atom. The O's and Cl are bonded directly to N)
SO_3
NO_2^-
NNO (This is also the skeleton structure.)
HCO_2^- (C is the central atom. The O's and the H are bonded directly to the C.)

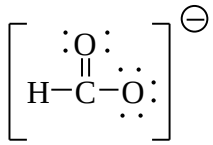
Formal Charges

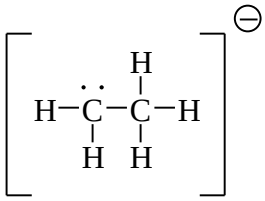
7. Assign formal charges to each element in the following compounds.

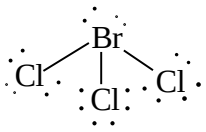




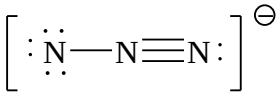


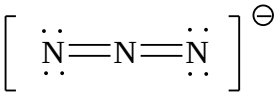




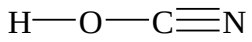


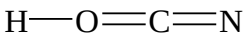
8. For the following two resonance structures assign formal charges and decide which is the most likely structure.





9. For the following two resonance structures assign formal charges and decide which is the most likely structure. You must first supply the lone pairs of electrons.





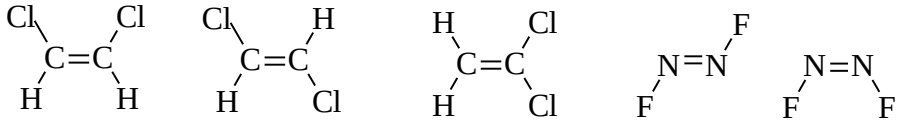
Hybridization, Molecular Geometry, Molecular Polarity, Sigma and Pi Bonds

10. If the following atomic orbitals overlap, what type of hybrid orbital forms? What is the bond angle separating these?
    a. an s and one p orbital
    b. an s and three p orbitals
    c. an s and two p orbitals

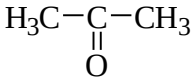
11. For the following compounds and ions:
    a. write the electron dot structure
    b. draw the 2-D representation of the 3-D shape
    c. give the molecular geometry
    d. give the bond angle around the central atom
    e. indicate if the molecule is polar
    f. give the hybridization for each atom (except where indicated not to)

SCO (C is the central atom)
IBr_2^- (skip hybridization)
NO_3^-
RnF_4 (skip hybridization)
NH_2Cl (N is the central atom, all atoms are bonded to N)
CH_2Br_2 (C is the central atom)
SCN^-
ClO_2^-
SF_6 (skip hybridization)
CO_3^{2-}
PCl_5 (skip hybridization)
BeF_3
SF_4^{2-} (skip hybridization)

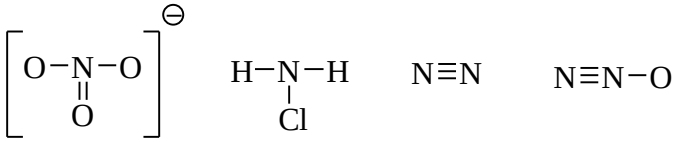
12. Show the charge distribution in the following and indicate which molecules are polar.



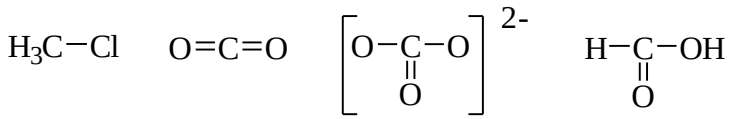
13. Give the hybridization for each atom (except H) in the following organic solvent. Unshared electrons are not shown. How many sigma and pi bonds are there?



14. Give the hybridization for the nitrogens and oxygens in the following. Unshared electrons are not shown. How many sigma and pi bonds are there in each?

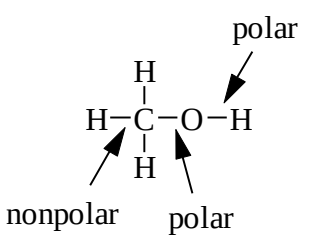


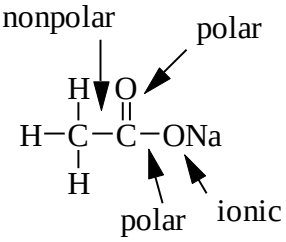
15. Give the hybridization for the carbons and oxygens in the following. Unshared electrons are not shown. How many sigma and pi bonds are there in each?



Chapter 7, Answers to Exercises

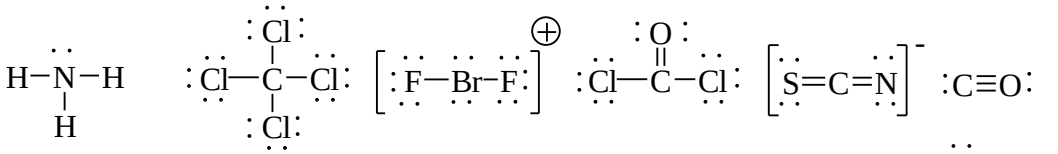
1. $MgBr_2$ ionic CF_4 polar covalent SiO_2 polar covalent
   $CaNO_3$ ionic between the Ca^{2+} and the NO_3^{2-} but polar covalent between N and O
   HOF polar covalent Br_2 nonpolar covalent

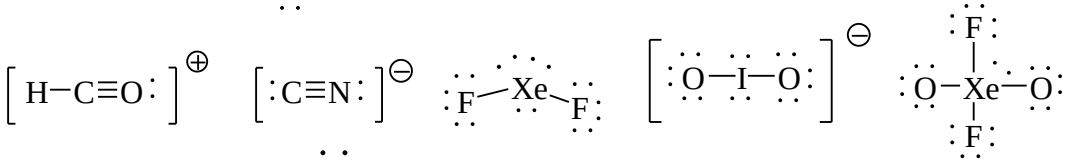


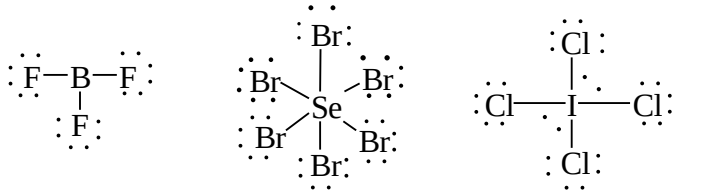


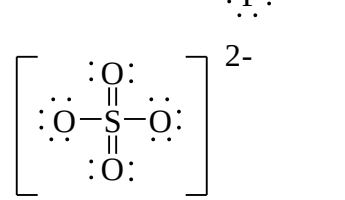
2. a. $2Na + I_2 \rightarrow 2NaI$
   b. $Mg + I_2 \rightarrow MgI_2$
   c. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
   d. $3Ca + N_2 \rightarrow Ca_3N_2$
   e. $2Fe + 3S \rightarrow Fe_2O_3$
   f. $6Rb + N_2 \rightarrow 2Rb_3N$

3.









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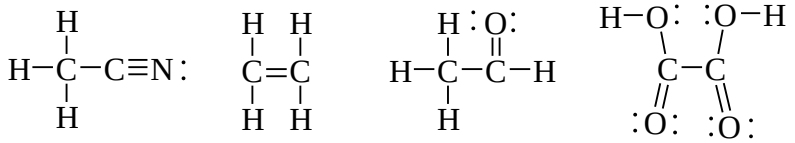

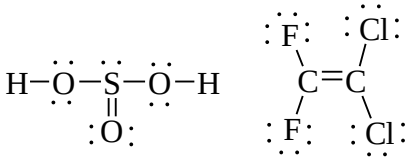

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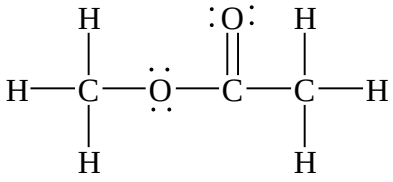

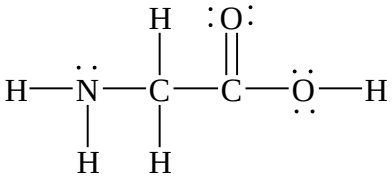

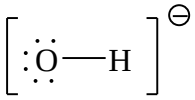

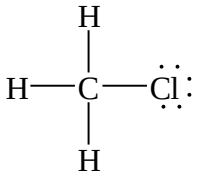

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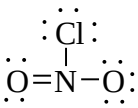

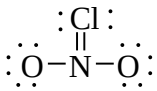

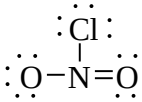

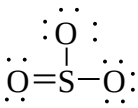

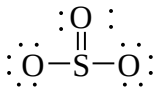

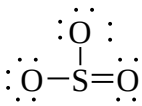

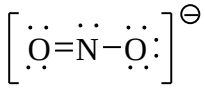

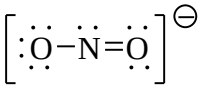

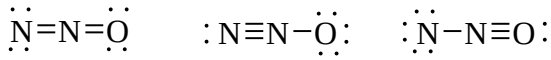

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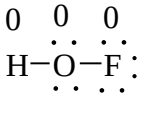

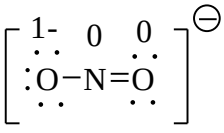

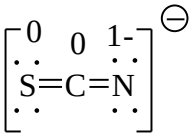

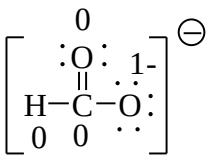

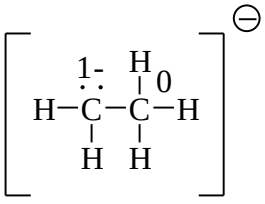

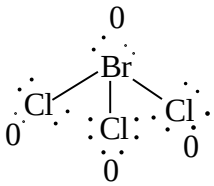

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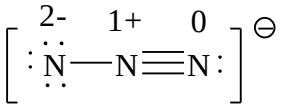
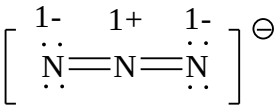
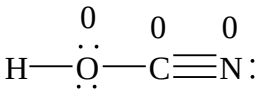
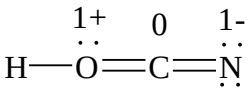




most likely

9.

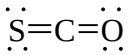




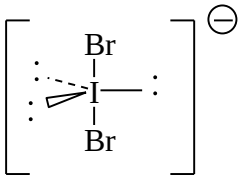
most likely

10. a. an s and one p orbital: sp hybrid orbital, 180^{o}
    b. an s and three p: sp^{3}, 109.5^{o}C
    c. an s and two p: sp^{2}, 120^{o}

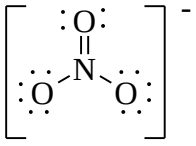
11.



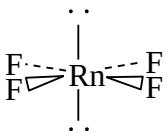
linear, 180^{o}, polar molecule, S sp^{2}, C sp, O sp^{2}



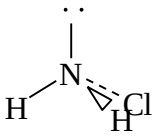
linear, 180^{o}, nonpolar



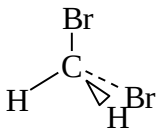
triginal planar, 120^{o}, nonpolar, N sp^{2}, =O sp^{2}, -O sp^{3}



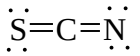
square planar, 90^{o}, nonpolar



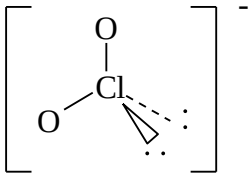
triginal pyramid, ~109.5^{o}, polar, N sp^{3}, Cl sp^{3}



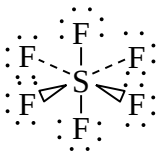
tetrahedral, 109.5^{o}, polar, C sp^{3}, Br sp^{3}



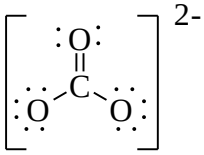
linear, 180°, polar, C sp, S sp^2, N sp^2



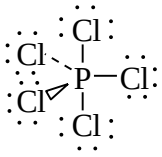
bent, ~109.5°, polar, Cl sp^3, O sp^3



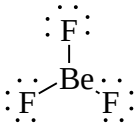
octahedral, 90°, nonpolar



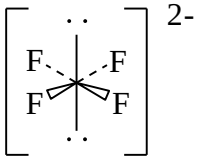
triginal planar, 120°, nonpolar, C sp^2, =O sp^2, -O sp^3



triginal bipyramid, 90° and 120°, nonpolar

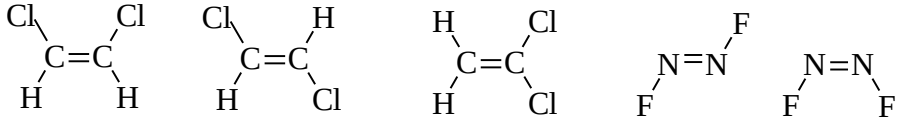


triginal planar, 120°, nonpolar, F sp^3, Be sp^2



square planar, 90°, nonpolar

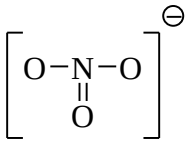
12.

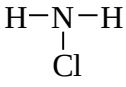


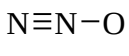
polar nonpolar polar nonpolar polar

13. Both CH_3 C's are sp^3, the central C is sp^2, O is sp^2. There are 9 sigma bonds and 1 pi bond.

14.







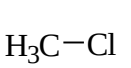
-O sp^3
=O sp^2
N sp^2
3σ 1π

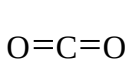
N sp^3
3σ

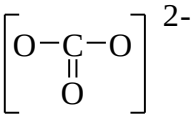
sp
2π 1σ

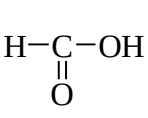
N sp
O sp^3
2π 2σ

15.









sp^3
4σ

O sp^2
C sp
2σ 2π

C sp^2
-O sp^3
=O sp^2
3σ 1π

C sp^2
-O sp^3
=O sp^2
4σ 1π