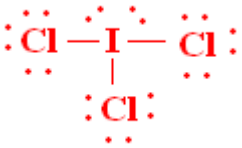
REVIEW QUESTIONS
Chapter 10

1. Draw Lewis structures and determine the molecular geometry of each molecule or ion shown below:

A) ClO_2^- **20 electrons**

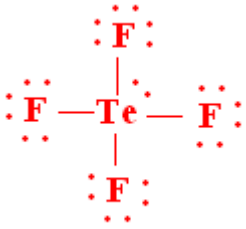
Bent (from tetrahedral)

B) ICl_3 **28 electrons**



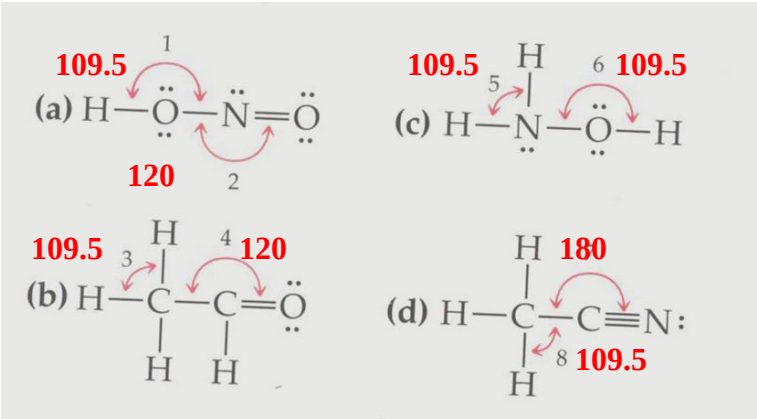
T-shaped (from trigonal bipyramidal)

C) TeF_4 **34 electrons**



e-saw (from trigonal bipyramidal)

2. Give approximate value for each bond indicated in the molecules shown below:



3. Determine if each molecule below would be polar or non-polar. Give a brief explanation for your choices.

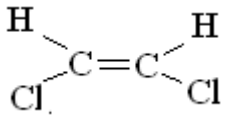
A) CS_2 **Non-polar** **(linear)**

B) SO_3 **Non-polar** **(trigonal planar)**

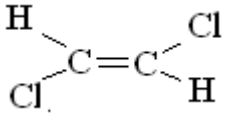
C) SF_4 **Polar** **(see-saw)**

D) IF_5 **Polar** **(square pyramidal)**

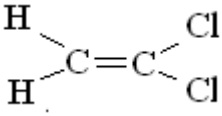
4. Dichloroethylene, $C_2H_2Cl_2$, can have any one of the geometries shown below, each of which is an individual substance.



(A)



(B)



(C)

a) What is the geometry around each carbon atom in any of these molecules?

Since each carbon has 3 groups around it, its geometry would be trigonal planar.

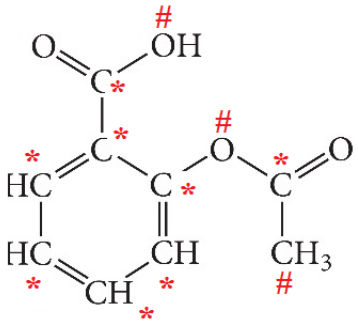
b) Which of these molecules would you expect to be non-polar?

B would be expected to be non-polar, since the opposite polarities of C—Cl bonds and C—H bonds cancel one another.

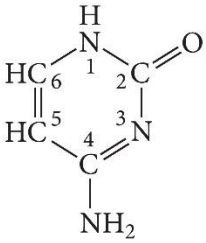
5. The structure of acetylsalicylic acid (aspirin) is shown below. How many pi bonds are present in this compound? How many sigma bonds? What parts of the molecule are free to rotate, and what parts are rigid?

21 sigma bonds
5 pi bonds

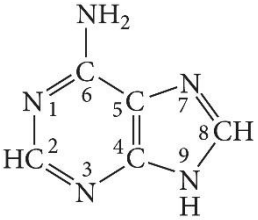
Rotation is possible along sp^3 hybridized centers (#) and not possible around sp^2 (*) hybridized centers.



6. Shown below are cytosine and adenine, two bases that are important in the genetic coding. Assign a molecular geometry and hybridization to each interior atom numbered in these two bases.



(a)



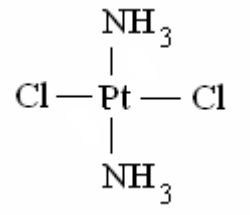
(b)

Atom	*Hybd.*	*Molecular Geometry*	*Atom*	*Hybd.*	*Molecular Geometry*
N_1	sp^3	trigonal pyramidal	N_1, N_3, N_7	sp^2	bent
C_2	sp^2	trigonal planar	C_2, C_4, C_5	sp^2	trigonal planar
N_3	sp^2	bent	C_6, C_8	sp^2	trigonal planar
C_4, C_5, C_6	sp^2	trigonal planar	N_9	sp^3	trigonal pyramidal

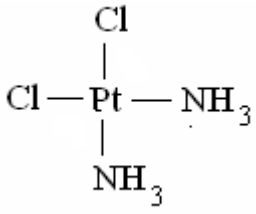
7. Which hybridization schemes allow the formation of at least one pi bond? Briefly explain why.

Sp and sp^2 hybridizations allow for formation of at least one pi bond. Each of these hybridizations leaves 1 or 2 p orbitals un-hybridized and allows them to make side-ways overlap with another standard p orbital to make a pi bond.

8. There are two compounds with the formula $Pt(NH_3)_2Cl_2$. Structure A is called cisplatin and is used in cancer therapy. Both molecules have square-planar geometry. Which structure do you expect to be polar? Explain.



(A)



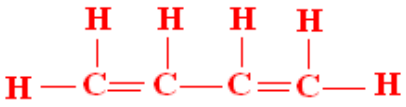
(B)

Since both molecules have square planar geometry, the opposite polarities of Pt—Cl bonds and Pt—NH_3 bonds cancel one another in A, but cannot cancel in B. Therefore, A would be expected to be non-polar, and B would be polar.

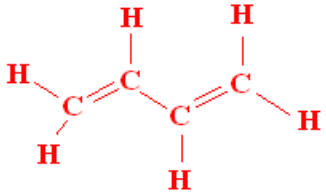
9. Butadiene, C_4H_6, is an important molecule found in natural rubber, and has the following structural formula:

$$CH_2{=}CH - CH{=}CH_2$$

Determine the bond angle around each carbon and sketch the molecule showing its actual structure. Is this molecule planar or not? (Hint: build a model).

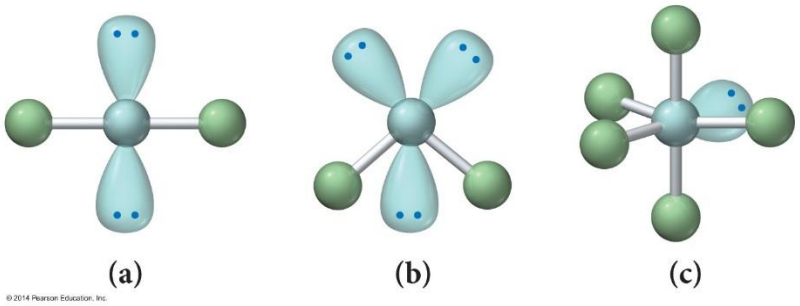


Based on the Lewis structure (above), each carbon has a trigonal planar geometry and an angle of 120°. The actual structure would be as shown below:



Since all the carbons are trigonal planar geometry, the entire molecule is therefore planar.

10. Each ball-and-stick model below shows the electron-pair and molecular geometry of a generic molecule. Explain what is wrong with each molecular geometry and provide the correct molecular geometry based on the number of lone and bonding pairs around the central atom.

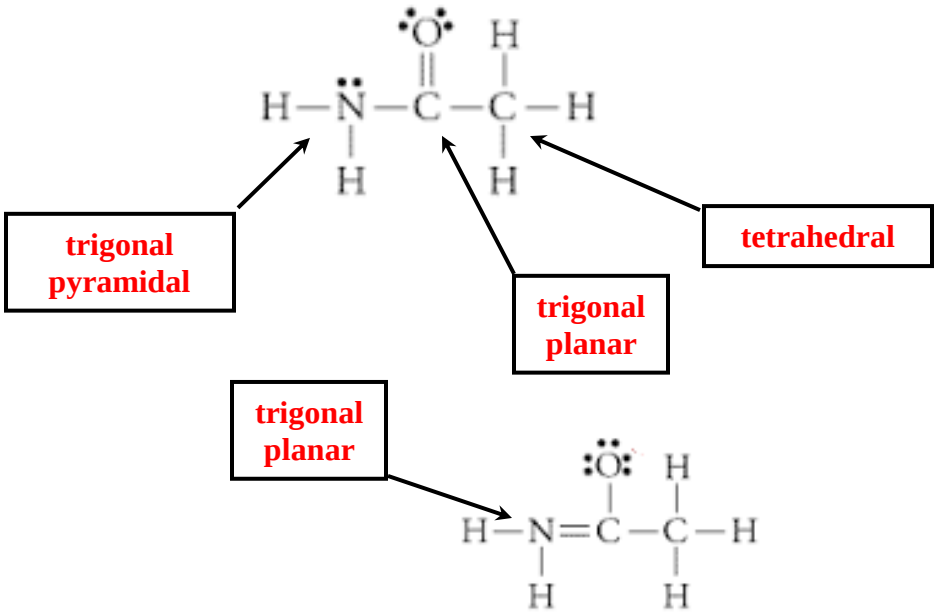


(a) Molecular geometry for a central atom with 2 lone pairs and 2 bonding pairs of electron should be bent (not linear as shown).

(b) Molecular geometry for a central atom with 3 lone pairs and 2 bonding pairs of electron should be linear (not bent as shown).

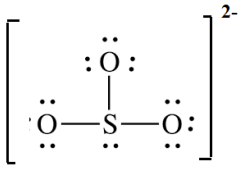
(c) Molecular geometry for a central atom with one lone pair and 5 bonding pairs of electrons should be square pyramidal (not trigonal bipyramidal as shown).

11. Draw the Lewis structure for acetamide (CH_3CONH_2) and determine the geometry about each interior atom. Experiments show that the geometry about the N atom in acetamide is nearly planar. Draw a resonance structure that can account for the planar geometry about the N atom.



12. Identify the hybridization and write the bonding schemes for each molecule or ion shown below. Label the bonds using notation discussed in class.

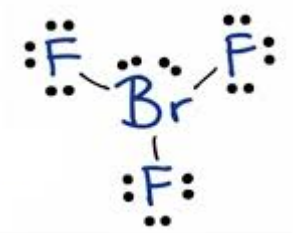
a) SO_3^{2-}



e⁻ pair geometry: trigonal pyramidal
hybridization: sp^3
bonding scheme: 3 σ bonds: S (sp^3)–O (p)

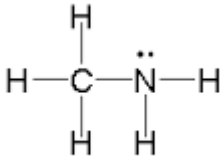
(Note: the resonance structure for this molecule which contains one double bond between S and O is not used for bonding scheme description)

b) BrF_3



e⁻ pair geometry: trigonal bipyramidal
hybridization: sp^3d
bonding scheme: 3 σ bonds: Br (sp^3d)–O (p)

c) H_3CNH_2



<u>Carbon as central atom</u>:
e⁻ pair geometry: tetrahedral
hybridization: sp^3
bonding scheme: 3 σ bonds: C (sp^3)–H (s)
1 σ bond: C (sp^3)–N (sp^3)

<u>Nitrogen as central atom</u>:
e⁻ pair geometry: trigonal pyramidal
hybridization: sp^3
bonding scheme: 2 σ bonds: N (sp^3)–H (s)
1 σ bond: N (sp^3)–C (sp^3)

13. Shown below is the amino acid alanine. Identify the hybridization of each interior atom and write the bonding scheme for all the expanded bonds.