Name: _____ Section: _____

Experiment 9 – Structure in Inorganic & Organic Compounds

Discussion

The Valence Shell Electron Pair Repulsion Theory (VSEPR) states that bonds and lone pairs are regions of high electron density in an atom that repel each other until they get as far apart as possible. This effect determines the atom's geometry and bond angles. Two regions will be 180° apart, three regions will be 120° apart, and four regions will be 109.5° apart.

Geometry Determination

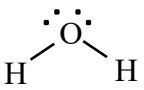
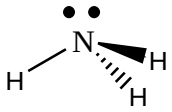
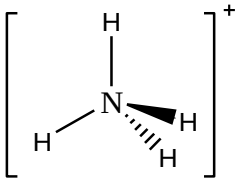
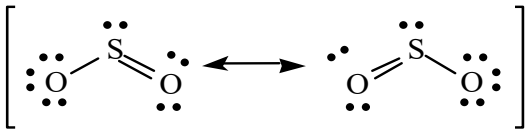
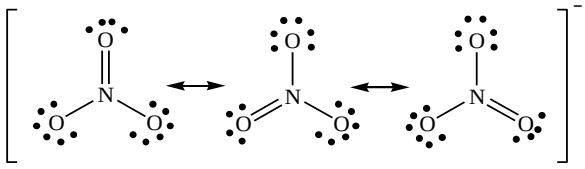
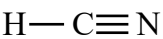
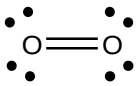
1. Determine the Lewis dot structure of the molecule or ion.
2. For each central atom in the structure, determine the areas of electron density that lie directly on that atom. An area of electron density may be:
    a. a lone pair that lies on the central atom. (Lone pairs on other atoms don't count.)
    b. a single bond.
    c. a double bond.
    d. a triple bond.
3. Assign geometry according to the table on the next page.

Procedure

For each of the ions or molecules listed:

1. Draw the Lewis dot structure, including all resonance where appropriate.
2. Use the model kit to build the structure.
    - Use yellow balls for hydrogens.
    - Use black balls for other atoms.
    - Use short sticks for nonbonded electron pairs
    - Use long sticks for single bonds.
    - Use springs for double and triple bonds. Two springs form a double bond. Three springs form a triple bond.
3. Sketch the shape of the structure in three dimensions. This is called the VSEPR structure.
4. Draw dipole moments on the VSEPR structure to show all polar bonds.
5. Give the name of the molecular geometry.
6. State whether the molecule is polar, nonpolar, or ionic.
7. Determine the approximate bond angle on the central atom(s).

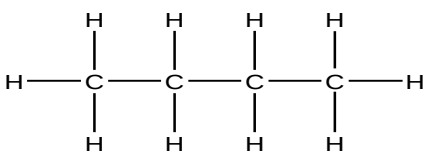
Name: _____ Section: _____

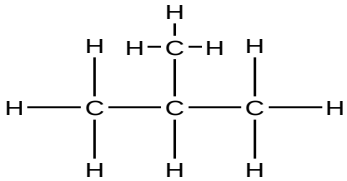
# of areas	# of bonds	# of lone pairs	Geometry and bond angles	Example
4	2	2	Angular or bent (109.5°)	
4	3	1	Pyramidal (109.5°)	
4	4	0	Tetrahedral (109.5°)	
3	2	1	Bent (120°)	 2 resonance forms
3	3	0	Trigonal (120°)	 3 resonance forms
2	2	0	Linear (180°)	
	1	any	Linear (Must be three or more atoms to form an angle.)	

Notice the convention for drawing bonds in 3-D space, where:

- the wedge (◥) represents a bond coming out of the paper, and
- the dash (⋯) represents a bond going behind the paper.

Finally, isomers will also be studied, or molecules having the same chemical formula but different connectivity of the atoms. Be sure not to confuse this phenomenon with resonance, where atoms are in the same place but electrons are delocalized throughout. For example, two isomers are possible for a molecule with the formula C_4H_{10}:





Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
I_2						
NO^-						
CO						
CH_3NH_2						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
H_2S						
PBr_3						
ClO_4^-						
CS_2						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
$CHCl_3$						
PO_3^{-3}						
PO_4^{-3}						
CH_2O						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
SO_3						
SO_3^{-2}						
SO_4^{-2}						
SCN^{-1}						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
NO_2^-						
HCOOH						
BrO_3^-						
IO_2^-						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
CH_2Cl_2						
C_2F_2						
C_2F_4						
C_2F_6						

Name: ______________________ Section: ______________

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
$C_2H_2Br_2$ (3 isomers)						
C_2H_6O (2 isomers)						
C_5H_{12} (3 isomers)						