Lab #9 Lewis Structures

Lewis Structures

Lewis structures show how valence electrons are distributed and shared in covalent molecules. We represent the elements by their symbols. The shared electron pair is shown as a line/bond between the two atoms. All the other valence electrons are shown as dots or lines around the symbol of the element.

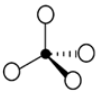
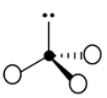
Steps for drawing Lewis Structures	Example with SO_2
1. Sum the valence electrons of all the atoms.	The total number of valence electrons is **18** (6 from sulfur and 6 from each oxygen).
2. Use single bonds (lines) to connect the central atom to the surrounding atoms. The central atom is usually the element there is one of, such as C in CBr_4. Each line represents two electrons.	O–S–O Sulfur is central. After making connections to the outer atoms, we have used 4 electrons.
3. Complete the octet for all outer atoms (other than H) by drawing lone pairs. If you have not reached the total number of valence electrons, give remaining electrons to the central atom	:Ö–S–Ö: (each O with two lone pairs) Each oxygen was given three lone pairs, with the bond they are surrounded by 8 electrons. That brought the count to 16. The two remaining electrons were put on the central sulfur for a to 18
4. If all atoms (except H) at this point have an octet the structure is finished. *If, and only if*, the central atom does not have an octet, turn lone pairs on outer atoms into double and triple bonds until it does have an octet.	:O=S–Ö: (one lone pair on each O) In the last step sulfur only had 6 electrons. One lone pair on an oxygen is shared as a double bond. All atoms now have octets and the Lewis structure is complete.

Molecular Shape – the Valence Shell Electron Pair Repulsion (VSEPR) Theory

The electron groups around the central atom repel each other and therefore prefer to be as far apart from each other as possible. This is the main idea of the VSPER theory. We can apply the VSEPR theory to predict the molecular shape/geometry of a molecule.

1. Draw the Lewis structure for the molecule in question.
2. Count the total **number of electron groups on the central atom = the number of atoms bonded to the central atom plus the number of lone pairs on the central atom**. Note that multiple bonds to <u>one</u> outer atom still count as <u>one</u> electron group.
3. The shape of the molecules is determined by minimizing the repulsion between the electron groups. (Spacing them out as much as possible)

The table to the right summarizes the shapes based on electron groups and lone pairs:

Electron Groups	0 Lone Pairs	1 Lone Pair	2 Lone Pairs
2	**linear** (180°)		
3	**trigonal planar** (120°) 	**bent** (<120°) 	
4	**tetrahedral** (109°) 	**trigonal pyramid** (<109°) 	**bent** (<109°) 

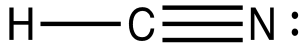
group	1	2		13	14	15	16	17	18
	1A	**2A**		**3A**	**4A**	**5A**	**6A**	**7A**	**8A**
period 1	1 H								2 He
2	3 Li	4 Be		5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg		13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21-30 Sc - Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39-48 Y - Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57-80 La - Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89-112 Lu - Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

Rubric

Criteria	Points possible	Points earned
Valence calculation, work shown (0.5 each)	4	
Electron total / Structure (1.5 pt each)	12	
Geometry / Angle (0.5 pt each)	4	
Total	16	

DO NOT USE THE INTERNET TO SOLVE THESE PROBLEMS.

Use the methods taught in this class. All atoms except H should have eight electrons. Online you will find alternate structures for some molecules that are beyond the scope of this class and should not be written as answers.

Formula	Total valence e- (show calc)	Structure	Total electron groups	Geometry (Shape)	Angle
HCN	1 + 4 + 5 = 10 e-		2 outer atoms + 0 lone pairs on center= **2**	linear	180°
SBr_2					
NSF					
SO_3					
$COBr_2$					

Formula	Total valence e- (show calc)	Structure	Total electron groups	Geometry (Shape)	Angle
CF_4					
NHF_2					
$POCl_3$					
CSe_2					