

Review: Lewis Structures, Shapes, Hybrid Orbitals

Fill in the table.

Consult the textbook for the rules used to draw Lewis structures

Brief summary of the rules:

- Count the total number of valence electrons in the structure. If the structure is an ion, take the charge on the ion into account. (Example: NO_3^- has 24 electrons, five from N, six from each O, and one from the negative charge.)
- Draw a skeletal structure for the molecule with all single bonds. The first atom listed, usually the less electronegative of the atoms, often is the central atom in the structure. H and F atoms are *never* central atoms.
- Counting each bond as two electrons, subtract the number of electrons used from the total number available. Place the remaining electrons on the atoms in the structure as non-bonding pairs, so that each atom has a total of 4 pairs of electrons around it. H atoms only require one pair.
- If there are too many electrons, place the extra electrons in pairs around the central atom. Put them in diagonal positions from the bonds already there.
- If there are too few electrons, then for each two electrons the molecule is short, place a non-bonding pair into a bonding position to form a multiple bond.
- If there is more than one position possible for the multiple bond, or if one triple bond could be used in place of two double bonds, then the molecule has resonance structures. Make note of the presence of resonance forms.
- An atom in a molecule has a *formal charge* if the number of electrons around the atom in the molecule differs from the number of electrons around the atom as an isolated atom. Show any formal charges other than zero.

Consult the textbook for the various VSEPR types.

AX_2	AX_3	AX_2E	AX_4	AX_3E	AX_2E_2	AX_5	AX_4E	AX_3E_2	AX_2E_3	AX_6	AX_5E	AX_4E_2
linear	trigonal planar	bent	tetrahedral	trigonal pyramid	bent	trigonal bipyramid	seesaw	T shaped	linear	octahedral	square pyramid	square planar

If there is more than one central atom, give the VSEPR designation and shape about each central atom.

Consult the textbook for the various Hybrid Orbital types.

sp	sp^2	sp^3	sp^3d	sp^3d^2	double bonds: one σ and one π bond; the π bond comes from two p orbital electrons on adjacent atoms
------	--------	--------	---------	-----------	--

EXAMPLES

Molecule	Lewis structure (show any formal charges)	VSEPR Type, Shape	Hybrid Orbitals
H_2O	$\begin{array}{c} \text{H}-\overset{\ominus}{\text{O}}-\text{H} \\ \\ \text{---} \end{array}$	AX_2E_2 , bent	sp^3 on O
$\text{C}_2\text{H}_5\text{OH}$	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\overset{\ominus}{\text{O}}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	AX_4 on each C, AX_2E_2 on O, all tetrahedral angles	sp^3 on C and O
SF_4	$\begin{array}{c} \text{F} \\ \\ \text{F}-\text{S}-\text{F} \\ \\ \text{F} \end{array}$	AX_4E , seesaw	sp^3d on S
NO_3^-	$\left[\begin{array}{c} \text{O} \\ \\ \text{O}=\text{N}^{\oplus}=\text{O} \\ \\ \text{O} \end{array} \right]^{-}$	AX_3 , trigonal planar	sp^2 on N, sp^2 on right O π bond between N & O There is resonance in the molecule.

Molecule	Lewis structure (show any formal charges)	VSEPR Type, Shape	Hybrid Orbitals
CF ₄			
NH ₃			
Cl ₂ O			
PO ₄ ³⁻			
NH ₄ ⁺			
C ₂ H ₆			
C ₂ H ₄			
C ₂ H ₂			
CO			

Molecule	Lewis structure (show any formal charges)	VSEPR Type, Shape	Hybrid Orbitals
XeF ₄			
BrO ₃ ⁻			
ClO ₄ ⁻			
I ₃ ⁻			
NO ₂			
CO ₃ ²⁻			
H ₂ O ₂			
CH ₃ OH			
CH ₃ NH ₂			