Lewis Structures

Molecular Geometries

A = central atom; X = ligands; E = lone pairs

Electron Regions	Molecular Formula	Name	Shape
2	AX_2 ($BeCl_2$, CO_2)	Linear	
3	AX_3 (BF_3, CO_3^{2-}, NO_3^-, SO_3)	Trigonal Planar	
	AX_2E (NO_2^-, SO_2, O_3)	Bent	
4	AX_4 (CH_4, NH_4^+, PO_4^{3-}, SO_4^{2-}, ClO_4^-)	Tetrahedron	
	AX_3E (NH_3, H_3O^+, PCl_3, SO_3^{2-})	Trigonal pyramidal	
	AX_2E_2 (H_2O, ClO_2^-, OF_2, SCl_2)	Bent	
5	AX_5 (PCl_5)	Trigonal bipyramidal	
	AX_4E (SF_4, SCl_4)	See-saw	
	AX_3E_2 (ClF_3, ICl_3)	T-shaped	
	AX_2E_3 (XeF_2, I_3^-)	Linear	
6	AX_6 (SF_6, PCl_6^-)	Octahedron	
	AX_5E (BrF_5, IF_5)	Square pyramidal	
	AX_4E_2 (XeF_4)	Square planar	

Electron Geometry = Shape
Molecular Geometry = Geometry

Lewis Structure Info

Key Structure Terms

- **Valence Shell:** Electrons in the outermost shell that are involved in bonding.
- **Lewis Structure:** A 2D representation of a molecule and its bonds.
- **Lone Pair:** Pair of electrons not being shared in a bond.
- **Bonding Pair:** Pair of electrons used to make a bond. Both atoms sharing the electrons can "count" them in their valence shell.
- **Single bond:** One pair of shared electrons.
- **Double bond:** Two pairs of shared electrons. Shorter and stronger than a single bond.
- **Triple bond:** Three pairs of shared electrons. Shorter and stronger than a double bond.
- **Valence Shell Electron Pair Repulsion Theory (VSEPR):** Bonds and lone pairs are electrons, all electrons are negative, negative things repel other negative things, therefore all bonds and lone pairs arrange themselves in 3D as far away from each other as possible.
- **Electron Geometry:** 3D structure of a molecule determined by counting the electron regions around a central atom (bonds and lone pairs).
- **Electron Region:** Each bond (single, double or triple) and lone pair count as "1" electron region.
- **Molecular Geometry:** 3D structure determined by the atoms bonded to the central atom.
- **Ligand:** Atoms bonded to the central atom.

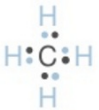
VSEPR Theory and Geometry

Electron geometry is determined by looking at the number of electron regions around the central atom.

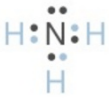
Molecular geometry is determined by looking at the number of atoms bonded to the central atom (ligand) and the number of lone pairs around the central atom.

Electronic Geometry Mnemonic: Linear(2) – Trigonal Planar(3) – Tetrahedral (4) – Trigonal Bipyramidal(5) – Octahedron(6) = "*Long TriP To TriBe Overseas.*"

Examples:



Electron geometry: Tetrahedron
Molecular geometry: Tetrahedron



Electron geometry: Tetrahedron
Molecular geometry: Trigonal pyramidal

Concepts

State Function	Energy, Entropy, Enthalpy
Extensive Property	Heat of a reaction
Intensive Property	Temperature
If products are at a higher temp, heat flows out of system	Q will be negative
If the volume increases during the reaction, the system does work	W is negative
Phase Change	7 times more energy needed to convert liquid water to steam than ice to liquid water because of hydrogen bonding. Specific Heat capacity for liquid water is higher than that of ice and steam.

Concepts

Formation of a bond	Exothermic
Breaking of a bond	Endothermic
Triple Bond	strongest but shortest
Single Bond	weakest but longest
Periodic Trend	As the ions get bigger (down a group) the distance between them does as well and the magnitude of the lattice energy decreases which means that less energy is released when the lattice forms.
If reaction is reversed, the new equilibrium constant:	K' = 1/K

Concepts (cont)	
If reaction is multiplied by m, the new equilibrium constant:	K'' = K^m
Q<Ksp	No precipitate; shift right
Q = Ksp	Saturated Solution
Q>Ksp	Precipitate Formed

Lewis Structure Info+Other
B and Be often have fewer than eight electrons
Period 3 and heavier elements often satisfy, but can exceed the octet rule using their empty d orbitals
Copper Config [Ar]:4s1 3d10
Chromium Config [Ar]: 4s1 3d5

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Not published yet.
Last updated 5th August, 2016.