

## Molecular Geometry

## Van Koppes/Offin

Central Atom, AX <sub>n</sub> E <sub>m</sub>	# of bonded atoms	# of lone pairs	Electron Geometry	Bond Angle(s)	Molecular Geometry	Example	Hybridization
AX	1	0	Linear	180°	Linear	HCl	sp
AX <sub>2</sub>	2	0	Linear	180°	Linear	CO <sub>2</sub>	sp
AX <sub>2</sub> E	2	1	Trigonal Planar	120°	Bent	SO <sub>2</sub>	sp <sup>2</sup>
AX <sub>3</sub>	3	0	Trigonal Planar	120°	Trigonal Planar	BF <sub>3</sub>	sp <sup>2</sup>
AX <sub>3</sub> E	3	1	Tetrahedral	109.5°	Trigonal Pyramidal	NH <sub>3</sub>	sp <sup>3</sup>
AX <sub>4</sub>	4	0	Tetrahedral	109.5°	Tetrahedral	CH <sub>4</sub>	sp <sup>3</sup>
AX <sub>4</sub> E	4	1	Trigonal Bipyramidal	90°, 120°	See-saw	SF <sub>4</sub>	sp <sup>3</sup> d
AX <sub>5</sub>	5	0	Trigonal Bipyramidal	90°, 120°	Trigonal Bipyramidal	PCl <sub>5</sub>	sp <sup>3</sup> d
AX <sub>5</sub> E	5	1	Octahedral	90°	Square Pyramidal	BrF <sub>5</sub>	sp <sup>3</sup> d <sup>2</sup>
AX <sub>6</sub>	6	0	Octahedral	90°	Octahedral	SF <sub>6</sub>	sp <sup>3</sup> d <sup>2</sup>
AX <sub>6</sub> E	6	1	Octahedral	90°	Square Planar	XeF <sub>4</sub>	sp <sup>3</sup> d <sup>2</sup>
AX <sub>6</sub> E <sub>2</sub>	6	2	Octahedral	90°	Linear	XeF <sub>2</sub>	sp <sup>3</sup> d <sup>2</sup>

**Example:** Draw Lewis Structures, Molecular Geometries, Bond Angles (90°, 109.5°, 120°, 180°), Hybridization and Hybrid Orbitals for the following molecules. Indicate the hybridization of the central atom and the hybrid orbitals used in the sigma bond formation of all atoms. (Note: lone pairs are not hybridized.)

**Tip:** If two substituents on a central atom are the same, they have one sp<sup>3</sup> hybrid orbital. The number of orbitals is determined by the number of substituents, not by how many are identical. For example, in CH<sub>3</sub>Cl, the central carbon has four sp<sup>3</sup> hybrid orbitals. The three C-H bonds are formed by the overlap of sp<sup>3</sup> hybrid orbitals from carbon and 1s orbitals from hydrogen. The C-Cl bond is formed by the overlap of an sp<sup>3</sup> hybrid orbital from carbon and a 3p orbital from chlorine. The sigma bond is formed by the overlap of an sp<sup>3</sup> hybrid orbital from carbon and a 3p orbital from chlorine.