

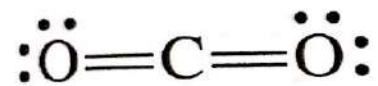
# Molecular Geometry

# VSEPR Theory and Shapes

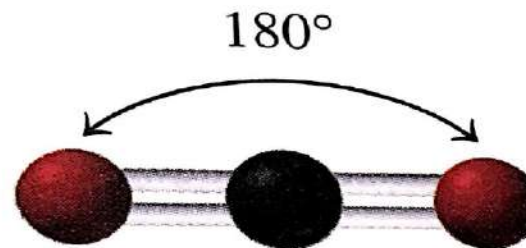
- ▶ Valence Shell Electron Pair Repulsion Theory
- ▶ Three dimensional shapes of molecules can be predicted using Lewis structures
- ▶ Shapes are determined by considering groups of electrons around central atom, both bonded and unbonded (lone pairs)
- ▶ Electron groups are arranged to minimize the repulsion between their negative charges
- ▶ Focus on central atom, number of bonds and number of lone pairs

# VSEPR Theory and Shapes

- ▶ Central atoms with two electron groups: minimal repulsion when electron groups are on opposite sides of central atom
- ▶ LINEAR



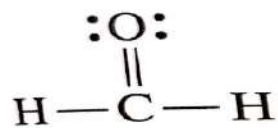
Linear  
electron-group  
geometry



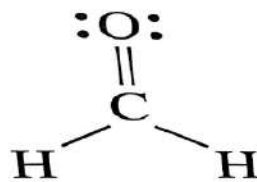
Linear shape

# VSEPR Theory and Shapes

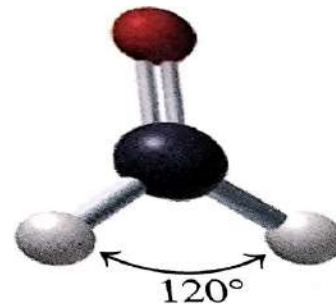
- ▶ Central atoms with three electron groups
- ▶ Example:  $\text{H}_2\text{CO}$
- ▶ Minimal repulsion occurs when three electron groups are as far apart as possible-  
TRIGONAL PLANAR<sup>Ⓟ</sup>



Lewis  
structure



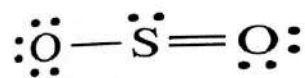
Trigonal planar  
electron-group  
geometry



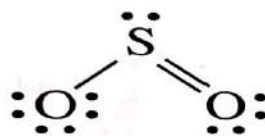
Trigonal planar shape

# VSEPR Theory and Shapes

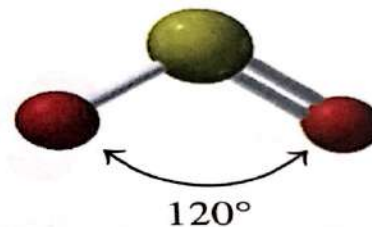
- ▶  $\text{SO}_2$  there are three electron groups, but one group is a lone pair, so the shape is bent



Lewis  
structure



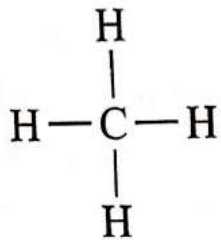
Trigonal planar  
electron-group  
geometry



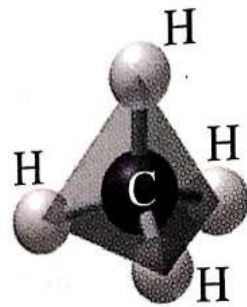
Bent shape

# VSEPR Theory and Shapes

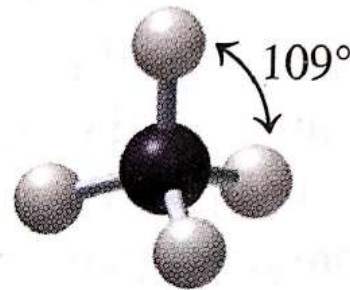
- ▶ Four electron groups
- ▶ When all of the electron groups are bonded, the shape is tetrahedral



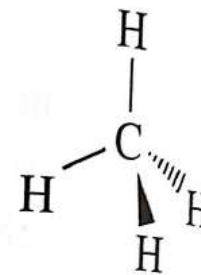
Lewis  
structure



Tetrahedral  
electron-group  
geometry



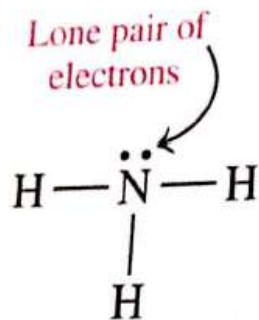
Tetrahedral  
shape



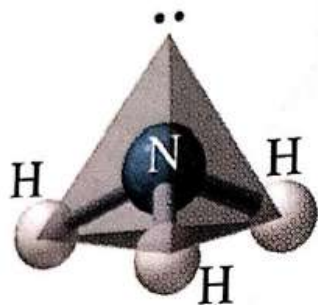
Tetrahedral wedge-dash  
notation

# VSEPR Theory and Shapes

- ▶ Four electron groups with one lone pair- trigonal planar



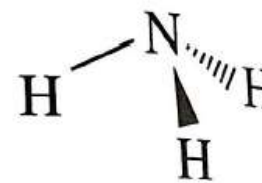
Lewis structure



Tetrahedral electron-group geometry



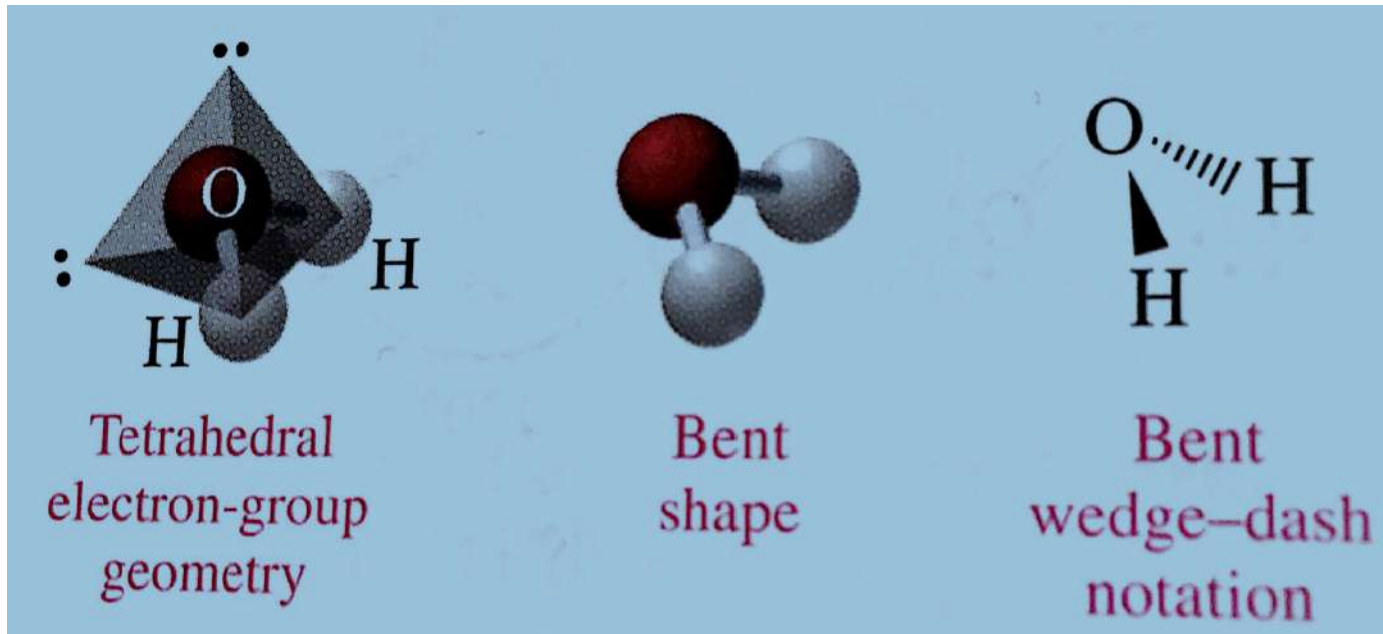
Trigonal pyramidal shape



Trigonal pyramidal wedge-dash notation

# VSEPR Theory and Shapes


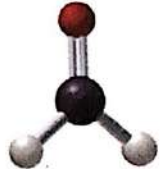

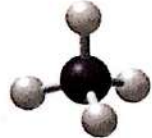


- ▶ Four electron groups, two lone pairs







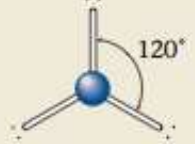
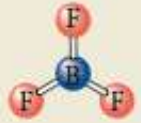
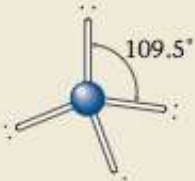

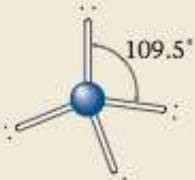

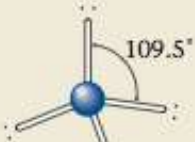

# VSEPR Theory and Shapes

**TABLE 10.5** Molecular Shapes for a Central Atom with Two, Three, and Four Bonded Atoms

Electron Groups	Electron-Group Geometry	Bonded Atoms	Lone Pairs	Bond Angle*	Molecular Shape	Example	Three-Dimensional Model
2	Linear	2	0	180°	Linear	CO <sub>2</sub>	
3	Trigonal planar	3	0	120°	Trigonal planar	H <sub>2</sub> CO	
3	Trigonal planar	2	1	120°	Bent	SO <sub>2</sub>	
4	Tetrahedral	4	0	109°	Tetrahedral	CH <sub>4</sub>	
4	Tetrahedral	3	1	109°	Trigonal pyramidal	NH <sub>3</sub>	
4	Tetrahedral	2	2	109°	Bent	H <sub>2</sub> O	

# VSEPR Shapes

**Table 12.4** Arrangements of Electron Pairs and the Resulting Molecular Structures for Two, Three, and Four Electron Pairs

Number of Electron Pairs	Bonds	Electron Pair Arrangement	Ball-and-Stick Model	Molecular Structure	Partial Lewis Structure	Ball-and-Stick Model
2	2	Linear		Linear	A—B—A	
3	3	Trigonal planar (triangular)		Trigonal planar (triangular)	<pre> A   B / \ A   A </pre>	
4	4	Tetrahedral		Tetrahedral	<pre> A   A—B—A   A </pre>	
4	3	Tetrahedral		Trigonal pyramid	<pre> A   A—B—A   A </pre>	
4	2	Tetrahedral		Bent or V-shaped	<pre> A   A—B—A   </pre>	

# Summary

- ▶ <https://www.youtube.com/watch?v=KjoQHqgzda8>
- ▶ [https://www.youtube.com/watch?v=wYZg1j7o2x4&ebc=ANyPxKryVMXWuhz6cg\\_UxEfwZHCa7yLX5elCuThuVg2h45P6bPR-UTe\\_bw3tO35eWdvZu7JSpJf7TmC3o129mvZ33r3FQ5wCA](https://www.youtube.com/watch?v=wYZg1j7o2x4&ebc=ANyPxKryVMXWuhz6cg_UxEfwZHCa7yLX5elCuThuVg2h45P6bPR-UTe_bw3tO35eWdvZu7JSpJf7TmC3o129mvZ33r3FQ5wCA)