
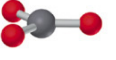
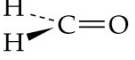
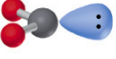

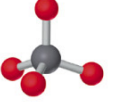
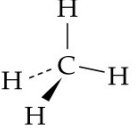
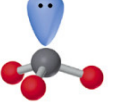
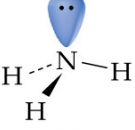
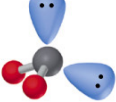
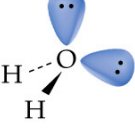


Molecular Shape

TABLE 7.4 Molecular Geometry Around Atoms with 2, 3, 4, 5, and 6 Charge Clouds

Number of Bonds	Number of Lone Pairs	Number of Charge Clouds	Molecular Geometry	Example		
2	0	2	 Linear	$O=C=O$		
3	0	3	 Trigonal planar			
	1				 Bent	
4	0	4	 Tetrahedral			
	1				 Trigonal pyramidal	
	2				 Bent	

Continued

VSEPR Theory

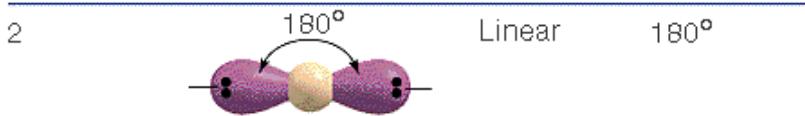
Its basic principle is that each group of electrons (valence electrons) around a central atom is located as far away from the others as possible in order to minimize repulsions.

This group of electrons could be shared pairs of electrons (two electrons in the case of a single bond, four electrons in the case of a double bond or six electrons if a triple bond is formed) or a lone pair.

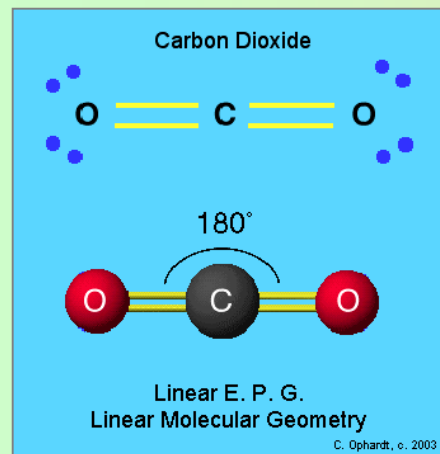
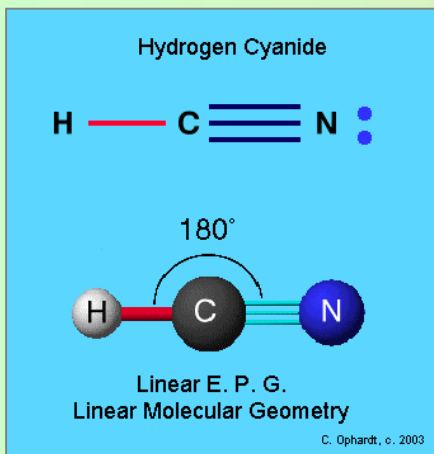
Molecular Shape

ELECTRON-PAIR GEOMETRIES AS A FUNCTION OF THE NUMBER OF ELECTRON PAIRS

Number of Electron Pairs	Arrangement of Electron Pairs	Electron-Pair Geometry	Predicted Bond Angles
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<http://www.800mainstreet.com/5/0005-000-vsepr.gif>



The Molecular Shape with Two Electron Groups (Linear Arrangement)

When two electron groups attached to a central atom are oriented as far as possible, they point in opposite directions. This linear arrangement of electron groups results in a linear molecular shape and a bond angle of 180°.

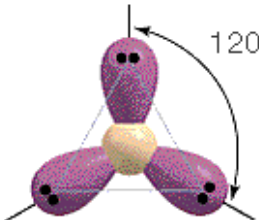
In the case of hydrogen cyanide we have two electron groups: the first group has two electrons (H-C bond) and the second group has six electrons (triple bond).

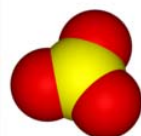
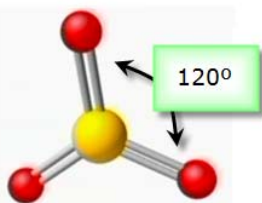
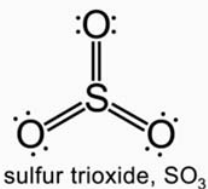
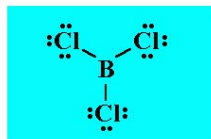
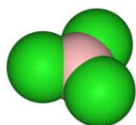
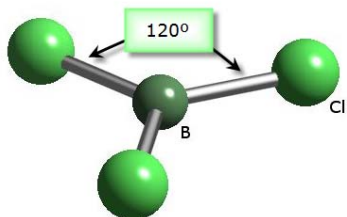
Carbon dioxide is also linear.

Molecular Shape

ELECTRON-PAIR GEOMETRIES AS A FUNCTION OF THE NUMBER OF ELECTRON PAIRS

Number of Electron Pairs	Arrangement of Electron Pairs	Electron-Pair Geometry	Predicted Bond Angles
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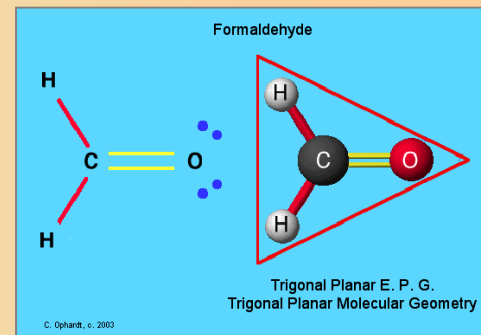
3		Trigonal planar	120°
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Molecular Shapes with Three Electron Groups (Trigonal Planar Arrangement)

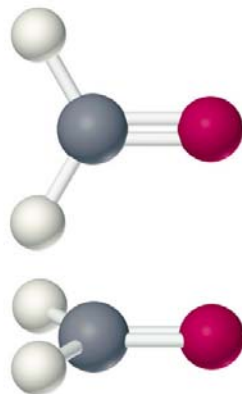
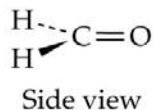
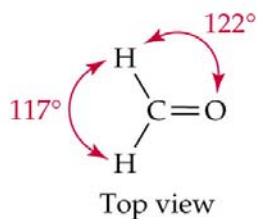
Three electron groups around the central atom repel each other to the corners of an equilateral triangle, which gives the **trigonal planar** arrangement.

When the three electron groups are bonding groups, the molecular shape is also trigonal planar (**AX₃**; A=Central atom, X=Surrounding atom).

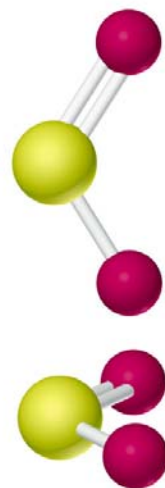
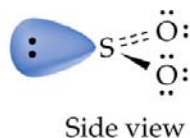
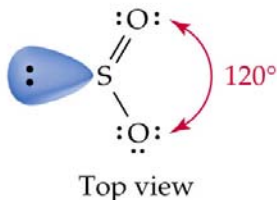


Molecular Shape

A formaldehyde molecule is trigonal planar, with bond angles of roughly 120° .



An SO_2 molecule is bent with a bond angle of approximately 120° .



Molecular Shapes with Three Electron Groups (Trigonal Planar Arrangement)

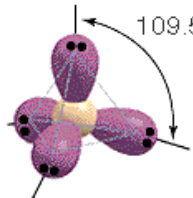
When one of the three electron groups is a lone pair, the molecular shape is V-shaped or bent (AX_2E ; A=Central atom, X=Surrounding atom, E lone pair).

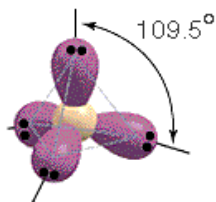
Molecular Shape

Molecular Shapes with Four Electron Groups (Tetrahedral Arrangement)

ELECTRON-PAIR GEOMETRIES AS A FUNCTION OF THE NUMBER OF ELECTRON PAIRS

Number of Electron Pairs	Arrangement of Electron Pairs	Electron-Pair Geometry	Predicted Bond Angles
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4		Tetrahedral	109.5°
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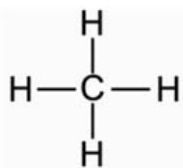


Tetrahedral 109.5°

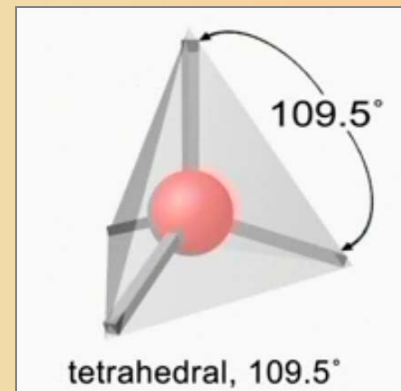
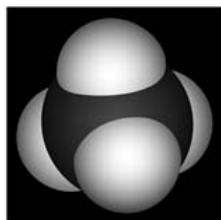
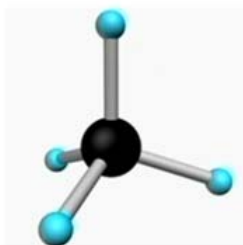
All molecules with four electron groups around a central atom adopt the **tetrahedral arrangement**.

When all four electron groups are bonding groups, as in the case of methane, the **molecular shape is also tetrahedral (AX₄)**.

Methane has a bond angle of 109.5°



methane, CH₄

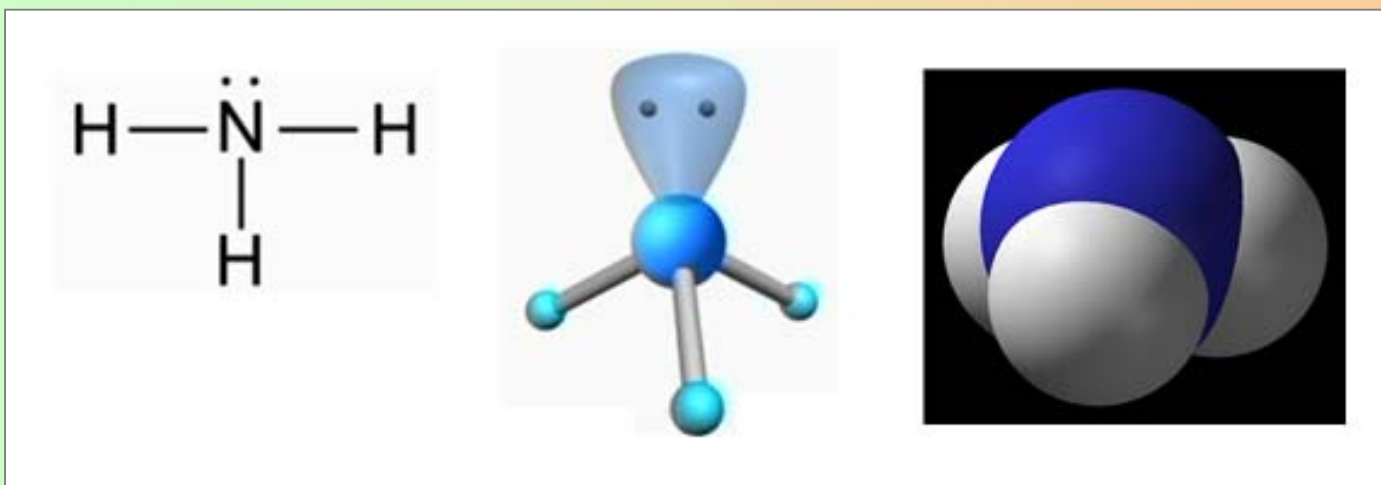


Molecular Shape

Molecular Shapes with Four Electron Groups (Tetrahedral Arrangement)

When one of the four electron groups in the tetrahedral arrangement is a lone pair, the molecular shape is that of a **trigonal pyramid** (AX_3E ; A=central atom, X=surrounding atom, E=lone pair).

In ammonia (NH_3) the lone pair forces the N-H bonding pairs closer, and the H-N-H angle is 107.3°



Molecular Shape

Molecular Shapes with Four Electron Groups (Tetrahedral Arrangement)

When the four electron groups around the central atom include two bondings and two nonbonding groups (AX_2E_2 ; A=central atom, X=surrounding atom, E=lone pair), the molecular shape is **bent** or **V shaped**.

Water is the most important V-shaped molecule in the tetrahedral arrangement.

