VSEPR Structures:
A Handy Guide

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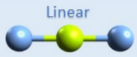
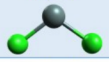
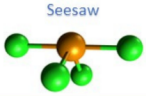
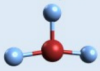
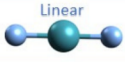
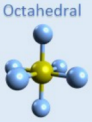
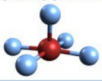
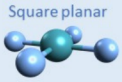
Rule: Atoms and lone pairs have electron density. The lowest energy state of a molecule is the one where atoms and lone pairs are the furthest away from each other.

The VSEPR Method

Step 1: Determine Lewis structure for the molecule.

Step 2: Assign it a VSEPR AXE notation based on the # of atoms and lone pairs.
A = # of central atoms; X = # of substituent atoms; E = # of lone pairs.

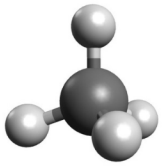
Step 3: Use this chart to determine the geometry.

# of electron groups	Types of electron groups	VSEPR	Name of molecular shape	Ex
2	2 Bonds	AX_2	Linear 	BeF_2
3	3 Bonds	AX_3	Trigonal planar 	BF_3
3	2 Bonds, 1 Lone Pair	AX_2E	Angular 	$SnCl_2$
4	4 bonds	AX_4	Tetrahedral 	CF_4
4	3 bonds, 1 lone pair	AX_3E	Trigonal pyramidal 	PCl_3
4	2 bonds, 2 lone pair	AX_2E_2	Angular 	H_2S
5	5 bonds	AX_5	Trigonal bipyramidal 	$SbCl_5$
5	4 bonds, 1 lone pair	AX_4E	Seesaw 	$TeCl_4$
5	3 bonds, 2 lone pair	AX_3E_2	T-shaped 	BrF_3
5	2 bonds, 3 lone pair	AX_2E_3	Linear 	XeF_2
6	6 bonds	AX_6	Octahedral 	SF_6
6	5 bonds, 1 lone pair	AX_5E	Square pyramidal 	BrF_5
6	4 bonds, 2 lone pair	AX_4E_2	Square planar 	XeF_4

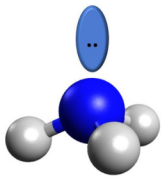
Frequently Asked Questions:

Q: Are bond angles exact for each molecule?

A: No, the bond angles are slightly influenced by whether the substituent is an atom or a lone pair and by atomic radii.



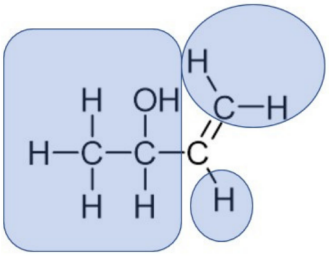
Methane, CH_4
AX_4 109.5°



Ammonia, NH_3
AX_3E 107°

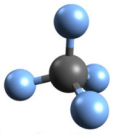
Q: Does VSEPR theory work for more complex molecules?

A: For the carbon atom at the far left, VSEPR predicts it will be a tetrahedral carbon as it has the AX4 configuration of four bonded groups and no lone pairs. We treat each hydrogen atom as a separate substituent and the everything else residing to the right of the carbon as one substituent.



Q: What is the difference between the molecular geometry and the electronic geometry of a molecule?

A: The molecular geometry only takes atoms into account, whereas electronic geometry accounts for both atoms and lone pair electrons.



Molecular: Tetrahedral
Electronic: Tetrahedral

Molecular: Bent
Electronic: Tetrahedral

This means that the electronic geometry and the molecular geometry can be different for the same molecule.