Chapter 7 Part 4

Dr. Turner

Valence-Shell Electron-Pair Repulsion

- Valence-Shell Electron-Pair Repulsion theory (VSEPR theory, pronounced “Vehs-pur”) is used to predict the three dimensional shapes of molecules from their Lewis structures.

How VSEPR theory works

1. Find the number of electron domains around the central atom
    1. Draw the Lewis structure of the molecule
    2. Lone pairs count as one electron domain
    3. Any type of bond (single, double, or triple) counts as one electron domain

Finding the number of electron domains

CH_4, H_2O, HCN, ClF_3

Electron Domains

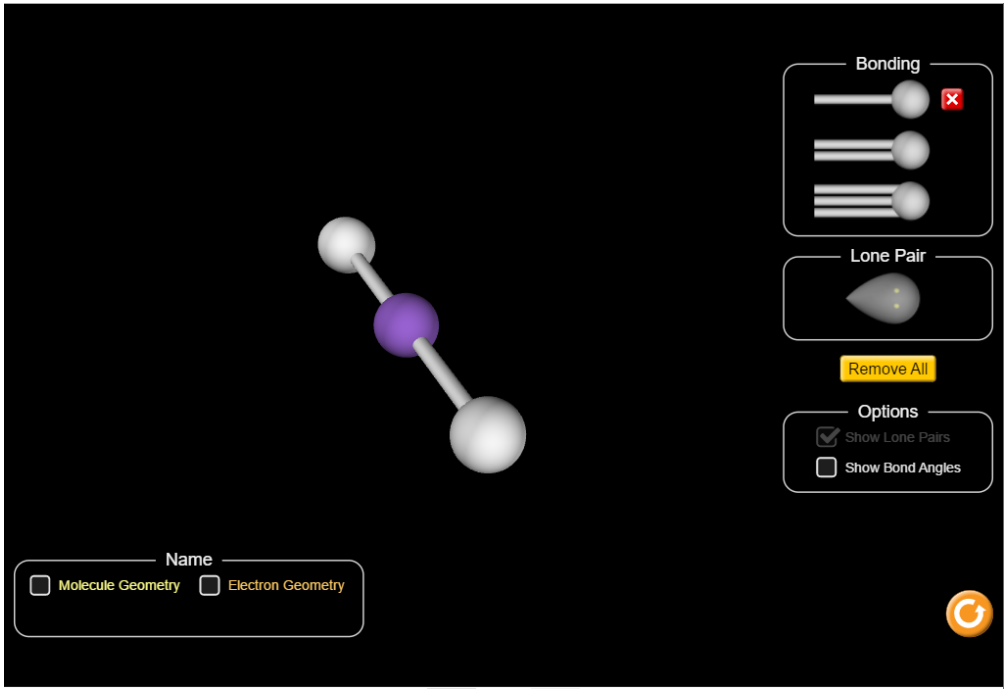
How many electron domains are on the central atom of XeF_2?

A. 3
B. 4
C. 5
D. 6

How VSEPR theory works

1. Find the number of electron domains around the central atom
    1. Draw the Lewis structure of the molecule
    2. Lone pairs count as one electron domain
    3. Any type of bond (single, double, or triple) counts as one electron domain
2. Based the number of electron domains around the central atom, determine the electron-pair geometry

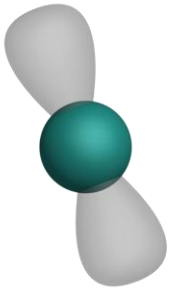
Molecular and Electron Geometry Interactive



Electron-pair geometry

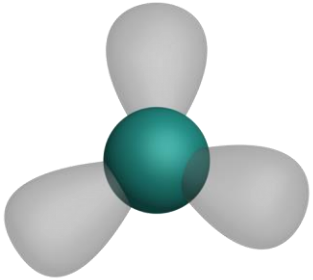
2 Electron domains

Linear



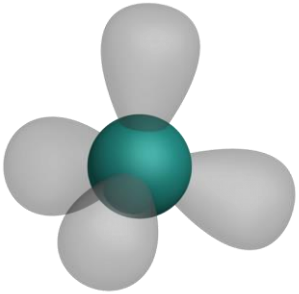
3 Electron domains

Trigonal Planar



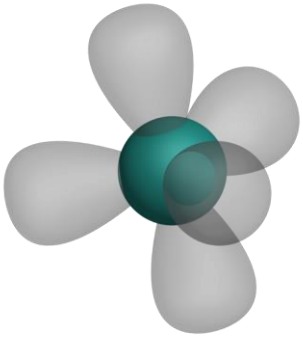
4 Electron domains

Tetrahedral



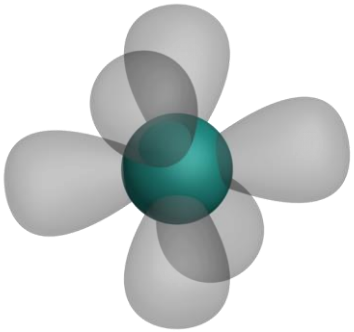
5 Electron domains

Trigonal Bipyramidal



6 Electron domains

Octahedral



Electron-pair geometries

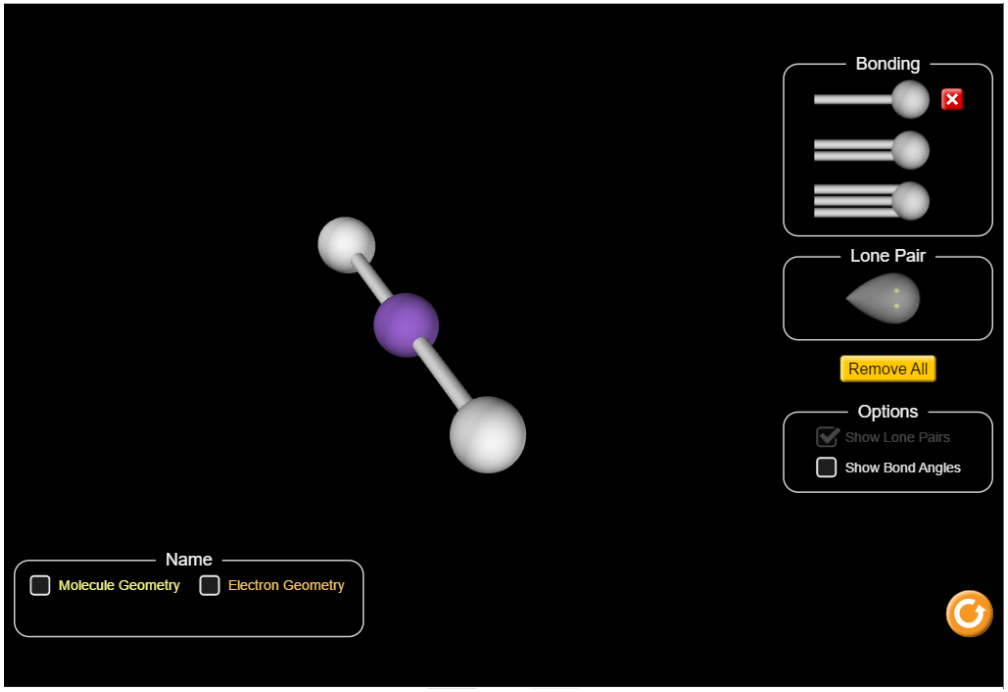
Determine the electron pair geometries of the following molecules

A. O_3
B. IF_5
C. SeF_6
D. SH_2

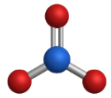
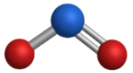
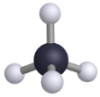
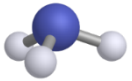
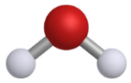
How VSEPR theory works

1. Find the number of electron domains around the central atom
    1. Draw the Lewis structure of the molecule
    2. Lone pairs count as one electron domain
    3. Any type of bond (single, double, or triple) counts as one electron domain
2. Based the number of electron domains around the central atom, determine the electron-pair geometry
3. Using the electron-pair geometry and number of lone pairs, determine the molecular geometry

Molecular and Electron Geometry Interactive

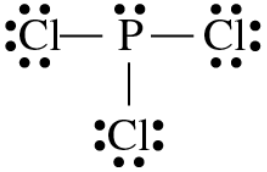


Molecular Geometries (Part 1 of 3)

Electron Domains	Bonding Pairs	Lone Pairs	Electron-Pair Geometry	Molecular Geometry	Bond Angles	Example	Model
2	2	0	Linear	Linear	180°	CO_2	
3	3	0	Trigonal planar	Trigonal planar	120°	NO_3^-	
	2	1	Trigonal planar	Bent	<120°	NO_2^-	
4	4	0	Tetrahedral	Tetrahedral	109.5°	CH_4	
	3	1	Tetrahedral	Trigonal pyramidal	<109.5°	NH_3	
	2	2	Tetrahedral	Bent	<109.5°	H_2O	

Determining Molecular Geometries

Determine the molecular geometries and bond angles for the molecules below.



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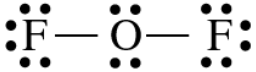

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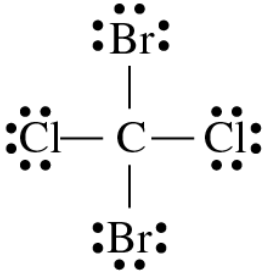

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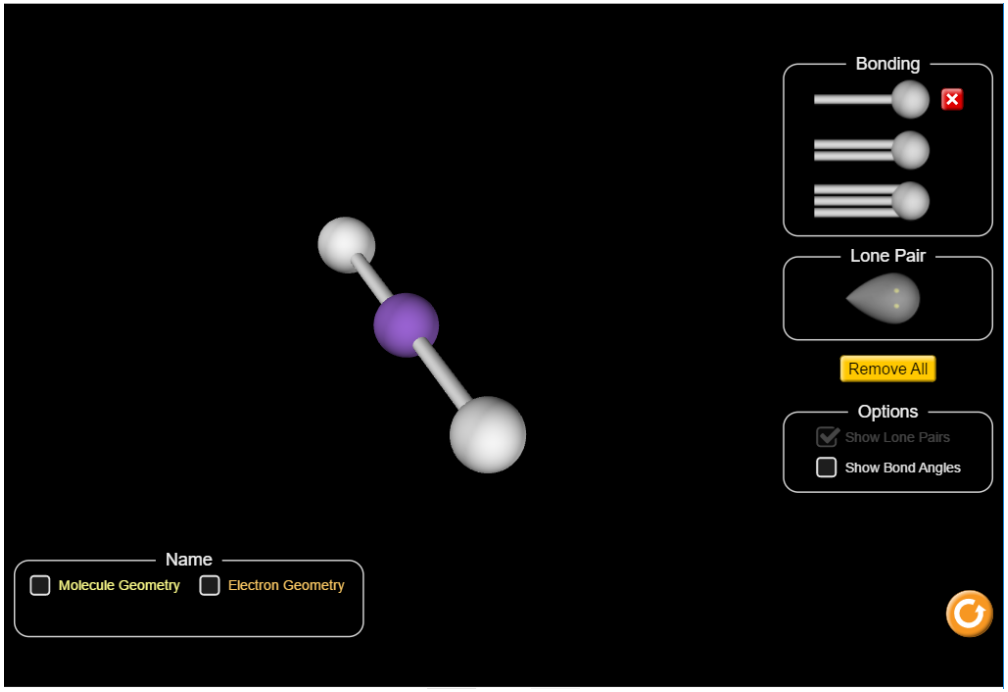
Determining Molecular Geometries

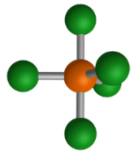
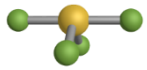
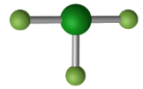
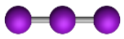
Predict the molecular geometry for a molecule with two bonded groups and two lone pairs.

A. linear
B. bent
C. trigonal planar
D. tetrahedral
E. trigonal bipyramidal

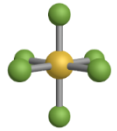
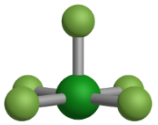
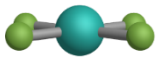
Molecular and Electron Geometry Interactive



Molecular Geometries (Part 2 of 3)

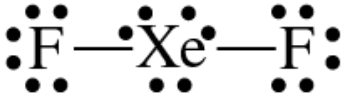
Electron Domains	Bonding Pairs	Lone Pairs	Electron-Pair Geometry	Molecular Geometry	Bond Angles	Example	Model
5	5	0	Trigonal bipyramidal	Trigonal bipyramidal	90°, 120°, 180°	PCl_5	
	4	1	Trigonal bipyramidal	Seesaw	<90°, <120°, <180°	SF_4	
	3	2	Trigonal bipyramidal	T-shaped	<90°, <180°	ClF_3	
	2	3	Trigonal bipyramidal	Linear	180°	I_3^-	

Molecular Geometries (Part 3 of 3)

Electron Domains	Bonding Pairs	Lone Pairs	Electron-Pair Geometry	Molecular Geometry	Bond Angles	Example	Model
6	6	0	Octahedral	Octahedral	90°, 180°	SF_6	
	5	1	Octahedral	Square pyramidal	<90°, <180°	ClF_5	
	4	2	Octahedral	Square planar	90°, 180°	XeF_4	

Determining Molecular Geometries

Determine the molecular geometries and bond angles for the molecules below.



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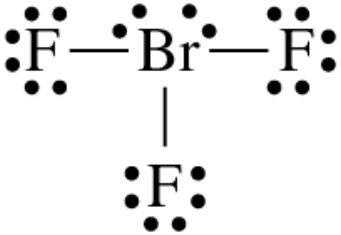

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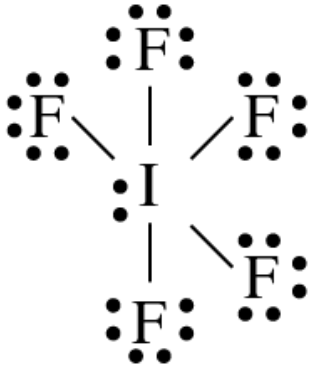

(c)

Determining Molecular Geometries

Predict the molecular geometry for the SeF_4 molecule.

A. tetrahedral
B. trigonal bipyramidal
C. seesaw
D. square pyramidal
E. square planar

Larger Molecules

- Shapes of larger molecules are usually described as a series of smaller shapes linked together.
- Any nonterminal atom can be considered a central atom.
- The shape around each central atom can be determined by the number of electron domains, bonding groups, and lone pairs.

Determining the Molecular Geometry

Describe the geometry around each carbon atom in propanol, CH_3CH_2CHO, using the Lewis structure below.