

The VSEPR Model applied to Steric Numbers 2 through 4. (VSEPR Part 3)


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Recall: The Basic Molecular Geometries (Shapes)

- ➡ **Linear (SN = 2)**
 - ➡ **Trigonal planar (SN = 3)**
 - ➡ **Tetrahedral (SN = 4)**
 - ➡ **Trigonal bipyramid (SN = 5)**
 - ➡ **Octahedral (SN = 6)**
- 

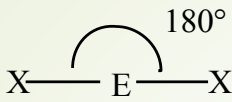
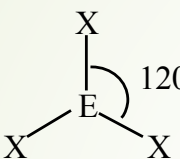
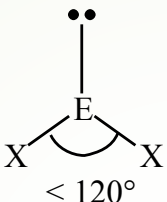
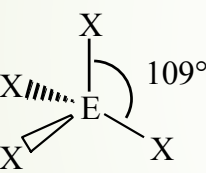
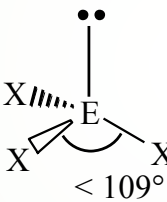
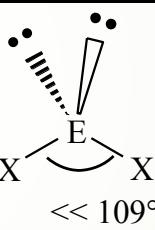
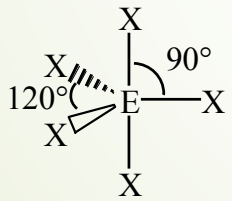
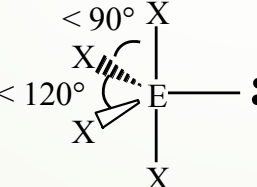
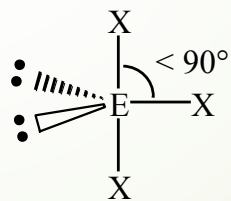
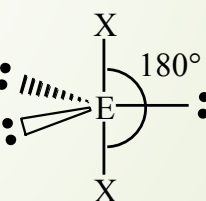
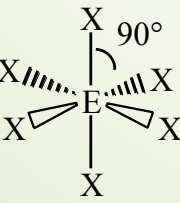
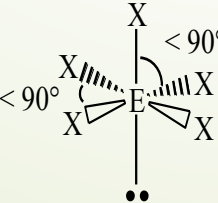
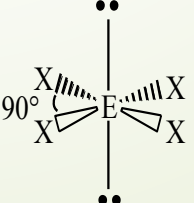
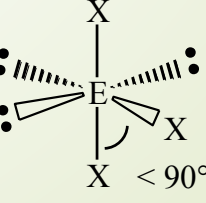
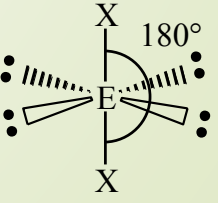
Basic Molecular Geometries and Lone Pairs

- Molecular geometries are organized into groups based on Steric Number (SN).
- All of the possible geometries for each **SN are built on a *basic geometry*.**

Basic Molecular Geometries and Lone Pairs

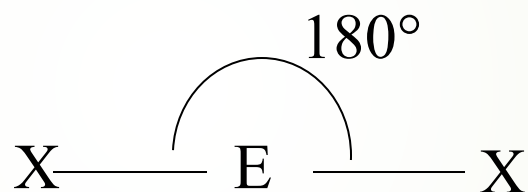
- As **lone pairs are substituted** for bonded atoms on the central atom, the **shape of the molecule changes**.
- **Bond angles** are also distorted due to lone pair electron repulsions.
- The **name of the shape** is based on the **bonded atoms**.

VSEPR Geometries

Steric No.	Basic Geometry 0 lone pair	1 lone pair	2 lone pairs	3 lone pairs	4 lone pairs
2	 <p>Linear</p>				
3	 <p>Trigonal Planar</p>	 <p>Bent or Angular</p>			
4	 <p>Tetrahedral</p>	 <p>Trigonal Pyramid</p>	 <p>Bent or Angular</p>		
5	 <p>Trigonal Bipyramid</p>	 <p>Sawhorse or Seesaw</p>	 <p>T-shape</p>	 <p>Linear</p>	
6	 <p>Octahedral</p>	 <p>Square Pyramid</p>	 <p>Square Planar</p>	 <p>T-shape</p>	 <p>Linear</p>

Recall: Basic Geometry for Steric Number 2

Steric # 2: Two electron domains, and both are bonded atoms

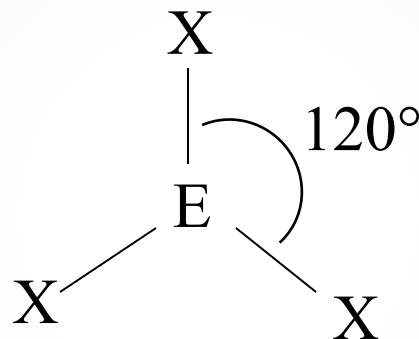


To minimize repulsion, atoms bonded by electron pairs lie on opposite sides of the central atom.

Molecular Shape: Linear

Recall: Basic Geometry for $SN = 3$

SN=3: Three electron “domains”

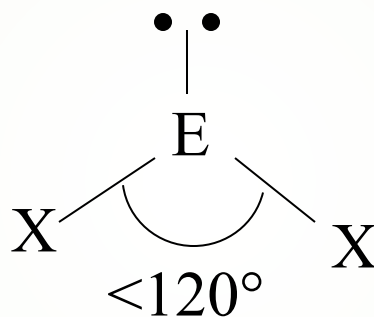


To minimize repulsions, bonded atoms are arranged in a plane with a $X-E-X$ bond angle of 120°

(Basic) Molecular Shape: Trigonal Planar

Lone Pairs and SN = 3

One bonded atom is substituted with a lone pair on the central atom.




The lone-pair repels the bonding pairs more than the bonding pairs repel each other, so the X—E—X bond angle “squeezes” together (reduces to $< 120^\circ$)


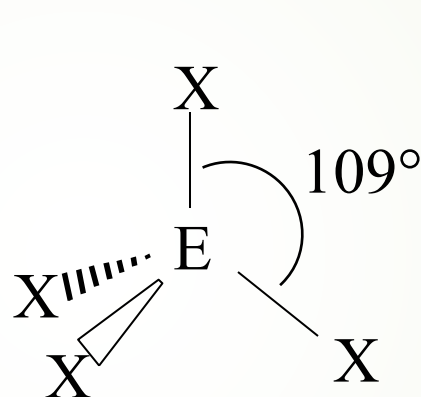
Molecular Shape: Bent

Recall: Basic Geometry for $SN = 4$

$SN = 4$: Four electron “domains”



Pointing out
of the page



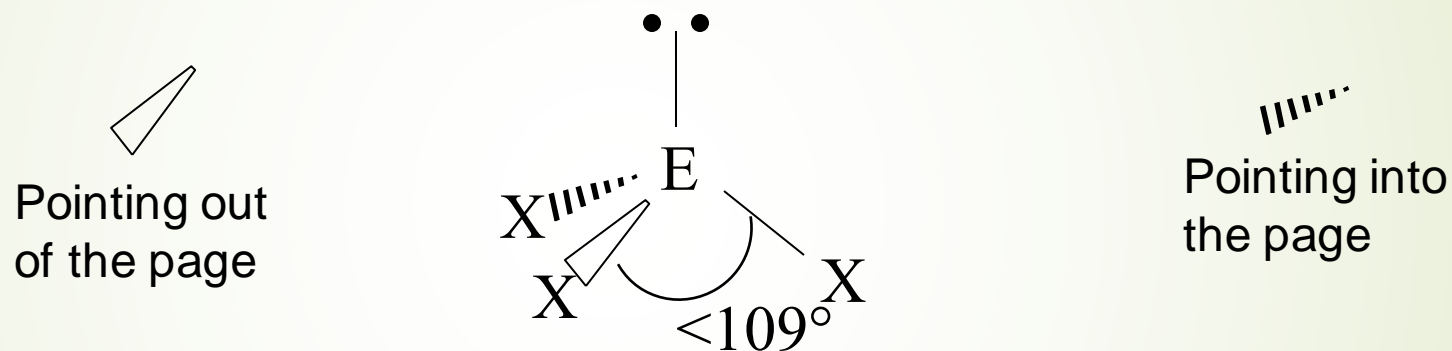
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the page

To minimize repulsions, bonded atoms are arranged around the central atom with a $X-E-X$ bond angle of 109.5°

(Basic) Molecular Shape: Tetrahedral

One Lone Pair and SN = 4

One bonded atom is substituted with a lone pair on the central atom.

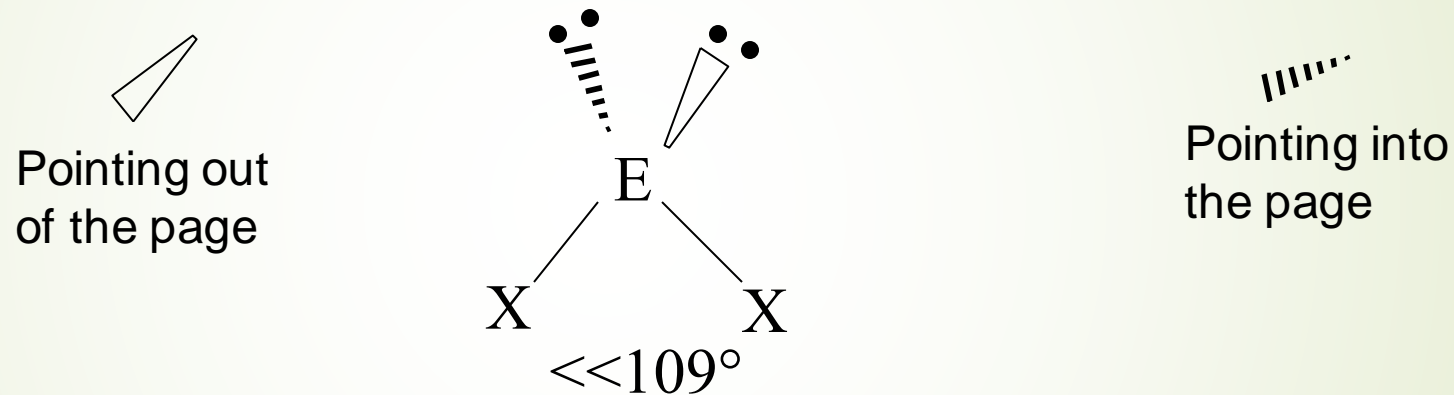


The lone pair repels the bonding pairs more than the bonding pairs repel each other, so the X—E—X bond angle “squeezes” together (reduces to $< 109^\circ$)

Molecular Shape: Trigonal pyramid

Two Lone Pairs and SN = 4

Two bonded atoms are substituted with a lone pair on the central atom.



The repulsions produced by lone pairs increases again, so the X—E—X bond angle “squeezes” together even more (reduces to $\ll 109^\circ$)

Molecular Shape: Bent

Example 1: Determining the SN and Naming the Geometry

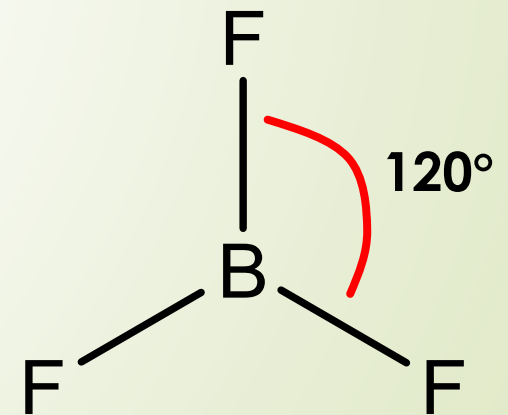
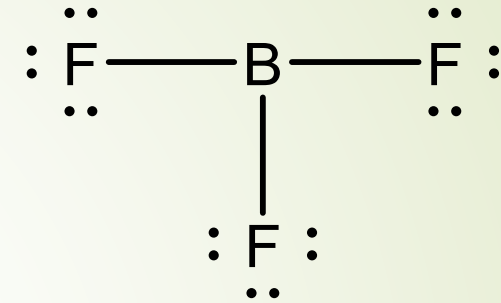
- ➡ Draw the Lewis structure for BF_3 . Determine the steric number and name the molecular geometry. Identify the bond angle, including distortions, if present.

Example 1 Solution:

➡ The Lewis structure for BF_3 is

There are three F atoms bonded to B, so **SN = 3**, the **basic geometry is trigonal planar**, and the **bond angles are 120°** .

Since there are no lone pairs, there are no distortions to the bond angles and the **geometry is trigonal planar**.

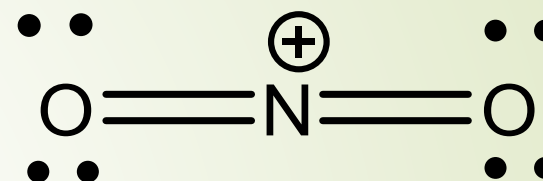


Example 2: Determining the SN and Naming the Geometry

- ➡ Draw the Lewis structure for the nitronium ion (NO_2^+). Determine the steric number and name the molecular geometry. Identify the bond angle, including distortions, if present.

Example 2 Solution:

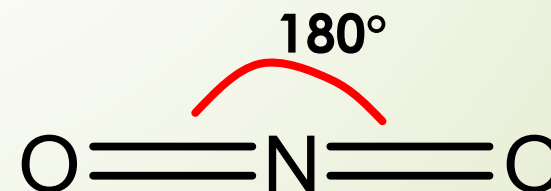
The Lewis structure for the nitronium ion is



SN = 2 (remember that each double bond counts as one electron domain)

The bond angle is 180° , and no distortions exist.

Linear shape

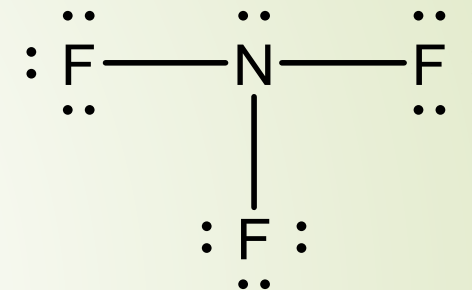


Example 3: Determining the SN and Naming the Geometry

- ➡ Draw the Lewis structure for NF_3 , determine the steric number, and name the molecular geometry. Identify the bond angle, including distortions, if present.

Example: Determining the Steric Number for the Central Atom

➡ The Lewis structure for NF_3 is

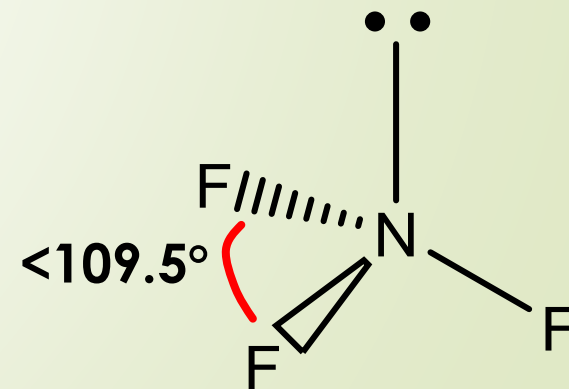


There are three F atoms bonded to N, plus a lone pair, so **SN = 4**, and the **basic geometry is tetrahedral**.

The ideal bond angles are 109.5° .

Since there is a lone pair on the central atom (N), the bond angles are less than 109° .

The **geometry name is trigonal pyramidal**.





➡ Additional examples will be posted separately. 😊

