Chem ch8

wkst: **Molecular Shapes**

The shapes of molecules can be predicted from their **Lewis structures** by using the **VSEPR** (**V**alence **S**hell **E**lectron **P**air **R**epulsion) model, which states that electron pairs around a central atoms will assume a geometry that keeps them as far apart from each other as possible.

This is illustrated by the drawings below.

**Six groups** surrounding a central atom will form an **octahedron**. All of the groups in this structure are at **90°** or **180°** to each other. All positions are equivalent

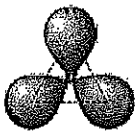
octahedral

**Five groups** will form a **trigonal bipyramid**. The two positions pointing up and down are called the **axial** positions. They are at **180°** to each other, and at **90°** to the other three, **equatorial** positions. The three **equatorial** positions are at **120°** to each other. There is more room in the equatorial positions, and large groups will occupy these positions.

Trigonal Bipyramidal

**Four groups** will form a **tetrahedron.** All of the angles in a tetrahedron are **109.5°**, and all positions are equivalent.

Tetrahedral



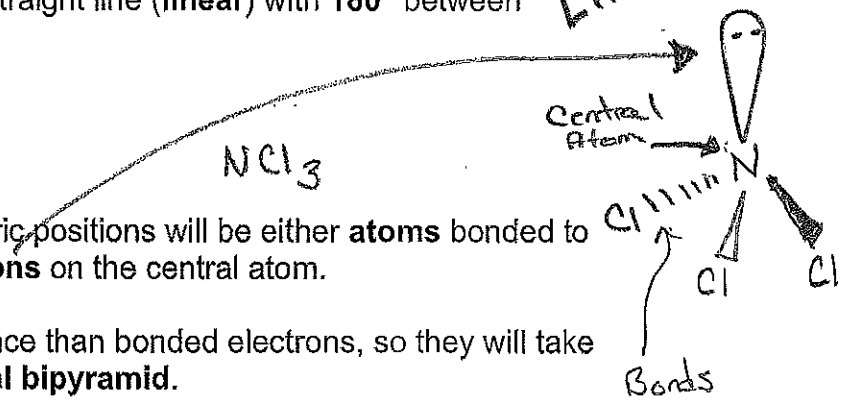
**Three groups** will form a flat triangle (**trigonal planar**). Each of the angles is **120°** and all positions are equivalent.

Trigonal

**Two groups** form a straight line (**linear**) with **180°** between them.

Linear

How does this apply to Chemistry?




The groups occupying these geometric positions will be either **atoms** bonded to the central atom, or **lone pair electrons** on the central atom.

Lone pair electrons occupy **more** space than bonded electrons, so they will take the **equatorial** position in the **trigonal bipyramid**.

**Lone pair electrons** will also occupy positions that put them as far apart from each other as possible.

1. Draw the Lewis structure for water, $H_2O$.

a) How many "groups" (atoms and lone pairs) surround the central oxygen?

b) What is the **geometry** of this molecule (look at atoms and lone pairs)? Draw this VSEPR structure next to the Lewis structure.

c) What is the **shape** of this molecule (look only at the atoms)?

d) What is the H-O-H bond angle?

e) Place the partial positive and negative charges on the H and O atoms, based on their relative electronegativities. Is water a **polar** compound?

2. Draw the Lewis structure for $NCl_3$

a) How many "groups" (atoms and lone pairs) surround the central nitrogen?

b) What is the **geometry** of this molecule (look at atoms and lone pairs)? Draw this VSEPR structure next to the Lewis structure.

c) What is the **shape** of this molecule (look only at the atoms)?

d) What is the bond angle?

3. Draw the Lewis and VSEPR structures for the following compounds and them with their **geometry**.

| | **Lewis** | **VSEPR** | **Geometry** |
|---|---|---|---|

A) $SF_6$

B) $CO_2$

C) $SO_3$

D) $BrF_3$

F) $BrF_5$

G) $SiCl_4$

4. Fill in the missing information in the chart using the structures you have drawn in part 3

| Compound | **Atoms** on Central Atom | **Lone pairs** on Central Atom | Geometry | Shape | Polar or nonpolar? |
|---|---|---|---|---|---|
| $SF_6$ | | | | | |
| $CO_2$ | | | | | |
| $SO_3$ | | | | | |
| BrF3 | | | | | |
| $BrF_5$ | | | | | |
| $SiCl_4$ | | | | | |