Name _____

Worksheet 15 - 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.

we did not learn these 2 So don't worry about them

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

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.

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

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

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

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 NH_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 H-N bond angle?

e) Place the partial positive and negative charges on the H and N atoms, based on their relative electronegativities. Is NH_3 a **polar** compound?

3. Draw the Lewis Structure and label Polar or non-polar for the following 12 compounds and label them with their **geometry**.

Lewis	Polar/Nonpolar	**Lewis**	Polar/nonpolar
a) BeF_2		b) CCl_4	
c) PCl_3		d) SF_2	
e) CF_4		f) H_2O	
g) PF_3		h) NH_3	
j) CO_2		k) $AlBr_3$	
l) $AlCl_3$		m) BF_3	

Now fill in the missing information in the chart using the structures you have drawn for the problems in question 3. The first two have been done for you so you can see how I would like it done.

Compound	Atoms Bonded to central atom	Lone pairs on central atom	geometry	polar
BeF_2	2	0	linear	no
PCl_3	3	1	Trigonal pyramidal	yes
CF_4				
PF_2				
CO_2				
$AlCl_3$				
CCl_4				
SF_2				
H_2O				
NH_3				
$AlBr_3$				
BF_3				