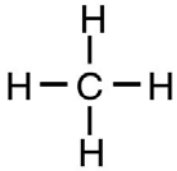
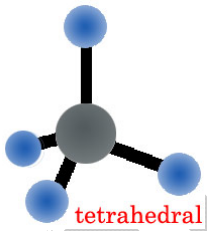
Name _____ **Honors Chemistry** ___/___/___

Valence Shell Electron Pair Repulsion (VSEPR)

VSEPR theory states that because electron pairs repel, molecules adjust their shapes so that the valence-electron pairs are as far apart as possible. In methane, CH_4, carbon is the central atom and the four hydrogen atoms are distributed around it. Two dimensionally it looks like:



Three dimensionally it (kind of) looks like:



But, molecules are not two dimensional, they are three dimensional. In the three dimensional arrangement, each of the hydrogen atoms align themselves as far away from each other as possible. The three dimensional shape of carbon tetrahydride is called tetrahedral. Using the two dimensional structural formula, which we can draw on paper, and molecular hybridization, you can determine the three dimensional shape of the molecule.

Central Atoms with Two Effective Pairs (sp hybridized)				
# of lone pair	shape	Example	Bond Angle	Lewis Structure
0	linear	$BeCl_2$	180°	

Central Atoms with Three Effective Pairs (sp^2 hybridized)				
# of lone pair	shape	Example	Bond Angle	Lewis Structure
0	triangular planar	BCl_3	120°	
1	bent (angular)	NO_2^{1-}	104.5°	

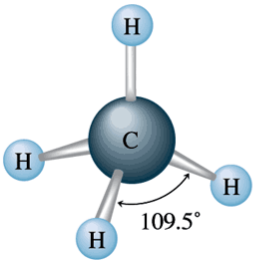
Central Atoms with Four Effective Pairs (sp^3 hybridized)				
# of lone pair	shape	Example	Bond Angle	Lewis Structure
0	tetrahedral	CCl_4	109.5°	
1	triangular pyramidal	NH_3	107°	
2	bent (angular)	H_2O	104.5°	

Central Atoms with Five Effective Pairs (dsp^3 hybridized)				
# of lone pair	shape	Example	Bond Angle	Lewis Structure
0	triangular bipyramidal	PF_5	120° 90°	
1	seesaw	SF_4	104.5°, 90°	
2	T-shaped	ClF_3	90°	
3	linear	XeF_2	180°	

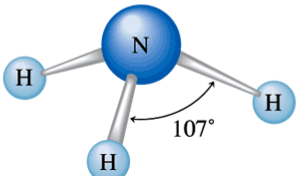
Central Atoms with Six Effective Pairs (d^2sp^3 hybridized)				
# of lone pair	shape	Example	Bond Angle	Lewis Structure
0	octahedral	SF_6	90°	
1	square pyramidal	BrF_5	90°	
2	square planar	XeF_4	90°	

- Note in the chart below that even though CH_4, NH_3 and H_2O are composed of central atoms with 4 electron pair, the bond angles between atoms varies in the different molecules.
- These observations provide evidence that lone pairs of electrons need more room than bonding pairs and tend to compress the angles between the bonding pairs.

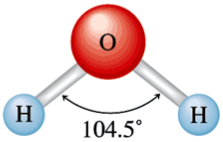
Methane

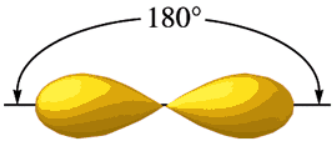
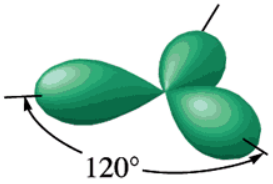
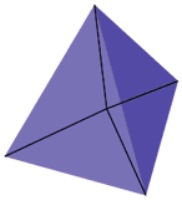
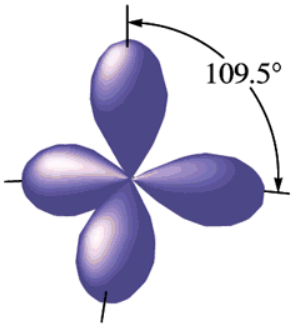
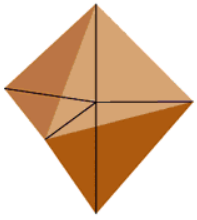
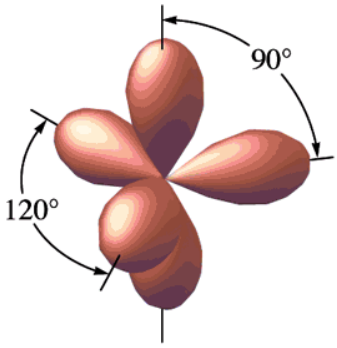
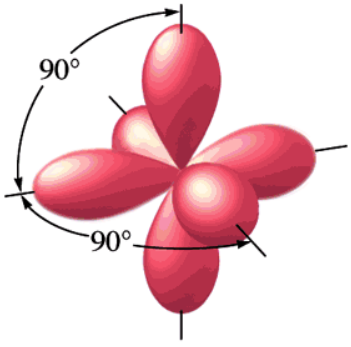


Ammonia



Water



Number of Effective Pairs	Arrangement of Pairs		Hybridization Required	
2		Linear	*sp*	
3		Trigonal planar	sp^2	
4		Tetrahedral	sp^3	
5		Trigonal bipyramidal	dsp^3	
6		Octahedral	d^2sp^3	

Homework:

Name	Formula	Lewis Structure	Hybridization	Shape
sulfur tetrafluoride				
bromine pentafluoride				
ammonia				
xenon difluoride				
methane				
carbon monoxide				
sulfate ion				
sulfur hexafluoride				
sulfur dioxide				
carbon dioxide				

Name	Formula	Lewis Structure	Hybriodization	Shape
dichloro, difluoromethane	CCl_2F_2			
nitrate ion				
carbonate ion				
carbon tetrachloride				
xenon tetrafluoride				
arsenic trifluoride				
formaldehyde	CH_2O			
chlorine trifluoride				
phosphorus pentafluoride				
beryllium dichloride				