

Chemistry 151 - Fundamentals of Chemistry II

Fall 2010

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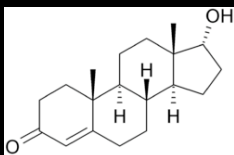
1st Edition Text for Chem 151

Nivaldo J. Tro (Tro) – Chapter 10

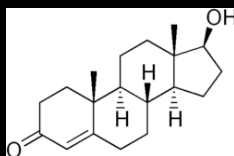
Review of molecular shape and polarity

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Molecular shape and biological activity



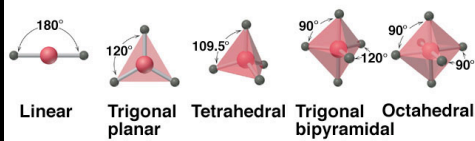
Epitestosterone



Testosterone

Tro - 10.2

Electron-Group Repulsions and the Five Basic Molecular Shapes



The Single Molecular Shape of the Linear Electron-Group Arrangement

LINEAR

Class	Shape
AX_2	<p>Linear</p>

Examples: CS_2 , HCN , BeF_2

$A =$

$X =$

$E =$

Key

Linear geometry

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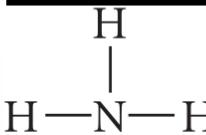
Linear geometry

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Tro 10.3 – VSEPR – lone pairs and their effect on geometry

The Three Molecular Shapes of the Tetrahedral Electron-Group Arrangement

TETRAHEDRAL	Trigonal pyramidal
	
Class Shape	AX₃E
	
AX₄	AX₂E₂
Tetrahedral Examples: CH ₄ , SiCl ₄ , SO ₄ ²⁻ , ClO ₄ ⁻	Bent (V shaped) Examples: H ₂ O, OF ₂ , SCl ₂



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Effect of Lone Pairs on Molecular Geometry

No lone pairs

One lone pair

Two lone pairs



CH₄





NH₃





H₂O

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The Four Molecular Shapes of the Trigonal Bipyramidal Electron-Group Arrangement

TRIGONAL BIPYRAMIDAL	
Class	Shape
AX_5	
Trigonal bipyramidal	
Examples: PF_5 , AsF_5 , SOF_4	
AX_4E	
Seesaw	
Examples: SF_4 , XeO_2F_2 , IF_4^+ , $IO_2F_2^-$	

AX_3E_2	
T-shaped	
Examples: ClF_3 , BrF_3	
AX_2E_3	
Linear	
Examples: XeF_2 , IF_3 , IF_2^-	

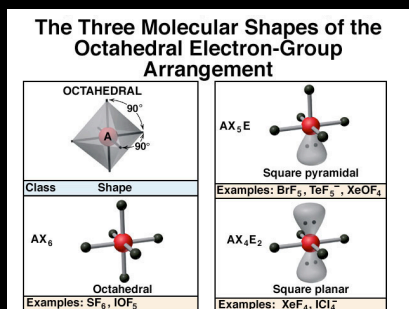


Table 10.1 Electron and Molecular Geometries

Electron Groups*	Bonding Groups	Lone Pairs	Electron Geometry	Molecular Geometry	Approximate Bond Angles	Example
2	2	0	Linear	Linear	180°	$\text{Cl}-\text{C}\equiv\text{C}-\text{Cl}$
3	3	0	Trigonal planar	Trigonal planar	120°	$\text{H}_2\text{C}=\text{CH}_2$
3	2	1	Trigonal planar	Bent	<120°	SO_2
4	4	0	Tetrahedral	Tetrahedral	109.5°	CH_4
4	3	1	Tetrahedral	Trigonal pyramidal	<109.5°	NH_3
4	2	2	Tetrahedral	Bent	<109.5°	H_2O
5	5	0	Trigonal bipyramidal	Trigonal bipyramidal	120° (equatorial), 90° (axial)	PCl_5
5	4	1	Trigonal bipyramidal	Seesaw	<120° (equatorial), <90° (axial)	SF_4
5	3	2	Trigonal bipyramidal	T-shaped	<180°	ClF_3
5	2	3	Trigonal bipyramidal	Linear	180°	XeF_2
6	6	0	Octahedral	Octahedral	90°	SF_6
6	5	1	Octahedral	Square pyramidal	<90°	XeF_5^-
6	4	2	Octahedral	Square planar	90°	XeF_4

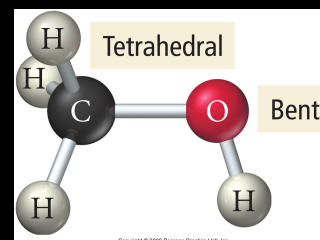
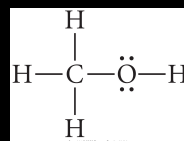
*Count only electron groups around the central atom. Each of the following is considered one electron group: a lone pair, a single bond, a double bond, a triple bond, or a single electron.

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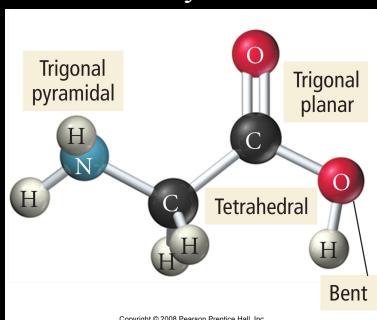
REMINDERS

1. Next on line homework will be available tomorrow; due next Thursday at 11:59 PM
2. Quiz one – next Friday- chapters 10 and 11

Describing the Geometry of Methanol

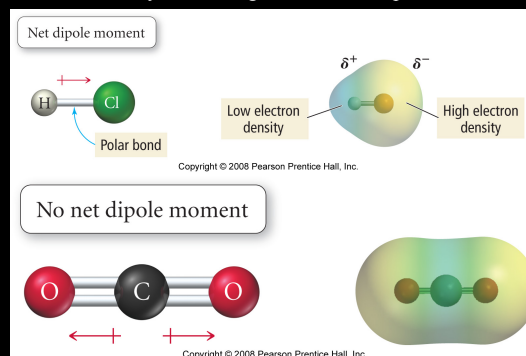


Describing the Geometry of Glycine



Tro 10.5 – Molecular Shape and Polarity

Bond Polarity, Bond Angle and Bond Dipole Moment



Bond Polarity, Bond Angle, and Bond Dipole Moment

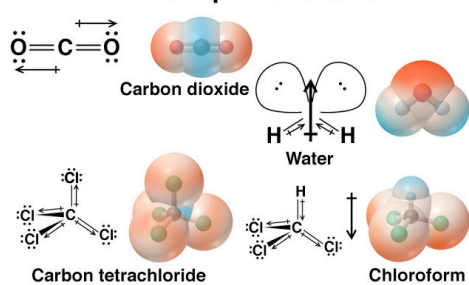
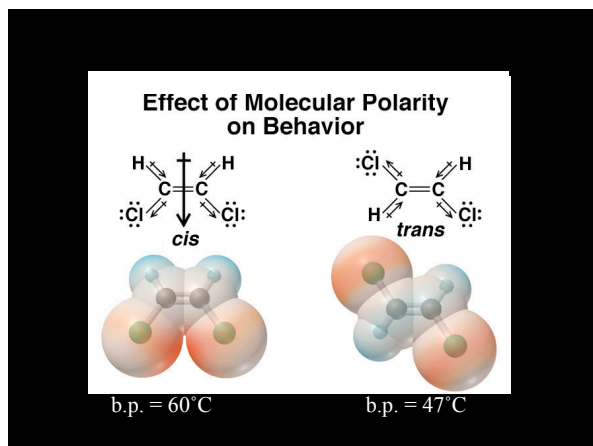


TABLE 10.2 Common Cases of Adding Dipole Moments to Determine whether a Molecule is Polar

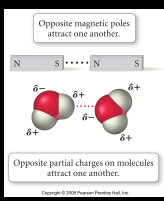
<p>Linear</p> <p>Nonpolar</p> <p>The dipole moments of two identical polar bonds pointing in opposite directions will cancel. The molecule is nonpolar.</p>	<p>Bent</p> <p>Polar</p> <p>The dipole moments of two polar bonds with an angle of less than 180° between them will not cancel. The resultant dipole moment vector is shown in red. The molecule is polar.</p>
<p>Trigonal planar</p> <p>Nonpolar</p> <p>The dipole moments of three identical polar bonds at 120° from each other will cancel. The molecule is nonpolar.</p>	<p>Tetrahedral</p> <p>Nonpolar</p> <p>The dipole moments of four identical polar bonds in a tetrahedral arrangement (109.5° from each other) will cancel. The molecule is nonpolar.</p>
<p>Trigonal pyramidal</p> <p>Polar</p> <p>The dipole moments of three polar bonds in a trigonal pyramidal arrangement (109.5° from each other) will not cancel. The resultant dipole moment vector is shown in red. The molecule is polar.</p>	

Note: In all cases where the dipoles of two or more polar bonds cancel, the bonds are assumed to be identical. If one or more of the bonds are different from the other(s), the dipoles will not cancel and the molecule will be polar.



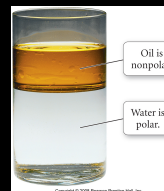
Molecular Polarity Affects Solubility in Water

- polar molecules are attracted to other polar molecules
- since water is a polar molecule, other polar molecules dissolve well in water
 - and ionic compounds as well
- some molecules have both polar and nonpolar parts



Opposite magnetic poles attract one another.

Opposite partial charges on molecules attract one another.



Oil is nonpolar.

Water is polar.

