Experiment #10: Geometrical Structure of Molecules and Ions using Molecular Models

In Chemistry 1A, you are introduced to four theories involving molecular models: Lewis dot structures, Valence Shell Electron Pair Repulsion (VSEPR) Theory, Valence Bond (VB) Theory, and Molecular Orbital (MO) Theory. This experiment combines the first three theories. It gives you an opportunity to predict the Lewis dot two-dimensional structures on paper, physically build the three-dimensional models using ball and stick pieces, determine the expected angles and shapes using VSEPR Theory, and identify the hybridized orbitals and number of sigma (σ) and pi (π) bonds using VB Theory.

Lewis dot structures are two-dimensional models that use all of the valence electrons available. Covalent bonds form when nonmetals combine to share electrons, creating single, double, or triple bonds. Ions are always represented inside brackets with the overall charge indicated on the outside upper right. For ionic compounds, you separate the cation and anion, keeping both inside their own brackets. Lewis structures give you a great amount of information such as bond types, resonances, structural isomers, formal charges, and dipole arrows between atoms. Most elements follow and prefer the octet rule; exceptions include: (1) octet deficient (H, Be, B) atoms, (2) an odd number of total electrons prevent the possibility of an octet for all atoms, and (3) expanded octets possessing 10 or 12 electrons around a central atom, beginning with period three and higher elements. The BEST Lewis structures follow the octet rule and minimize formal charges.

Valence Shell Electron Pair Repulsion (VSEPR) Theory states that bonds and lone pairs are regions of high electron density in an atom that repel each other until they get as far apart as possible. This effect determines the atom's three-dimensional geometry and bond angles. Two regions will be 180° apart; three regions will be 120° apart; and four regions will be 109.5° apart. Expanded octets which are not pictured here include the trigonal bipyramidal electronic geometry that has five regions (2 axial positions 180° apart from each other) and the octahedral electronic geometry that has six regions (all 180° and 90° apart from each other) and the octahedral electronic geometry that has six regions (all 180° and 90° apart from each other) and the other as in an x, y, z three-dimensional axis).

The Valence Bond (VB) Theory is also three-dimensional and has the same angles as predicted by VSEPR Theory. In addition, VB Theory promotes the notion that these shapes appear because the atomic orbitals have become hybridized. Hydrogen keeps its simple *s* orbital. Atoms with two regions now possess two identical *sp*-hybridized orbitals, three regions have $3 sp^2$ hybrid orbitals, 4 regions become sp^3 hybridized, five regions are sp^3d hybridized, and six regions form sp^3d^2 hybrid orbitals. All bonds also have a sigma (σ) bond that directly overlaps. Multiple bonds possess sigma and pi (π) bonds that indirectly overlap perpendicular to the hybridized orbitals, where double bonds include 1 sigma and 1 pi bond, and triple bonds include 1 sigma and 2 pi bonds.

# of areas	# of bonds	# of lone pairs	Geometry and bond angles	Example
4	2	2	Angular or bent (~109.5°)	H H
4	3	1	Trigonal Pyramidal (~109.5°)	H
4	4	0	Tetrahedral (109.5°)	
3	2	1	Bent (~120°)	$\begin{bmatrix} \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ 2 \text{ resonance forms} \end{bmatrix}$
3	3	0	Trigonal Planar (120°)	$\begin{bmatrix} & & & & & & & & & & & & & & & & & & &$
2	2	0	Linear (180°)	H–C≡N:
	1	any	Linear (Must have three or more atoms to form an angle.)	

Partial VSEPR Table (look to your book or notes for expanded octets)

Notice the convention for drawing bonds in 3-D space, where:

- the dash (......) represents a bond going behind the paper.

Do not confuse resonance structures with structural isomers. Resonance structures contain atoms in the same position but electrons are delocalized throughout. Structural isomers are molecules having the same chemical formula but different connectivity of the atoms. For example, two isomers are possible for a molecule with the formula C_4H_{10} :



Procedure

For each of the ions or molecules listed:

- A. Draw the Lewis dot structure. For those with resonance, draw all possibilities. When requested, draw all the different structural isomers. Remember that single bonds can twist, but multiple bonds cannot.
- B. Use the model kit to build the structure.
 - The white atoms represent hydrogen and can form one bond each.
 - The black, blue, and red atoms represent atoms that desire a complete octet.
 - Use short sticks for nonbonded electron lone pairs
 - Use long sticks for single bonds.
 - Use multiple springs for double and triple bonds.
 - Use purple atoms for trigonal bipyramidal electron geometry
 - Use silver atoms for octahedral electron geometry
- C. For each central atom in the structure, determine the number of areas of electron density that lie directly on that atom. An area of electron density may be:
 - a lone (nonbonding) pair or dot that lies on the atom in question
 - a single bond
 - a double bond
 - a triple bond
- D. Fill in the empty spots on the table. Assign bond angles, formal charges, dipole arrows for polar bonds, and molecular geometries. Determine the polarity of the species, atomic and hybridized orbitals, and number of pi bonds.

Complete the following table for the indicated species:						
Substance	H ₂ O	HF	O2	СО		
a) Draw the best Lewis structure(s), resonances, and structural isomers if any	(does NOT need to be bent at this point!)					
b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom						
c) Include formal charges if they are not zero	formal charge $_{\rm O} = 0$					
	formal charge $_{\rm H} = 0$					
Name the electronic geometry around central atom(s)	Tetrahedral					
Give hybridization for central atom(s)	sp ³					
Name the shape around central atom(s)	Bent (or angular)					
Show 3-D sketch of the structure and label all bond angles	н 109.5° Н					
How many sigma bonds? How many pi bonds?	2σ and 0π bonds					
Is the substance an ionic compound, a polar molecule, a nonpolar molecule, or a polyatomic ion?	polar molecule					

Complete the following table for the indicated species:

	Complete the followin			1
Substance	$\mathbf{NH4^{+1}}$	Na ₂ S	SO ₃	ClO ₂ -
a) Draw the best Lewis structure(s), resonances, and structural isomers if any				
b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom				
c) Include formal charges if they are not zero				
Name the electronic geometry around central atom(s)				
Give hybridization for central atom(s)				
Name the shape around central atom(s)				
Show 3-D sketch of the structure and label all bond angles				
How many sigma bonds? How many pi bonds?				
Is the substance an ionic compound, a polar molecule, a nonpolar molecule, or a polyatomic ion?				

Complete the following table for the indicated species:

Substance	SO ₃ ⁻²	CH ₂ O	CO ₂	SCN-
a) Draw the best				
Lewis structure(s),				
resonances, and				
structural isomers if				
any				
b) In your structure				
above, indicate polar				
bonds with dipole				
arrows toward the				
more				
electronegative atom				
8				
c) Include formal				
charges if they are				
not zero				
Name the electronic				
geometry around				
central atom(s)				
Give hybridization				
for central atom(s)				
Name the shape				
around central				
atom(s)				
Show 3-D sketch of				
the structure and				
label all bond angles				
TT .				
How many sigma				
bonds? How many				
pi bonds?				
Is the substance				
an ionic compound,				

Complete the following table for the indicated species:

a polar molecule, a nonpolar molecule, or a polyatomic ion?

a) Draw the best Lewis structure(s), resonances, and structural isomers if any b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule,	Substance	$\frac{\text{Complete the following}}{\text{C}_2\text{H}_2\text{Br}_2}$	NF ₃	CH ₂ Cl ₂	CH ₃ OH
Lewis structure(s), resonances, and structural isomers if any b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Mame the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an onpolar molecule,	Substance	U2Π 2 D Γ2	11173		
Lewis structure(s), resonances, and structural isomers if any b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Mame the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an onpolar molecule,					
resonances, and structural isomers if any b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles bods? How many pi bonds? Is the substance an onpolar molecule, a polar molecule,	-				
structural isomers if any b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule,					
any b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) c) Include formal charges if they are not zero c) Name the electronic geometry around central atom(s) c) Give hybridization for central atom(s) c) Name the shape around central atom(s) c) Show 3-D sketch of the structure and label all bond angles c) How many sigma bonds? c) Is the substance an ionic compound, a polar molecule, anonpolar molecu	-				
b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? Is the substance an ionic compound, a polar molecule,	structural isomers if				
above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? Is the substance an onpolar molecule,	any				
above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? Is the substance an onpolar molecule,					
bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? Is the substance an onpolar molecule,					
arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule,					
more electronegative atom c) Include formal charges if they are charges if they are not zero Name the electronic geometry geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? substance an ionic compound, a polar molecule, an onpolar molecule, an onpolar molecule,	bonds with dipole				
electronegative atom	arrows toward the				
c) Include formal charges if they are not zero	more				
c) Include formal charges if they are not zero	electronegative atom				
charges if they are not zero Image: second seco					
not zero Image: Second sec	c) Include formal				
Name the electronic geometry around central atom(s) Image: central atom(s) Give hybridization for central atom(s) Image: central atom(s) Name the shape around central atom(s) Image: central atom(s) Show 3-D sketch of the structure and label all bond angles Image: central atom cen	charges if they are				
geometry around central atom(s) Image: second seco	not zero				
geometry around central atom(s) Image: second seco					
central atom(s) Give hybridization Give hybridization Give hybridization for central atom(s) Name the shape Name the shape around central atom(s) Show 3-D sketch of the structure and Image: Structure and label all bond angles Image: Structure and How many sigma Image: Structure and bonds? How many Image: Structure and Is the substance an ionic compound, a polar molecule, Image: Structure and	Name the electronic				
central atom(s) Give hybridization Give hybridization Give hybridization for central atom(s) Name the shape Name the shape around central atom(s) Show 3-D sketch of the structure and Image: Structure and label all bond angles Image: Structure and How many sigma Image: Structure and bonds? How many Image: Structure and Is the substance an ionic compound, a polar molecule, Image: Structure and	geometry around				
Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule,					
for central atom(s) Name the shape around central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule, a nonpolar molecule,					
Name the shape around central atom(s) Image: Central structure and label all bond angles How many sigma bonds? How many pi bonds? Image: Central structure and label all bond angles Is the substance an ionic compound, a polar molecule, a nonpolar molecule, Image: Central analysis					
around central atom(s)					
Show 3-D sketch of the structure and label all bond angles Image: Comparison of the structure and label all bond angles How many sigma bonds? How many pi bonds? Image: Comparison of the structure and label all bond angles Is the substance an ionic compound, a polar molecule, a nonpolar molecule, Image: Comparison of the structure and label all bond angles					
the structure and label all bond angles Image: Constraint of the structure and bonds? How many sigma bonds? How many pi bonds? Image: Constraint of the structure and bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule, Image: Constraint of the structure and bonds of the structure an	atom(s)				
the structure and label all bond angles Image: Constraint of the structure and bonds? How many sigma bonds? How many pi bonds? Image: Constraint of the structure and bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule, Image: Constraint of the structure and bonds of the structure an					
the structure and label all bond angles Image: Constraint of the structure and bonds? How many sigma bonds? How many pi bonds? Image: Constraint of the structure and bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule, Image: Constraint of the structure and bonds of the structure an					
label all bond anglesHow many sigma bonds? How many pi bonds?Is the substance an ionic compound, a polar molecule, a nonpolar molecule,	Show 3-D sketch of				
How many sigma bonds? How many pi bonds?Image: Comparison of the substance an ionic compound, a polar molecule, a nonpolar molecule,Image: Comparison of the substance the substance of the substance of th	the structure and				
How many sigma bonds? How many pi bonds?Image: Comparison of the substance an ionic compound, a polar molecule, a nonpolar molecule,Image: Comparison of the substance the substance of the substance of th	label all bond angles				
bonds? How many ibonds? pi bonds? ibonds? Is the substance ibonds an ionic compound, ibonds a polar molecule, ibonds a nonpolar molecule, ibonds					
bonds? How many ibonds? pi bonds? ibonds? Is the substance ibonds an ionic compound, ibonds a polar molecule, ibonds a nonpolar molecule, ibonds					
bonds? How many ibonds? pi bonds? ibonds? Is the substance ibonds an ionic compound, ibonds a polar molecule, ibonds a nonpolar molecule, ibonds	How many sigma				
pi bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule,					
Is the substance an ionic compound, a polar molecule, a nonpolar molecule,					
an ionic compound, a polar molecule, a nonpolar molecule,	-				
a polar molecule, a nonpolar molecule,					
a nonpolar molecule,					
	or a polyatomic ion?				

	Complete the followin		ated species:	
Substance	C ₆ H ₆ (ring)	S8	PO4 ⁻³	C ₃ H ₈ O
a) Draw the best Lewis structure(s), resonances, and structural isomers if any				
 b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero 				
Name the electronic geometry around central atom(s)				
Give hybridization for central atom(s)				
Nametheshapearoundcentralatom(s)				
Show 3-D sketch of the structure and label all bond angles				
How many sigma bonds? How many pi bonds?				
Is the substance an ionic compound, a polar molecule, a nonpolar molecule, or a polyatomic ion?				

Complete the following table for the indicated species:

Complete t	the following table	for the indicated	species:
			T T T T T T T

Substance	NO ₃ -	NO ₂	H ₂ O ₂	C ₂ H ₂
Substance	1103	1102	11202	02112
a) Draw the best				
Lewis structure(s),				
resonances, and				
structural isomers if				
any				
ully				
b) In your structure				
above, indicate polar				
bonds with dipole				
arrows toward the				
more				
electronegative atom				
c) Include formal				
charges if they are				
not zero				
Name the electronic				
geometry around				
central atom(s)				
Give hybridization				
for central atom(s)				
Name the shape				
around central				
atom(s)				
Show 2 D alratah -f				
Show 3-D sketch of the structure and				
label all bond angles				
laber all bolid angles				
How many sigma				
bonds? How many				
pi bonds?				
Is the substance				
an ionic compound,				
a polar molecule,				
a nonpolar molecule,				
or a polyatomic ion?				

resonances, and structural isomers if any is acetic acid b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? B the substance an onpolar molecule,	Substance	A: C ₂ H ₄ O ₂		B: C ₂ H ₄ O ₂	C2H6	BaO
Lewis structure(s), that has one C resonances, and connected to 3 H and connected to 2 O. This any is acetic acid More than 5 isomers are possible b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c.) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Rame the electronic geometry around central atom(s) Show 3-D sketch of the substance an oncic compound, a polar molecule, anonpolar molecule, anonpola			ural	Draw a new structural		
resonances, and structural isomers if any is acetic acid b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an onpolar molecule, a polar molecule, a polar molecule,	a) Draw the best	isomer with C–C b	ond i	isomer keeping all		
structural isomers if any is de other to 2 O. This is acetic acid b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an onpolar molecule,	Lewis structure(s),					
anyis acetic acidb) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atomImage: Image: Image	resonances, and	connected to 3 H	and	More than 5 isomers are		
b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule,	structural isomers if	the other to 2 O. 7	This]	possible		
above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an onpolar molecule,	any	is acetic acid				
above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an onpolar molecule,						
bonds with dipole arrows toward the more electronegative atom						
arrows toward the more electronegative atom	· ·					
more electronegative atom c) Include formal height and the selectronic charges if they are not zero not zero Name the electronic geometry around central atom(s) give hybridization Give hybridization for central atom(s) Name the shape around central atom(s) give not zero Name the shape around central atom(s) give not zero Show 3-D sketch of the structure and label all bond angles give not zero How many sigma bonds? How many pi bonds? give substance an ionic compound, a polar molecule, an onpolar molecule, and the substance an nonpolar molecule, and the substance and the substan	_					
electronegative atom						
c) Include formal charges if they are not zero Name the electronic geometry around central atom(s) Give hybridization for central atom(s) Name the shape around central atom(s) Show 3-D sketch of the structure and label all bond angles How many sigma bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule,						
charges if they are not zero Image: Charges if they are not zero Name the electronic geometry around central atom(s) Image: Charges if they are not zero Give hybridization for central atom(s) Image: Charges if they are not zero Name the shape around central atom(s) Image: Charges if they are not zero Name the shape around central atom(s) Image: Charges if they are not zero Show 3-D sketch of the structure and label all bond angles Image: Charges if they are not zero How many sigma bonds? How many pi bonds? Image: Charges if they are not zero Is the substance an ionic compound, a polar molecule, a nonpolar molecule, Image: Charges if they are not zero	electronegative atom					
charges if they are not zero Image: Charges if they are not zero Name the electronic geometry around central atom(s) Image: Charges if they are not zero Give hybridization for central atom(s) Image: Charges if they are not zero Name the shape around central atom(s) Image: Charges if they are not zero Name the shape around central atom(s) Image: Charges if they are not zero Show 3-D sketch of the structure and label all bond angles Image: Charges if they are not zero How many sigma bonds? How many pi bonds? Image: Charges if they are not zero Is the substance an ionic compound, a polar molecule, a nonpolar molecule, Image: Charges if they are not zero	-) In 1-1- f					
not zero Image: Second sec	,					
Name the electronic geometry around central atom(s) Image: Control of the shape around central atom(s) Give hybridization for central atom(s) Image: Control of the shape around central atom(s) Name the shape around central atom(s) Image: Control of the structure and label all bond angles How many sigma bonds? How many pi bonds? Image: Control of the substance an ionic compound, a polar molecule, a nonpolar molecule, an nonpolar molecule,						
geometry around central atom(s)	not zero					
geometry around central atom(s)	Name the electronic					
central atom(s)						
Give hybridization for central atom(s) Image: state						
for central atom(s)	· · ·					
Name the shape around central atom(s) Image: second s						
atom(s) Image: Constraint of the structure and label all bond angles Image: Constraint of the structure and label all bond angles Image: Constraint of the structure and label all bond angles How many sigma bonds? How many pi bonds? Image: Constraint of the substance an ionic compound, a polar molecule, a nonpolar molecule,	Name the shape					
Show 3-D sketch of the structure and label all bond anglesImage: Construct of the structure and label all bond anglesImage: Construct of the structure and loods?How many sigma bonds? How many pi bonds?Image: Construct of the structure and the substance an ionic compound, a polar molecule, a nonpolar molecule,Image: Construct of the structure and the substance an ionic compound, a polar molecule, a nonpolar molecule,Image: Constructure and the substance anonpolar molecule,	around central					
the structure and label all bond angles How many sigma bonds? How many pi bonds? If the substance an ionic compound, a polar molecule, a nonpolar molecule, a nonpolar molecule, a substance an ionic compound, a nonpolar molecule, a nonpolar	atom(s)					
the structure and label all bond angles How many sigma bonds? How many pi bonds? If the substance an ionic compound, a polar molecule, a nonpolar molecule, a nonpolar molecule, a substance an ionic compound, a nonpolar molecule, a nonpolar						
the structure and label all bond angles How many sigma bonds? How many pi bonds? If the substance an ionic compound, a polar molecule, a nonpolar molecule, a nonpolar molecule, a substance an ionic compound, a nonpolar molecule, a nonpolar						
label all bond anglesImage: Constraint of the substance an ionic compound, a polar molecule, a nonpolar molecule,Image: Constraint of the substance of the subs						
How many sigma bonds? How many pi bonds?Image: Comparison of the substance an ionic compound, a polar molecule, a nonpolar molecule,Image: Comparison of the substance the substance of the substance of th						
bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule,	label all bond angles					
bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule,						
bonds? How many pi bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule,	How many sigma					
pi bonds? Is the substance an ionic compound, a polar molecule, a nonpolar molecule,						
Is the substance an ionic compound, a polar molecule, a nonpolar molecule,						
an ionic compound, a polar molecule, a nonpolar molecule,	-	<u> </u>				
a polar molecule, a nonpolar molecule,						
a nonpolar molecule,						
	or a polyatomic ion?					

			ach species has an expan	
Substance	I_{3}^{-}	ICl ₅	SF ₆	XeOCl ₂
a) Draw the best Lewis structure(s), resonances, and structural isomers if any				
 b) In your structure above, indicate polar bonds with dipole arrows toward the more electronegative atom c) Include formal charges if they are 				
Name the electronic				
geometryaroundcentral atom(s)Givehybridization				
for central atom(s)Nametheshape				
around central atom(s)				
Show 3-D sketch of the structure and label all bond angles				
How many sigma bonds? How many pi bonds?				
Is the substance an ionic compound, a polar molecule, a nonpolar molecule,				
or a polyatomic ion?				

Complete the following table (the central atom for each species has an expanded octet):