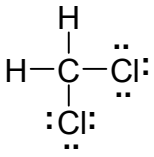
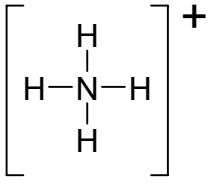
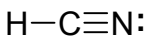
Lewis Symbolism, Molecular Structure (VSEPR), and Hybridization (VB Theory)

1. Draw the Lewis structures for the following molecules or ions:

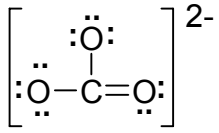
CH_2Cl_2 NH_4^+ HCN



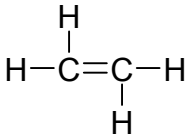


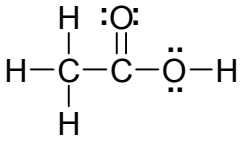


CO_3^{2-} C_2H_4 CH_3CO_2H

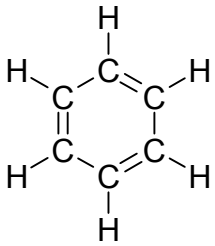


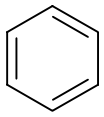
(With the two other resonance hybrids)



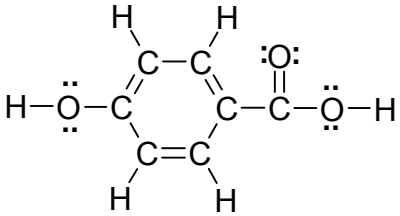


2. Draw the Lewis structure of benzene, C_6H_6. Benzene is a 6-carbon ring molecule. Show also the conventionally used abbreviated drawing of benzene.



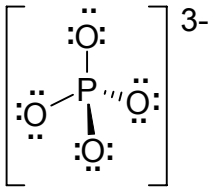
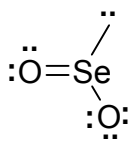
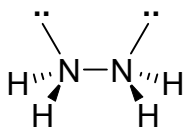


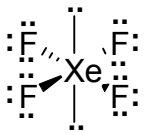
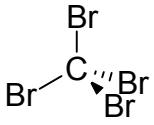
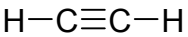
3. Draw the Lewis structure of parahydroxybenzoic acid, (PABA, $C_7H_6O_3$). PABA is an excellent UV-radiation absorber once used in sunscreens. As the name implies, PABA contains the benzene ring and the carboxylic acid group. The prefix "para" means "across the ring".

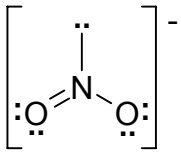
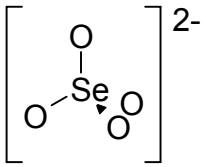
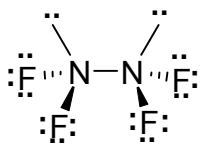


5. Two kinds of covalent bonds exist; nonpolar covalent and polar covalent. Describe the carbon-hydrogen bond in CH_4 as either polar or nonpolar.

6. Draw the Lewis structures of the following molecules or ions. For each, indicate the electronic geometry, molecular geometry, hybridization (if any) of central atoms, and whether the molecule or ion possesses a permanent dipole moment.

	PO_4^{3-}	SeO_2	N_2H_4
	 This ion may have 1 double bond.	 This ion shows resonance.	
electronic geometry	**tetrahedral**	**trigonal planar**	**tetrahedral both N**
molecular geometry	**tetrahedral**	**bent**	**trigonal pyramidal**
hybridization	**sp^3 (on P)**	**sp2 (on Se)**	**sp^3 (both N)**
Dipole Moment	**no**	**yes**	**yes**

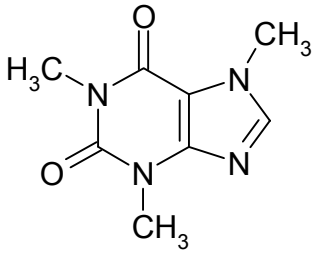
	XeF_4	CBr_4	C_2H_2
		 Lone-pairs omitted because I was tired.	
electronic geometry	**octahedral**	**tetrahedral**	**linear (both C)**
molecular geometry	**square planar**	**tetrahedral**	**linear (both C)**
hybridization	**sp^3d^2 (on Xe)**	**sp^3 (on C)**	**sp (on C)**
Dipole Moment	**no**	**no**	**no**

	NO_2^-	SeO_4^{2-}	N_2F_2
			
	This ion shows resonance.	This ion may have 1 or 2 double bonds.	
electronic geometry	**trigonal planar**	**tetrahedral**	**tetrahedral both N**
molecular geometry	**bent**	**tetrahedral**	**trigonal pyramidal**
hybridization	**sp2 (on N)**	**sp^3 (on Se)**	**sp^3 (both N)**
Dipole Moment	**yes**	**no**	**yes**

	SO_3	CF_2Cl_2	C_2H_4
electronic geometry			
molecular geometry			
hybridization			
Dipole Moment			

	NO	PBr_5	SF_6
electronic geometry	_____	_____	_____
molecular geometry	_____	_____	_____
hybridization	_____	_____	_____
Dipole Moment	_____	_____	_____

7. Shown below is the molecule caffeine. Describe the hybridization of every atom that uses hybridized atomic orbitals for bonding. Determine the approximate bond angles. Also indicate the type of bonds formed between atoms (*i.e.*, $\sigma(sp^2\text{-}p)$, $\pi(p\text{-}p)$, etc.) Notice that lone-pairs are omitted but assumed present; this convention is typical of many drawings of organic molecules.



Atom	Hybridization	Bond Angle on Atom
1	sp^3	109.5°
2	sp^3	~107°
3	sp^2	~120°
4	sp^2	~120°
5	sp^2	~120°
6	sp^3	~107°
7	sp^2	~120°
8	sp^3	109.5°
9	sp^2	~118°
10	sp^2	~120°
11	sp^3	107°
12	sp^3	109.5°