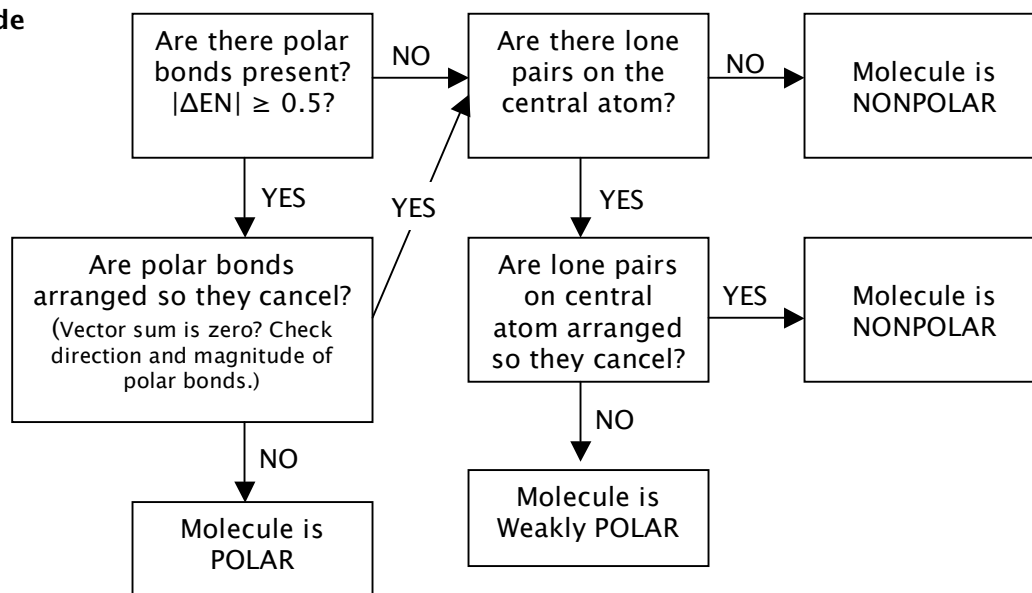


Molecular Geometry Worksheet: VSEPR Theory, Orbital Hybridization, and Molecule Polarity

Correlation Table

Electron Domains	Electron-Domain Geometry of Atom	Predicted Bond Angle(s)	Orbital Hybridization of Atom	Bonding Domains	Nonbonding Domains	Molecular Geometry of Atom
2	Linear	180°	sp	2	0	Linear
3	Trigonal planar	120°	sp ²	3	0	Trigonal planar
				2	1	Bent
4	Tetrahedral	109.5°	sp ³	4	0	Tetrahedral
				3	1	Trigonal pyramidal
				2	2	Bent
5 (expanded octet)	Trigonal bipyramidal	90° axial, 120° equatorial	sp ³ d	5	0	Trigonal bipyramidal
				4	1	Seesaw
				3	2	T-shaped
				2	3	Linear
6 (expanded octet)	Octahedral	90°	sp ³ d ²	6	0	Octahedral
				5	1	Square pyramidal
				4	2	Square planar

Polar Molecule Guide

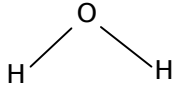


	1A																				8A	
1	1																			2		
	H																			He		
	1.008																			4.003		
2	3	4															5	6	7	8	9	10
	Li	Be															B	C	N	O	F	Ne
	6.941	9.012															10.81	12.01	14.01	16.00	19.00	20.18
3	11	12															13	14	15	16	17	18
	Na	Mg															Al	Si	P	S	Cl	Ar
	22.99	24.31															26.98	28.09	30.97	32.07	35.45	39.95
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr				
	39.10	40.08	44.96	47.90	50.94	52.00	54.94	55.85	58.93	58.70	63.55	65.39	69.72	72.59	74.92	78.96	79.90	83.80				
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54				
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe				
	85.47	87.62	88.91	91.22	92.91	95.94	(98)	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.6	126.9	131.3				
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86				
	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn				
	132.9	137.3	138.9	178.5	180.9	183.9	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	(209)	(210)	(222)				
7	87	88	89	104	105	106	107	108	109	110	111											
	Fr	Ra	Ac	Rf	Ha	Sg	Ns	Hs	Mt													
	(223)	(226)	(227)	(261)	(262)	(266)	(262)	(265)	(266)													

6	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
	140.1	140.9	144.2	(145)	150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0
7	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lw
	232.0	(231)	238.0	(244)	(242)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(260)

	Electronegativities of selected elements																He	
1	H															—		
	2.2															—		
2	Li	Be											B	C	N	O	F	Ne
	0.98	1.57											2.04	2.55	3.04	3.44	3.98	—
3	Na	Mg											Al	Si	P	S	Cl	Ar
	0.93	1.31											1.61	1.9	2.19	2.58	3.16	—
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
	0.82	1.0	1.36	1.54	1.63	1.66	1.55	1.83	1.88	1.91	1.90	1.65	1.83	2.01	2.18	2.55	2.96	—
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
	0.82	0.95	1.22	1.33	1.6	2.16	1.9	2.2	2.28	2.20	1.83	1.69	1.78	1.96	2.05	2.1	2.66	—
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
	0.79	0.89	1.10	1.3	1.5	2.36	1.9	2.2	2.20	2.80	2.54	2.00	2.04	2.33	2.02	2.0	2.2	—
7	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt									
	0.7	0.9	1.1	—	—	—	—	—	—									

Complete the following tables.

Compound or Ion	Most Stable Lewis Structure (smallest formal charges)	Electron Domains	Electron Domain Geometry	Orbital Hybridization notation	Molecular Geometry	3-D drawing of Molecular Geometry	Polar or nonpolar?
H ₂ O	$\text{H}-\overset{\cdot\cdot}{\underset{\cdot\cdot}{\text{O}}}-\text{H}$	4	Tetrahedral	sp ³	Bent		Polar
NH ₃							
CCl ₄							
CO ₂							
HCN							
SO ₂							

Lab section: MW or TTh Locker # _____

Name: _____

Compound or Ion	Most Stable Lewis Structure (smallest formal charges)	Electron Domains	Electron Domain Geometry	Orbital Hybridization notation	Molecular Geometry	3-D drawing of Molecular Geometry	Polar or nonpolar?
BF_3							
PO_4^{3-}							NA
PCl_5							
C_3H_8							
BrF_5							
SF_6							

Lab section: MW or TTh Locker # _____

Name: _____

Compound or Ion	Most Stable Lewis Structure (smallest formal charges)	Electron Domains	Electron Domain Geometry	Orbital Hybridization notation	Molecular Geometry	3-D drawing of Molecular Geometry	Polar or nonpolar?
SO_3^{2-}							NA
BrO_3^-							NA
TeCl_4							
ClF_3							
XeF_2							
ICl_4^-							NA

Lab section: MW or TTh Locker # _____

Name: _____

Molecular Geometry and Bonding Questions

1. Molecules of H_2O and CO have dipole moments, but CO_2 does not. Sketch the geometry of these molecules **and use the sketches to explain these facts.**

2. Make a **three dimensional sketch** of the geometry of the following species. Above each sketch indicate the direction of the species' dipole moment, if any.

(a) CH_3F

(b) SiF_4

(c) NO_2

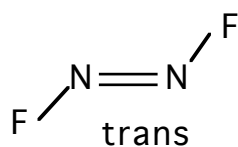
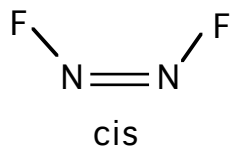
(d) HCN

3. Give a possible bonding scheme using **Valence Bond Theory** for the following molecules. To do this, **sketch a ball and stick model of each molecule** and **identify each sigma and pi bond** in the molecule. Indicate the orbitals used by each atom for each bond using the following notation: Csp^2-Csp^2 overlap for the C-C sigma bond, etc.

(a) Dimethyl ether, CH_3OCH_3

(b) Ethylene, CH_2CH_2

4. Dinitrogen difluoride exists in the following forms called *cis* and *trans* isomers (l.p. not shown). **Explain in terms of Valence Bond Theory and bond energies** why the two different forms exist as separate molecules and do not interconvert at room temperature.



5. Draw Lewis structures for the following two acids:

(a) HNO_3

(b) H_2SO_4