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Chemistry: Semester 1
VSEPR Worksheet 2

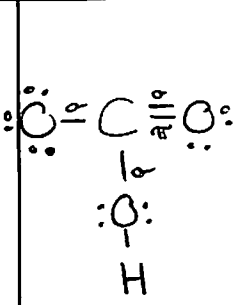
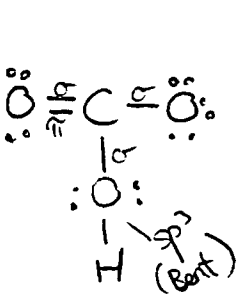
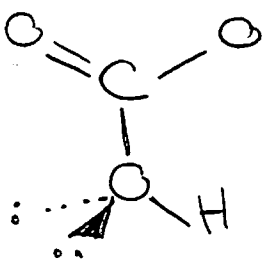
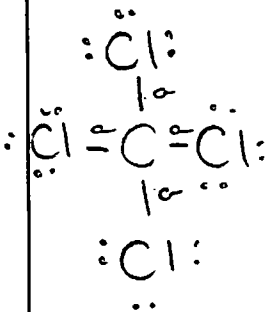
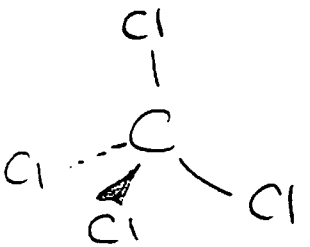
3-D Lewis STRUCTURES

For each of the following molecules or ions:
(a) Draw a correct **Lewis Structure;**
(b) Indicate if it can demonstrate **resonance** (if so, draw *one* alternate resonance form).

For the **underlined/bold atom**), give:
(c) **hybridization,** (d) the **bond angle(s),** (e) the **formal charge** (f) the **number of pi (π) bonds** in structure.

Lastly,
(g)) the **geometry** of structure **(see list)** and (h) its 3-D **Lewis structure** (3-D)

Geometries (in alpha-order): *bent, linear, octahedral, seesaw,square planar, square pyramidal, tetrahedral, trigonal bipyramidal, trigonal planar, trigonal pyramidal, T-shaped*

Compound/Ion	a) Lewis Structure	b) Resonance? Draw 1 of them	c)Hybridization	d)Bond Angle	g) Geometry	h) 3-D Lewis Structure
$\underline{H}CO_3^{1-}$ (1+4+18+1 = 24) (3×6)			sp^2	120°	Trigonal Planar	
			e) Formal Charge	f) Pi Bonds		
			O (4-4)	1		
$\underline{C}Cl_4$ (4+28 = 32) (7×4)		—	c)Hybridization	d)Bond Angle	Tetrahedral	
			sp^3	109.5°		
			e) Formal Charge	f) Pi Bonds		
			O (4-4)	O		

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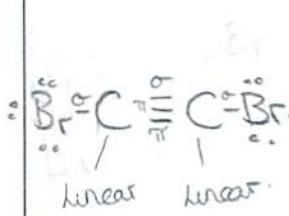
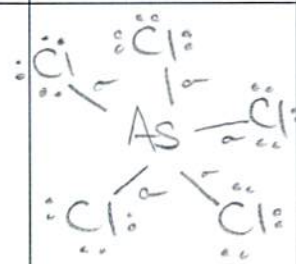
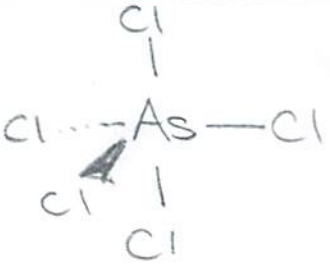
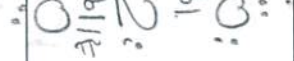
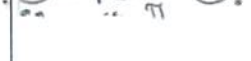
			c)Hybridization	d)Bond Angle		
$\underline{C_2}Br_2$ (2×4) (2×7) (8 + 14 = 22)		–	sp	180°	linear	
			e) Formal Charge	f) Pi Bonds		
			0 (4-4)	2		

Compound/Ion	a) Lewis Structure	b) Resonance? Draw 1 of them	c)Hybridization	d)Bond Angle	g) Geometry	3-D h) Lewis Structure
$\underline{As}Cl_5$ (5 + 5×7 = 40)		–	sp^3d	Equatorial = 120 Axial = 90	Trigonal Bipyramidal	
			e) Formal Charge	f) Pi Bonds		
			0 (5-5)	0		
$\underline{NO_2}^{1-}$ (5 + 6×2 + 1 = 18)			c)Hybridization	d)Bond Angle	Bent	
			sp^2	<120°		
			e) Formal Charge	f) Pi Bonds		
			+1 (5-5)	1		

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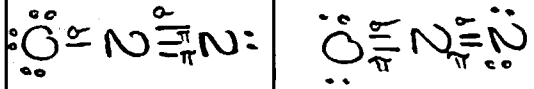
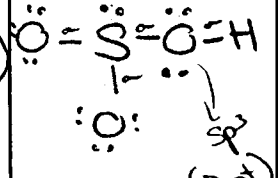
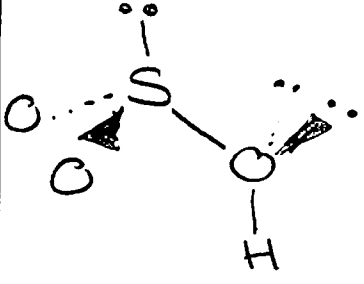
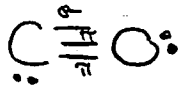
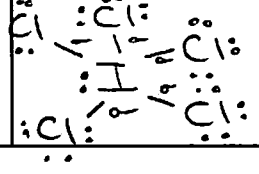
			c)Hybridization	d)Bond Angle		
N_2O (2x5) (10+6 = 16)			sp	180	Linear	O = N = N
			e) Formal Charge	f) Pi Bonds		
			+1 (5-4)	2		

3-D

Compound/Ion	a) Lewis Structure	b) Resonance? Draw 1 of them	c)Hybridization	d)Bond Angle	g) Geometry	h) Lewis Structure
HSO_3^{1-} (6x3) (1+6+18+1 = 26)		–	sp^3	< 109.5	Trigonal Pyramidal	
			e) Formal Charge	f) Pi Bonds		
			+1 (6-5)	0		
CO (4+6 = 10)		–	c)Hybridization	d)Bond Angle	Linear	:-C≡O-:
			sp	180		
			e) Formal Charge	f) Pi Bonds		
			-1 (4-5)	2		
ICl_5 (0x5) (7+35 = 42)		–	c)Hybridization	d)Bond Angle		
			sp^3d^2	< 90°		

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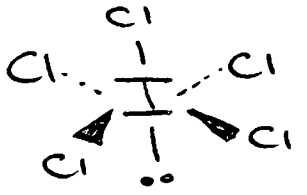
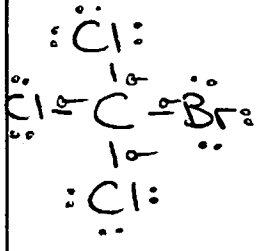
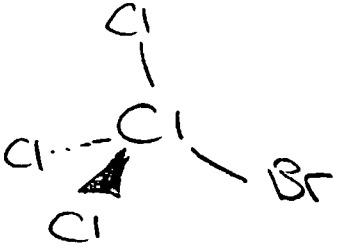
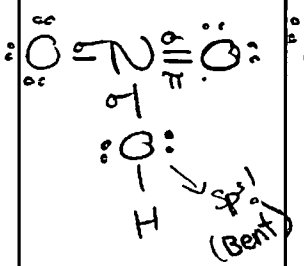
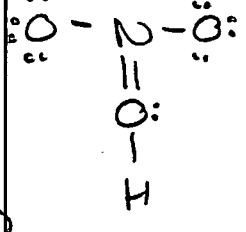
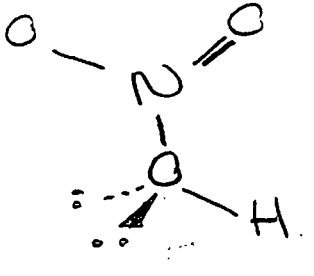
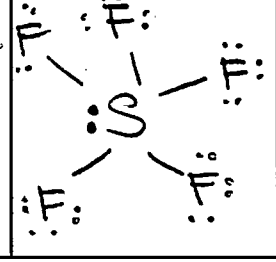
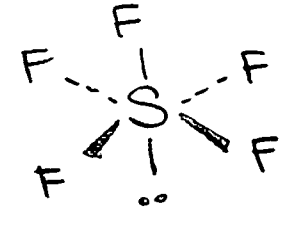
			e) Formal Charge	f) Pi Bonds	Square Pyramidal	
			7-7=0	0		

Compound/Ion	a) Lewis Structure	b) Resonance? Draw 1 of them	c)Hybridization	d)Bond Angle	g) Geometry	h) 3-D Lewis Structure
$\underline{C}BrCl_3$ $(4+7+\overset{(3\times7)}{21}=32)$		–	sp^3	109.5°	Tetrahedal	
			e) Formal Charge	f) Pi Bonds		
			$(4-4)^{0}$	0		
$H\underline{N}O_3$ $(1+5+\overset{(3\times6)}{18}=24)$			c)Hybridization	d)Bond Angle	Trigonal Planar	
			sp^2	120°		
			e) Formal Charge	f) Pi Bonds		
			$(5-4)+1$	1		
$\underline{S}F_5^{1-}$ $(\overset{(7\times5)}{6+35}+1=42)$		–	c)Hybridization	d)Bond Angle	Square Pyramidal	
			sp^3d^2	<90		

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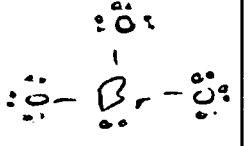
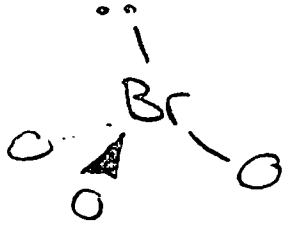
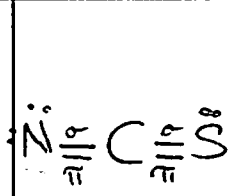
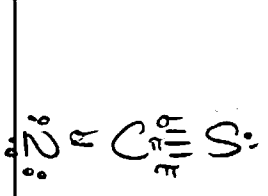
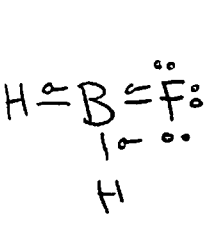
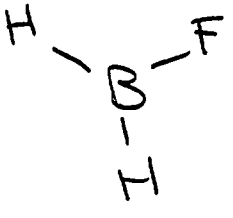
			e) Formal Charge	f) Pi Bonds		
			(6-7) -1	0		

Compound/Ion	a) Lewis Structure	b) Resonance? Draw 1 of them	c)Hybridization	d)Bond Angle	g) Geometry	h) 3-D Lewis Structure
$\underline{BrO_3}^{1-}$ (3x6) (7+18+1=26)		–	sp^3	<109.5	Trigonal Pyramidal	
			e) Formal Charge	f) Pi Bonds		
			(7-5) 2	0		
SCN^{1-} (6+4+5+1=16)			c)Hybridization	d)Bond Angle	Linear	$N=C=S$
			sp	180		
			e) Formal Charge	f) Pi Bonds		
			O (4-4)	2		
$\underline{BH_2F}$ (2x1) (3+2+7=12)		–	c)Hybridization	d)Bond Angle	Trigonal Planar	
			sp^2	120°		
			e) Formal Charge	f) Pi Bonds		
			(3-3) 0	0		

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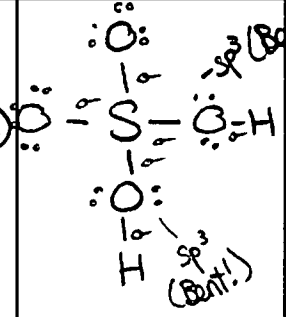
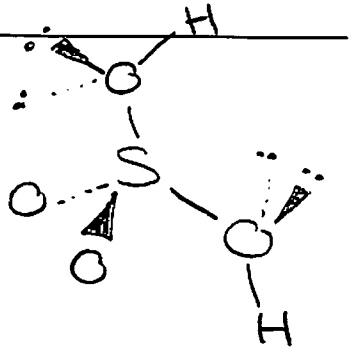
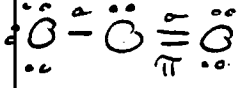
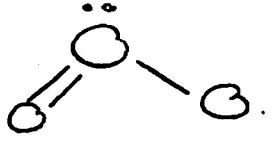
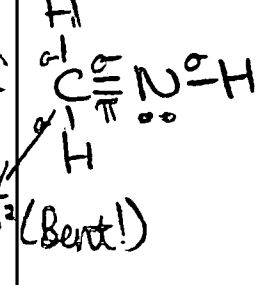
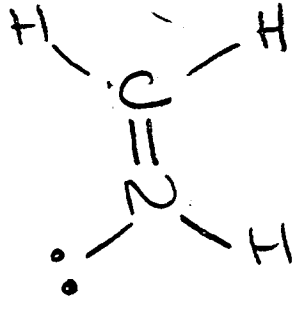
Compound/Ion	a) Lewis Structure	b) Resonance? Draw 1 of them	c)Hybridization	d)Bond Angle	g) Geometry	h) 3-D Lewis Structure
H_2SO_4 (4x6) (2+6+24=32)		–	sp^3	109.5	Tetrahedral	
			e) Formal Charge	f) Pi Bonds		
			(6-4) +2	0		
O_3 (6x3=18)			c)Hybridization	d)Bond Angle	Bent	
			sp^2	<120		
			e) Formal Charge	f) Pi Bonds		
			(6-5) +1	1		
CH_2NH (2x1) (4+2+5+1=12)		–	c)Hybridization	d)Bond Angle	Bent	
			sp^2	<120°		
			e) Formal Charge	f) Pi Bonds		
			(5-5) 0	1		

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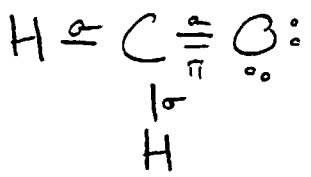
Consider the carbon-oxygen bond in formaldehyde (H_2CO) and carbon monoxide (CO). In which molecule is the CO bond longer? In which is the CO bond stronger? Explain your responses.

H_2CO

$(2\times1) + 4 + 6 = 12$

CO

$4 + 6 = 10$



Double bond = Sigma + $\tilde{\pi}$ Bond

Less electron shared
↓
Less attraction
↙ longer bond
↘ weaker bond

Triple Bond = Sigma + 2 $\hat{\pi}$ Bonds

More electron shared
↓
More attraction
↙ shorter bond
↘ stronger bond