KEY

Bonding and Molecular Geometry Review

1) Identify the type of bond that would occur between the following elements

1.9 2.1 ΔEN = 0.2 EN = 2.0

a. Mg & Cl — Ionic

b. Cu & P — Semi Metallic

c. Zn & Zn — Metallic

d. C & P — Covalent

2) Identify the subatomic particles involved in bonding (be specific) and use them to describe the difference between ionic, covalent, and metallic bonding.

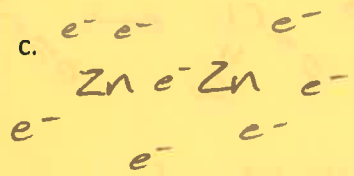
- Valence e^-
- Transferred during ionic, delocalized & shared in metallic, shared evenly (non polar) or unevenly (polar) in covalent bonds.

3) Use Lewis Dot diagrams to show bonding occurring between the elements in question 1.

a.

b. N/A

c.



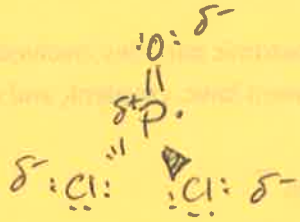
d.

4) Draw the best Lewis Dot diagram (in 3 dimensions) for the following molecules including lone pairs and formal charges. Draw all resonance structures if applicable. Identify the electron and molecular geometry of the central atom and the label the bond angles on your diagram if the molecular geometry is not an expanded octet.

a. $POCl_2$ 3-D Lewis Dot Structure

EG: Tetrahedral

MG: Trigonal Pyramidal

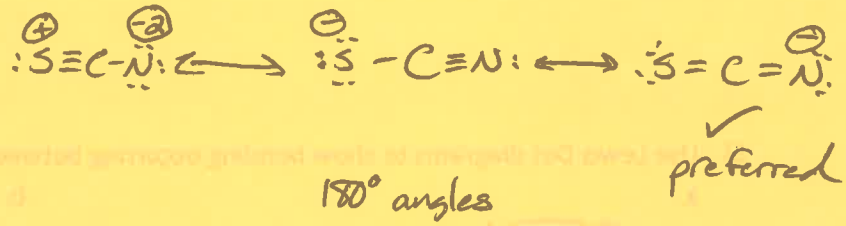


>109.5° angles

b. SCN^- 3-D Lewis Dot Structure

EG: linear

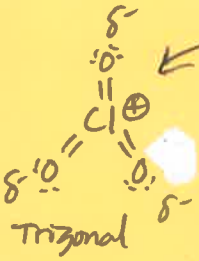
MG: linear



preferred

180° angles

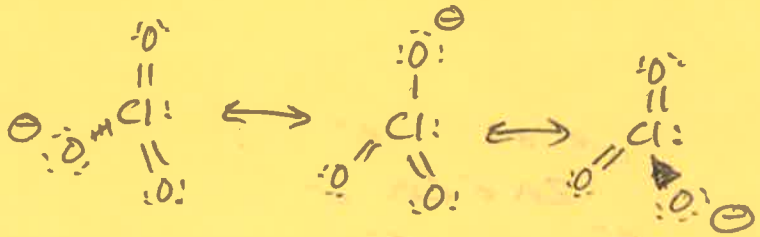
c. ClO_3^+ (sorry, did ClO_3^-) 3-D Lewis Dot Structure



Trigonal Planar EG & MG

EG: Tetrahedral

MG: Trigonal Pyramidal

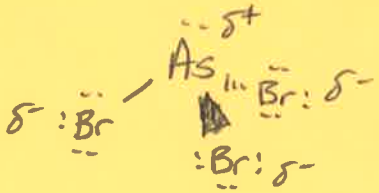


109.5° angles

d. $AsBr_3$ 3-D Lewis Dot Structure

EG: Tetrahedral

MG: Trigonal pyramidal



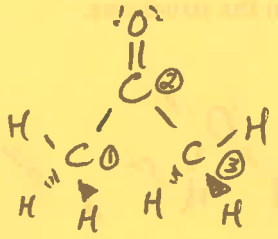
109.5° angles

e. $(CH_3)_2CO$

EG: Tetrahedral (1 & 3), Trigonal Planar (2)

MG: Same

3-D Lewis Dot Structure

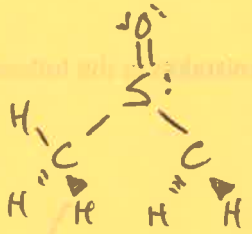


f. $(CH_3)_2SO$

EG: (S) Tetrahedral

MG: (S) Trigonal Pyramidal

3-D Lewis Dot Structure

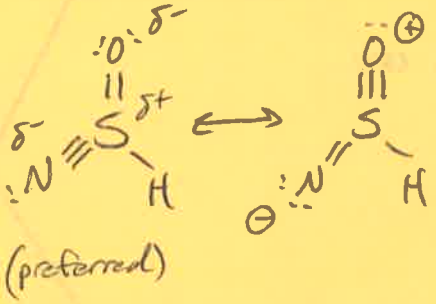


g. SONH

EG: Trigonal Planar

MG: Trigonal Planar

3-D Lewis Dot Structure

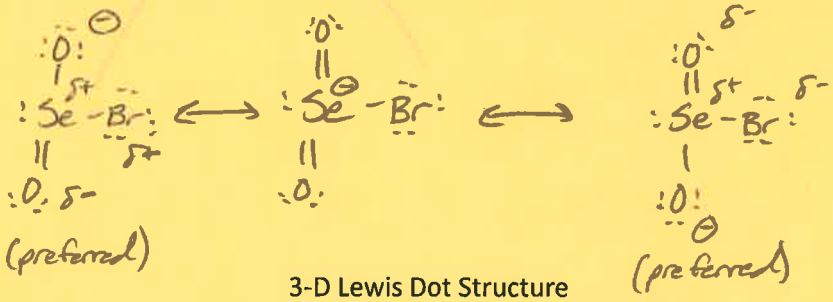


h. SeO_2Br^-

EG: Tetrahedral

MG: Trigonal Pyramidal

3-D Lewis Dot Structure

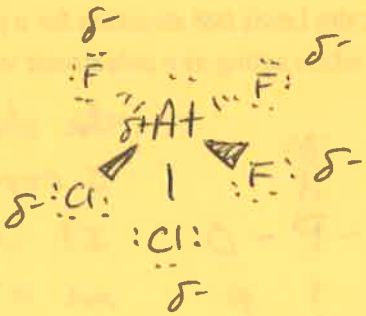


i. AtF_3Cl_2

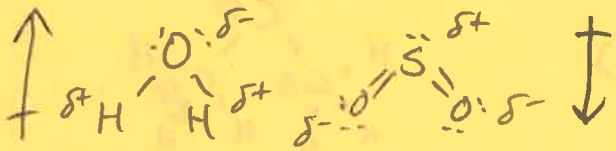
EG: Octahedral

MG: Square Pyramidal

3-D Lewis Dot Structure



5) Draw the Lewis Dot structures for water and sulfur dioxide. Discuss similarities and differences between the structures.

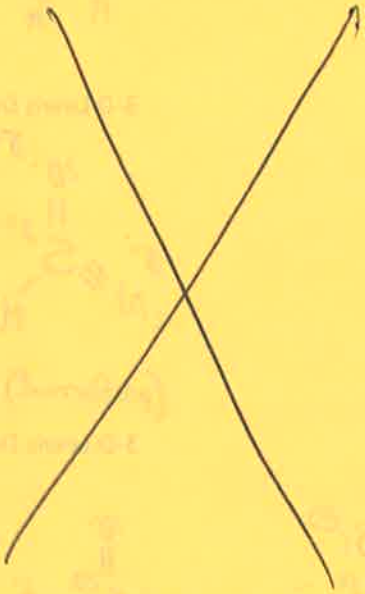


Similar
- MG (bent)
- Polar

Different
- SO_2 has larger bond angle ($<120°$)
- EG (H_2O = tetra) (SO_2 = trig. planar)
- H_2O more polar (larger $\delta+/\delta-$)
- H_2O stronger IMF (H-bond vs. Dipole)

6) Identify mistakes in the following Lewis Dot Structures

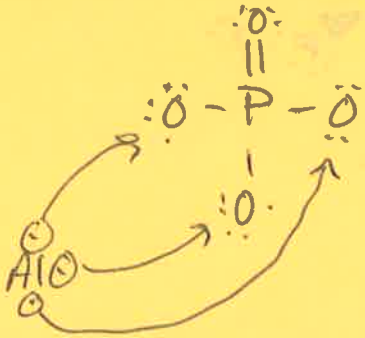
a. NO_2



b. ClO_3^-

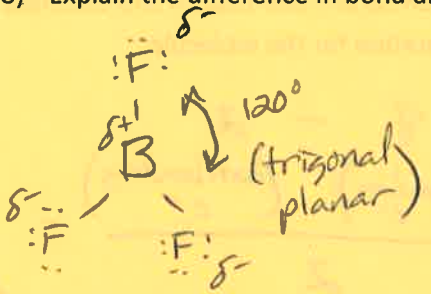
c. XeF_4

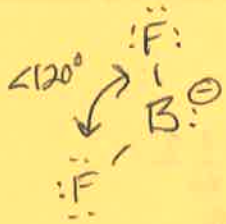
7) Draw the Lewis Dot structure for a phosphate group and explain why it takes on the charge it does when acting as a polyatomic ion.



The structure is deficient by 3 e^-, not allowing 3 oxygen to achieve a noble gas e^- configuration. It will therefore readily accept 3 e^- from an e^- donor (metal) when it bonds ionically, taking on a 3- ionic charge.

8) Explain the difference in bond angle observed for a BF_3 molecule versus a BF_2^- molecule.

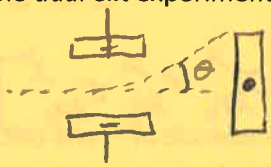




- unbonded pair region repels more than a bonding region, decreasing the bond angle in BF_2^-.

9) Discuss how electrons behave both as particles and as waves by explaining the photo electric effect and the dual-slit experiments.

Cathode Ray



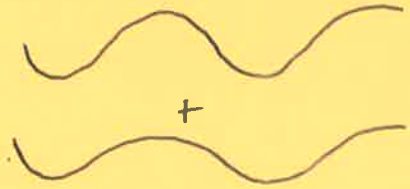
- e^- beam is deflected at predictable angles, shows charge/mass ratio = particle behavior
- Detection is a precise "dot" region rather than spreading / propagating like a wave = particle behavior

Dual slit

- "Bullet" like detection predicted by particle behavior was not observed (2 precise regions in-line w/ the slits)
- Constructive & Destructive pattern was observed (wave behavior)

10) What is meant by the terms destructive and constructive interference and how do they relate to bonding?

As e^- have duality (particle & wave behavior), the concept of bonding and antibonding regions formed from constructive or destructive interference during orbital cloud overlap describes/predicts bonding with wave behavior.



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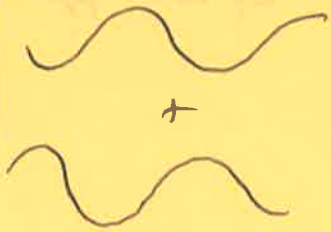
constructive (bond)



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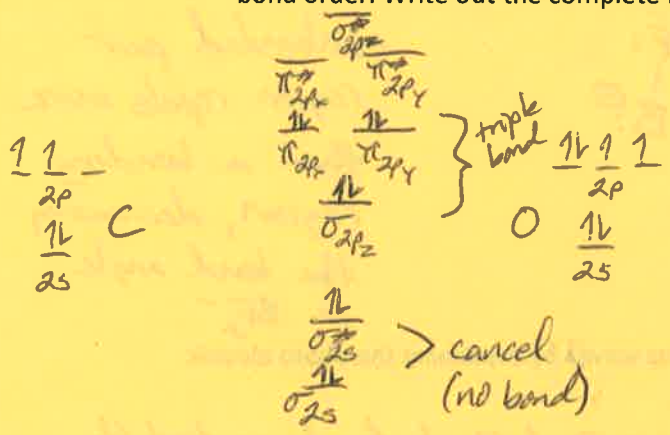
destructive (antibond)

11) Draw a molecular orbital diagram for the bonding between carbon and oxygen and calculate the bond order. Write out the complete MO electron configuration for the molecule.



$$\frac{8 - 2}{2} = 3 \text{ bonds}$$

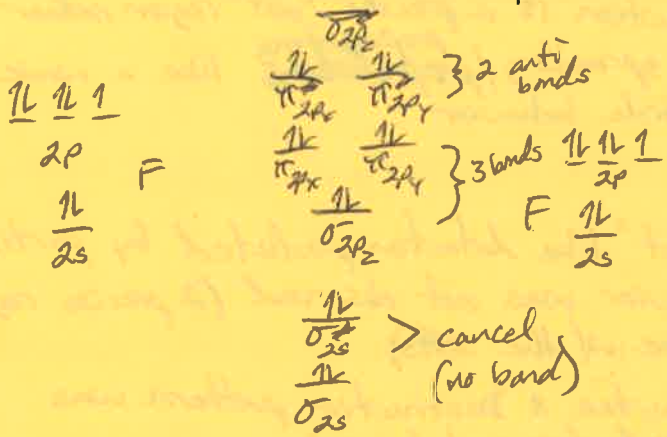
(bonding e^-) (antibonding e^-)

(from σ_{2p_z} & π_{2p_x} & π_{2p_y})

:C≡O:

$$[\sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2 \sigma_{2s}^{*2} \sigma_{2p_z}^2 \pi_{2p_x}^2 \pi_{2p_y}^2]$$

12) Draw a molecular orbital diagram for the bonding in a molecule of F_2 and calculate the bond order. Write out the complete MO electron configuration for the molecule.



$$\frac{8 - 6}{2} = 1 \text{ bond}$$

(from σ_{2p_z})

:F–F:

$$[\sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2 \sigma_{2s}^{*2} \sigma_{2p_z}^2 \pi_{2p_x}^2 \pi_{2p_y}^2 \pi_{2p_x}^{*2} \pi_{2p_y}^{*2}]$$

13) Explain the concepts of paramagnetism and diamagnetism and show how MO diagrams can predict these properties.

- Paramagnetic substances align with and are attracted to an applied magnetic field. (predicted by unpaired e^- in MO)
- Diamagnetic substances align against and are repelled by an applied magnetic field. (predicted by all paired e^- in MO)

14) Identify the orbitals that make-up each type of sp hybridization: sp, sp^2, sp^3

$sp = 1s + 1p$

$(2s) + (2p_z)$

$sp^2 = 1s + 2p$

$(2s) + (2p_z \text{ \& } 2p_y)$

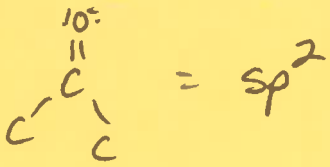
$sp^3 = 1s + 3p$ $(2s, 2p_z, 2p_y \text{ \& } 2p_x)$

15) For question 4, go back and identify the hybridization occurring around the central atom for structures a, b, & e.

a) sp^3

b) sp

c) $CH_3 - C \equiv$ sp^3



$= sp^2$