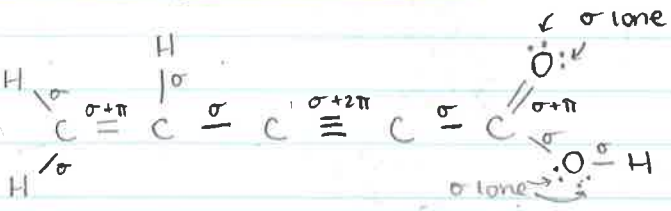
Lewis Dot Diagrams → Shape

Oct. 21st

σ vs. π

sigma pi



e.g1 BeF_2

covalent!

total valence pairs | σ | lone | π

2 | 2 | 0 | 0

base shape = linear

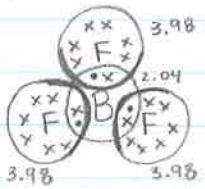
actual shape = linear

bond angle = 180°

oxidation states: Be^{2+} F^{1-}

e.g2 BF_3

covalent!



total | σ | lone | π

3 | 3 | 0 | 0

NOTE when zero these are the same

base shape = trigonal planar

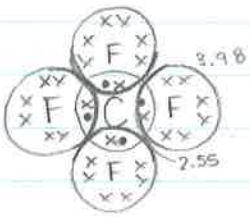
actual shape = trigonal planar

bond angle = 120°

oxidation states: B^{3+} F^{1-}

e.g3 CF_4

covalent!



total | σ | lone | π

4 | 4 | 0 | 0

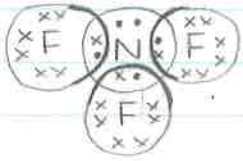
base shape = tetrahedral

actual shape = tetrahedral

bond angle = 109.5°

oxidation states: C^{4+} F^{1-}

e.g4 NF_3



total | σ | lone | π

4 | 3 | 1 | 0 ← common!

base shape = tetrahedral (e⁻ shape based on σ pairs)

actual shape = pyramidal (trigonal pyramidal)

bond angle = <109.5°

(lone pair occupy more space around central atom & ∴ repel more effectively "tweak")

oxidation states: N^{3+} F^{1-}

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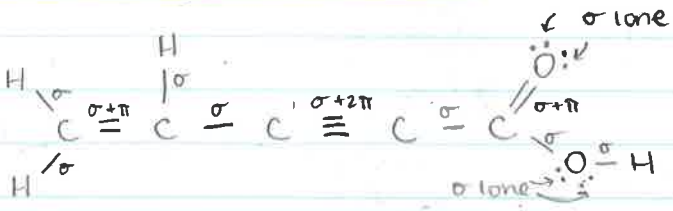
σ vs. π

sigma pi



e.g1 BeF_2

covalent!

oxidation states: Be^{2+} F^{1-}

total valence pairs

	σ	lone	π
2	2	0	0

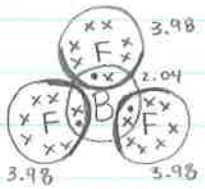
base shape = linear

actual shape = linear

bond angle = 180°

e.g2 BF_3

covalent!



oxidation states: B^{3+} F^{1-}

total	σ	lone	π
3	3	0	0

NOTE when zero these are the same

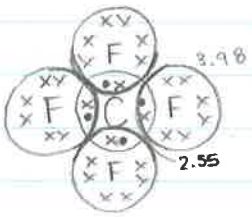
base shape = trigonal planar

actual shape = trigonal planar

bond angle = 120°

e.g3 CF_4

covalent!



oxidation states: C^{4+} F^{1-}

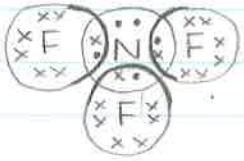
total	σ	lone	π
4	4	0	0

base shape = tetrahedral

actual shape = tetrahedral

bond angle = 109.5°

e.g4 NF_3



oxidation states: N^{3+} F^{1-}

total	σ	lone	π
4	3	1	0

← common!

base shape = tetrahedral (e⁻ shape based on σ pairs)

actual shape = pyramidal (trigonal pyramidal)

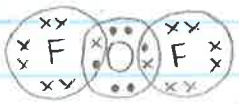
bond angle = <109.5°

(lone pair occupy more space around central atom & ∴ repel more effectively "tweak")

e.g 5 OF_2

vs.

O^{2+} F^{1-}



total σ lone π

4 | 2 2 | 0

base shape = tetrahedral

actual shape = angular

bond angle = < 109.5°

e.g 6 HF

total σ lone π

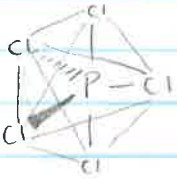
4 | 1 3 | 0

base shape = tetrahedral

actual shape = linear

bond angle = NA

e.g 7 PCl_5



P^{5+}

5 | 5 0 | 0

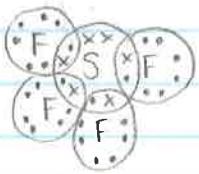
base shape = trigonal bi-pyramidal

actual shape = trigonal bi-pyramidal

bond angle = 120° and 90°

↑ in the plane ↑ above & below the plane

e.g 8 SF_4



5 4 1 0

base shape = trigonal bi-pyramidal

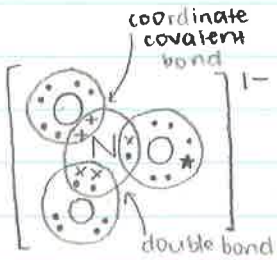
actual shape = see-saw

bond angle = <120° and <90°

↑ in the plane ↑ above & below the plane

e.g9 NO_3^{1-}

N^{5+}



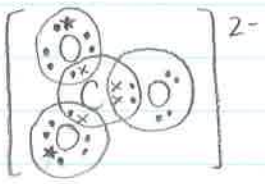
4 | 3 0 | 1 (but does not determine shape)

base shape = trigonal planar

actual shape = trigonal planar

bond angle = 120°

e.g10 CO_3^{2-}



4 | 3 0 | 1

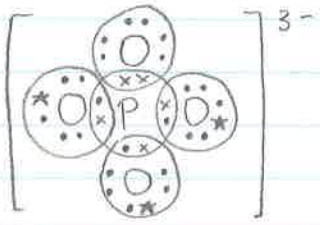
trigonal planar

trigonal planar

120°

e.g11 PO_4^{3-}

P^{5+}



4 | 4 0 | 0

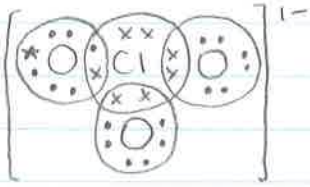
tetrahedral

tetrahedral

109.5°

e.g12 ClO_3^{1-}

Cl^{5+}



4 | 3 1 | 0

tetrahedral

pyramidal

< 109.5°

presence of lone pairs cause θ= to be < (square planar is an exception)

e.g13 SF_6

S^{6+}

6 | 6 0 | 0

octahedral

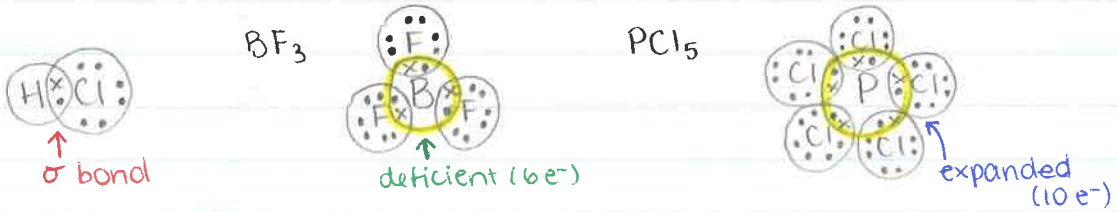
octahedral

90°

Covalent Bonding (including polyatomic ions)

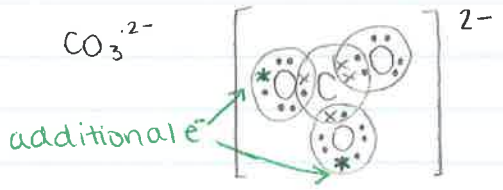
1. All halogens get their way. They form simple single sigma bonds, σ, even if it means breaking the octet rule.
   ↳ Octet deficient & expanded valence shells can result.

e.gs: HCl BF_3 PCl_5



2. Any extra electrons (x^{2-}) will go to the most electronegative element. (usually oxygen)

e.g. CO_3^{2-}



* NOTE: added e⁻ are drawn farthest from central atom / σ bonds (π)

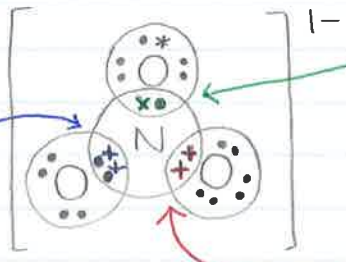
3. Oxygen always finds a way to satisfy the octet rule for the central atom.

1st step → a) Halogen-like oxygens* (see #2) behave like halogens and always form simple single sigma bonds

as needed { 2nd step → b) Double bonds will add two electrons to the central atom (use until you have a full octet, 8e⁻)

3rd step → c) Coordinate Covalent Bonds** will keep the number of electrons around the central atom the same.

e.g. NO_3^{1-}



a) Halogen-like oxygen

b) double bond

c) coordinate covalent bond.

* full octet is achieved for Nitrogen ☺

* includes oxygens that already have one single bond, i.e. 

** single bonds in which both bonding electrons are contributed by one of the bonded atoms:
↳ indistinguishable from regular covalent bonds