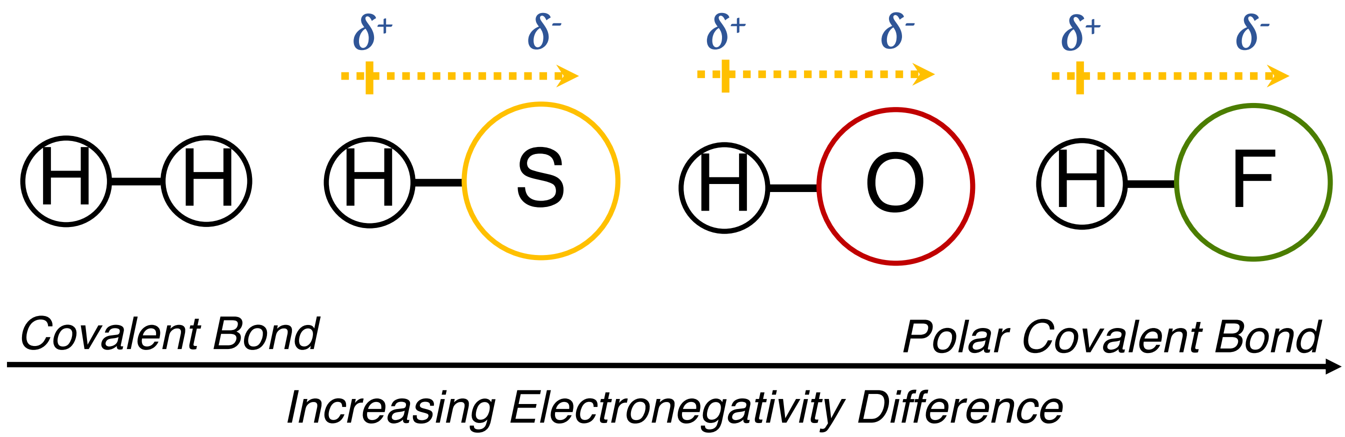
Polarity, Formal Charge, and Resonance

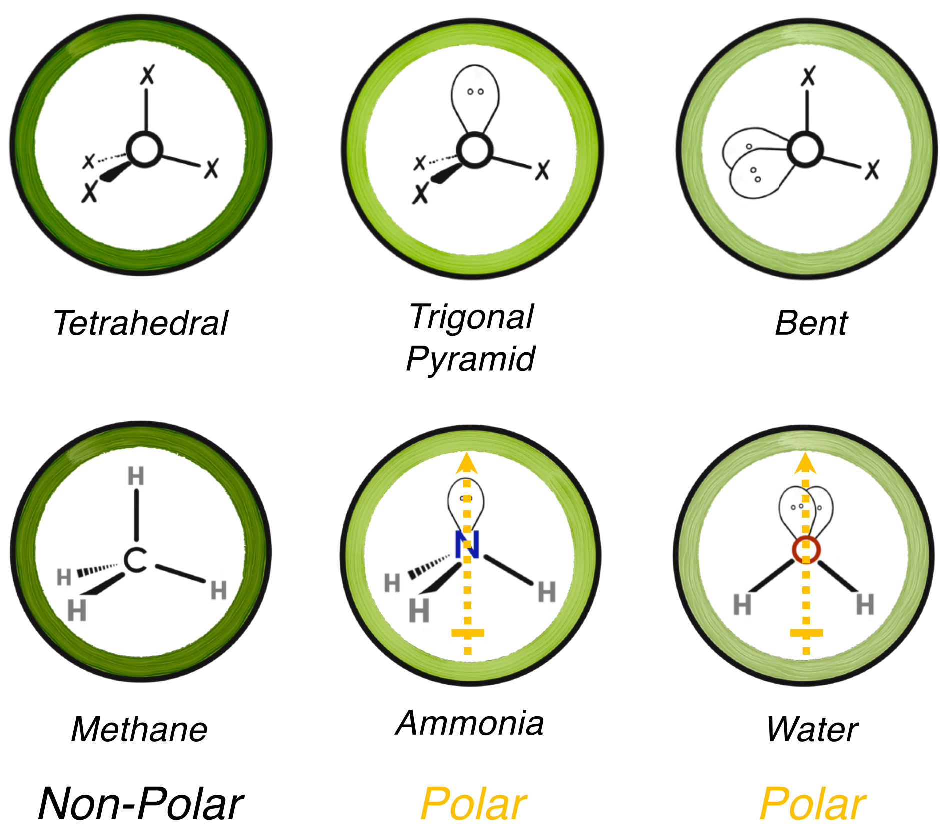
Flash Review

CHEM 371

Dr. Christopher B. Durr

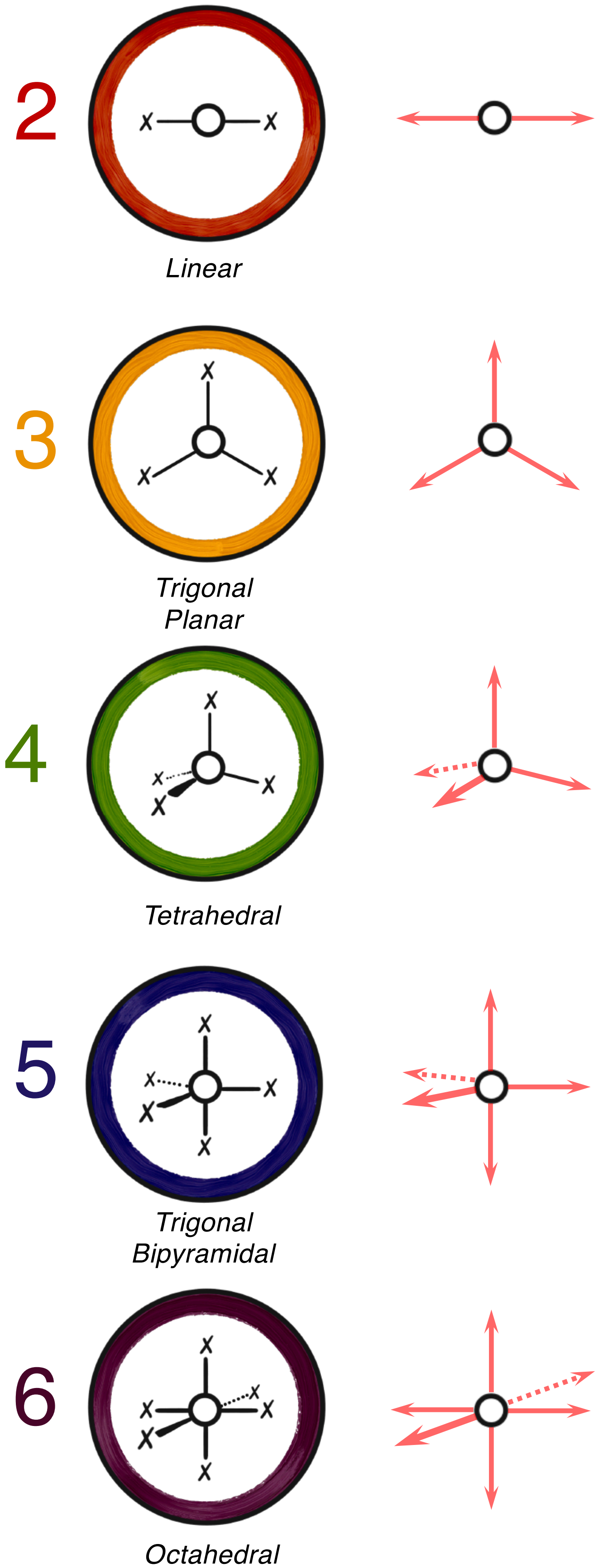
Polarity


δ+
δ-
H
S
O
F
Covalent Bond
Polar Covalent Bond
Increasing Electronegativity Difference


Tetrahedral
Trigonal Pyramid
Bent
H
C
N
O
Methane
Ammonia
Water
Non-Polar
Polar
Polar

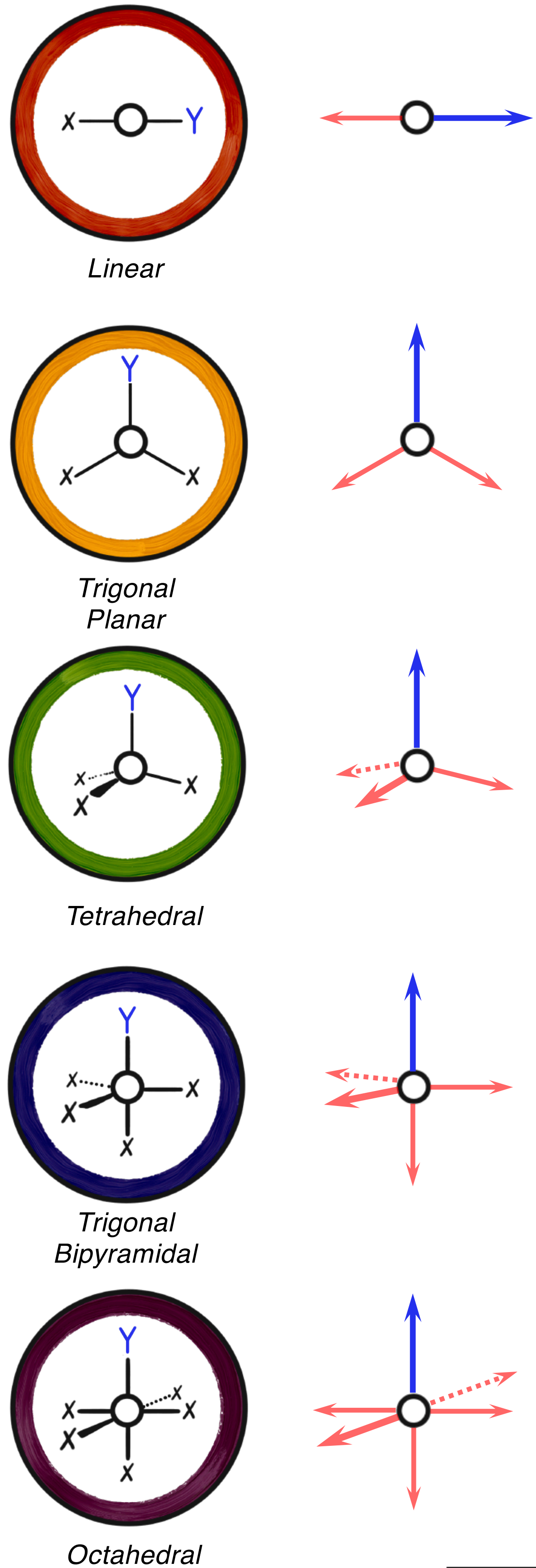
Non-Polar

Bond dipoles are equivalent and cancel out

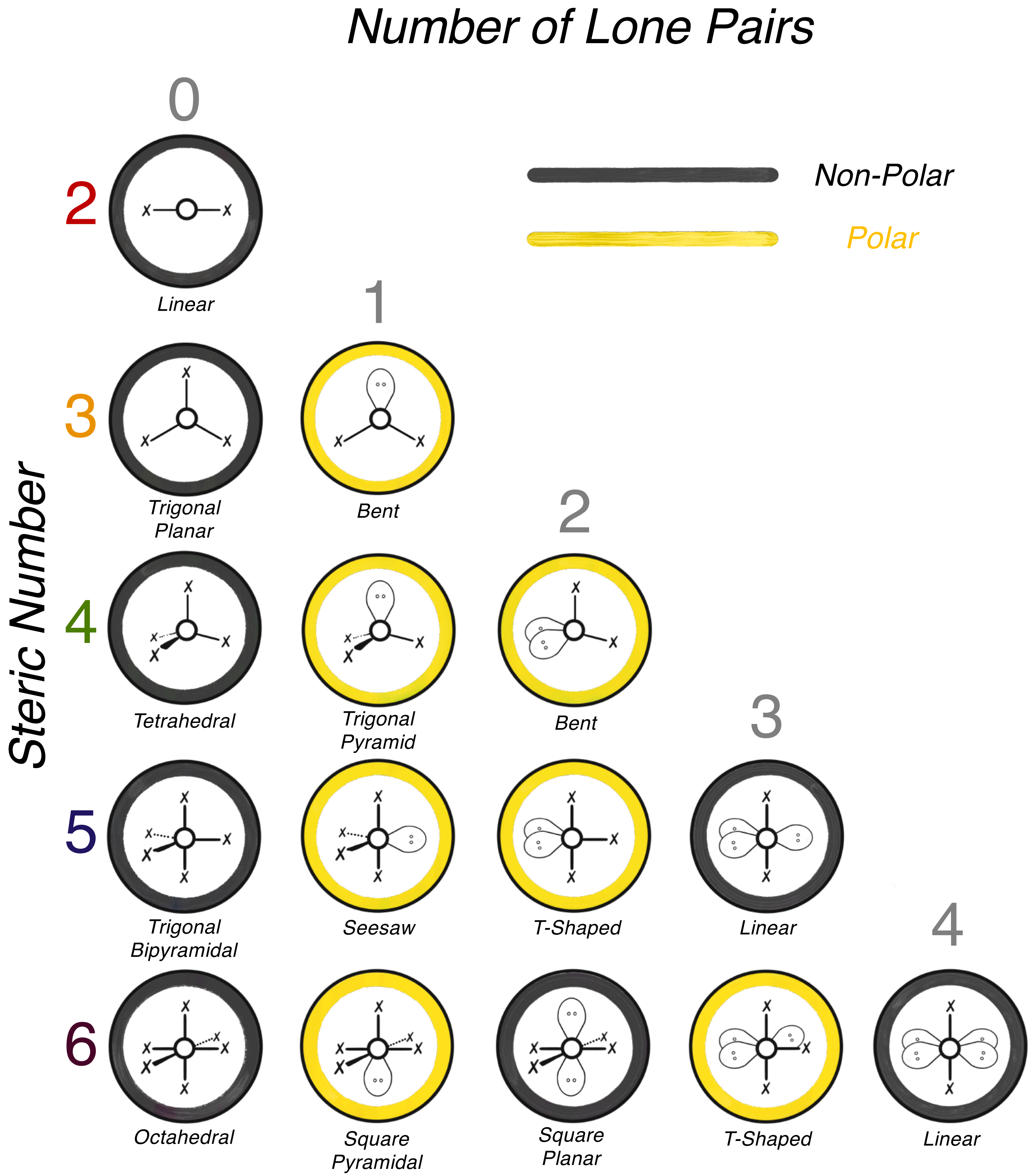


Polar

Bond dipoles are inequivalent and *do not* cancel out



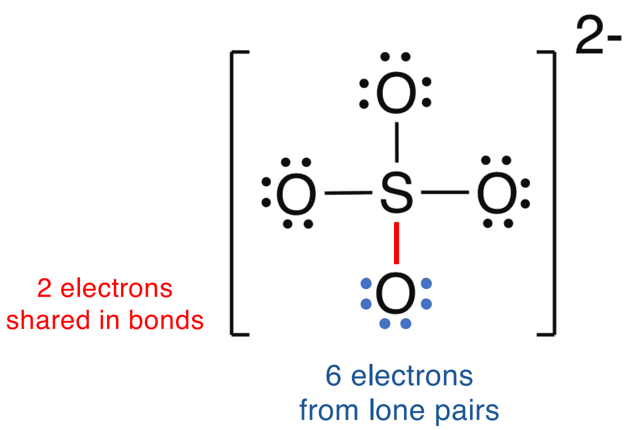
Polarity


Number of Lone Pairs
Steric Number
0
1
2
3
4
2
3
4
5
6
Non-Polar
Polar
Linear
Trigonal Planar
Bent
Tetrahedral
Trigonal Pyramid
Bent
Trigonal Bipyramidal
Seesaw
T-Shaped
Linear
Octahedral
Square Pyramidal
Square Planar
T-Shaped
Linear

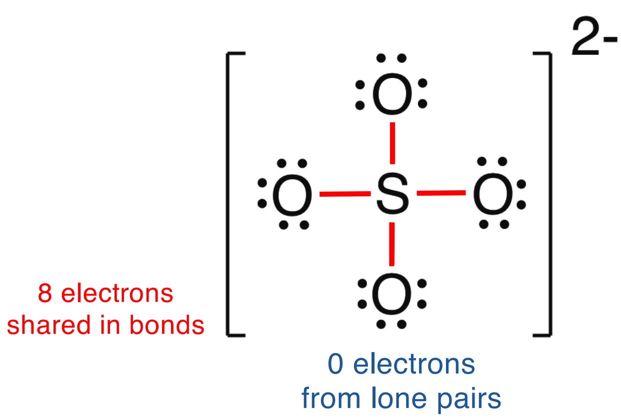
Calculating Formal Charge

Formal Charge = # of electrons in free atom − # of electrons assigned in molecule

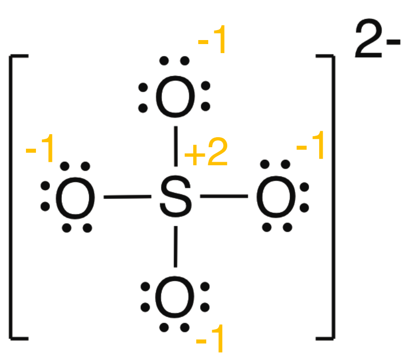
# of electrons assigned in molecule = # of electrons from lone pairs + ½ # of electrons shared in bonds



F.C. (O) = 6 – (6 + ½ (2))
F.C. (O) = -1



F.C. (S) = 6 – (0 + ½ (8))
F.C. (S) = +2



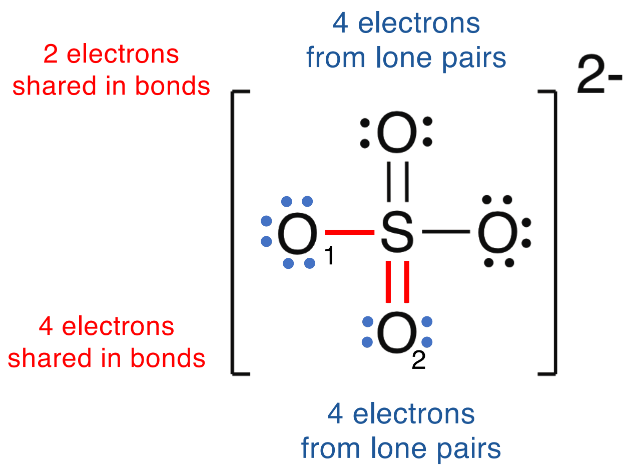
Sum of formal charges agrees with overall charge

Large Absolute Formal Charge

Calculating Formal Charge

Formal Charge = # of electrons in free atom − # of electrons assigned in molecule

# of electrons assigned in molecule = # of electrons from lone pairs + ½ # of electrons shared in bonds

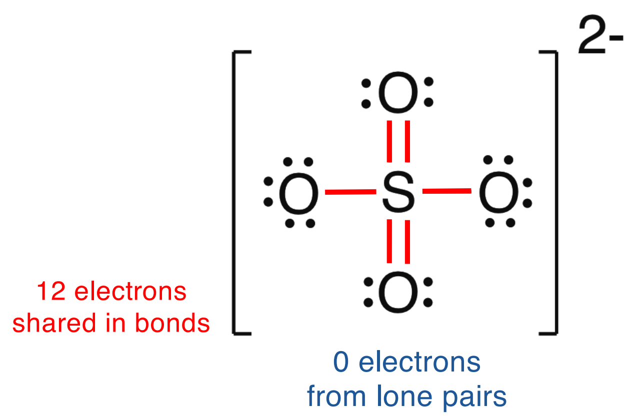


$$F.C. (O_1) = 6 - (6 + \tfrac{1}{2}(2))$$

$$F.C. (O_1) = -1$$

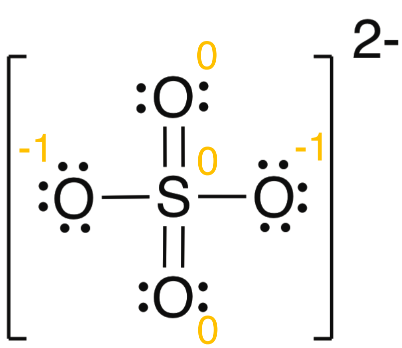
$$F.C. (O_2) = 6 - (4 + \tfrac{1}{2}(4))$$

$$F.C. (O_2) = 0$$



$$F.C. (S) = 6 - (0 + \tfrac{1}{2}(12))$$

$$F.C. (S) = 0$$



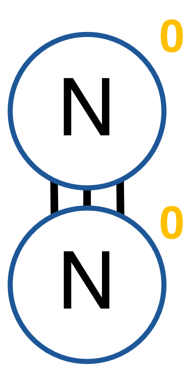
Sum of formal charges agrees with overall charge

Reduced Formal Charge

Examples of Formal Charge

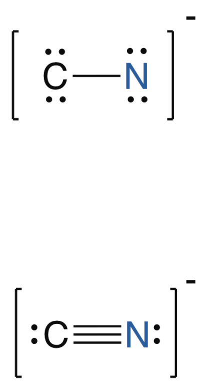
N_2

N $= 5 - (2 + \frac{1}{2}(6))$
$= 0$



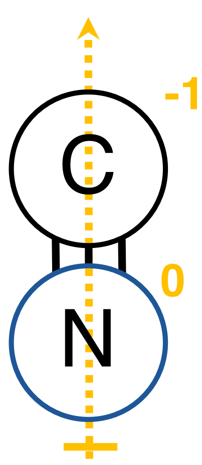
No Net Dipole

CN^-



N $= 5 - (2 + \frac{1}{2}(6))$
$= 0$

C $= 4 - (2 + \frac{1}{2}(6))$
$= -1$

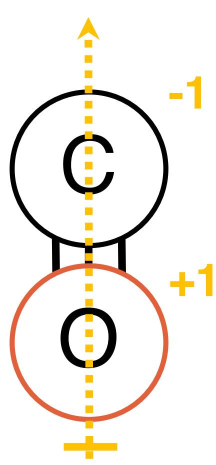


Dipole Towards C

CO

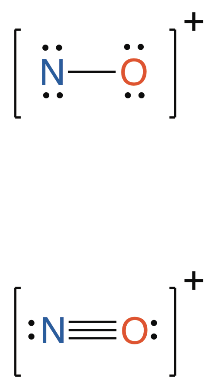
C $= 4 - (2 + \frac{1}{2}(6))$
$= -1$

O $= 6 - (2 + \frac{1}{2}(6))$
$= +1$



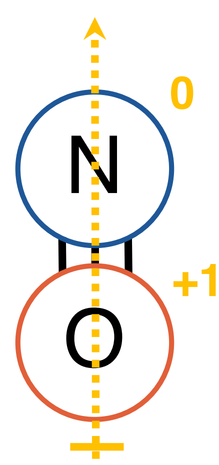
Dipole Towards C

NO^+



N $= 5 - (2 + \frac{1}{2}(6))$
$= 0$

O $= 6 - (2 + \frac{1}{2}(6))$
$= +1$

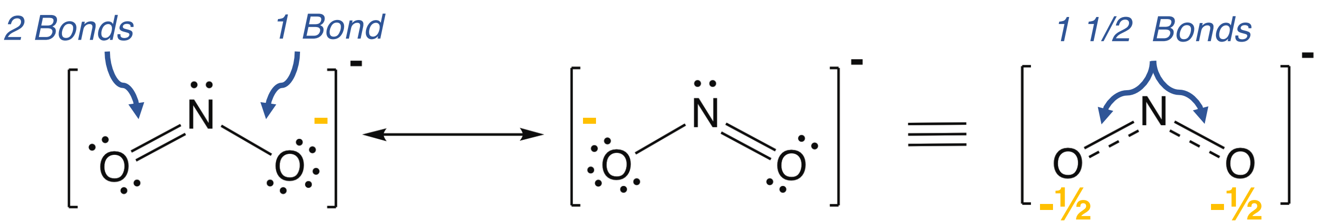


Dipole Towards N

Resonance

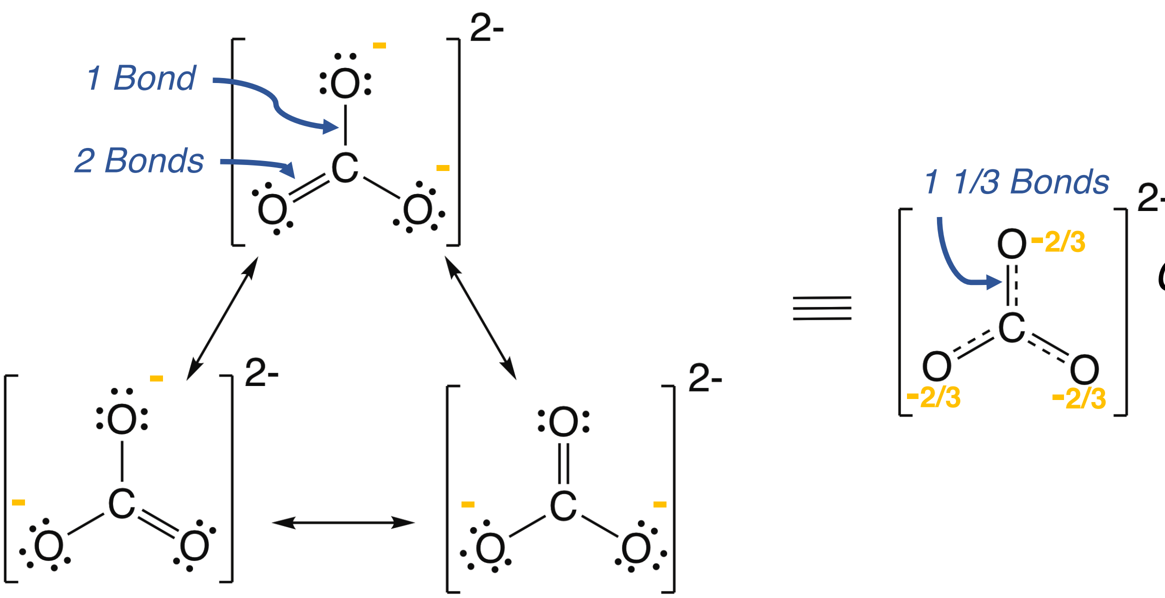
Resonance Hybrids result from two or more Resonance Contributors.

Please note, electrons are *not* shifting back and forth, this is importantly *not* an interconverting equilibrium.

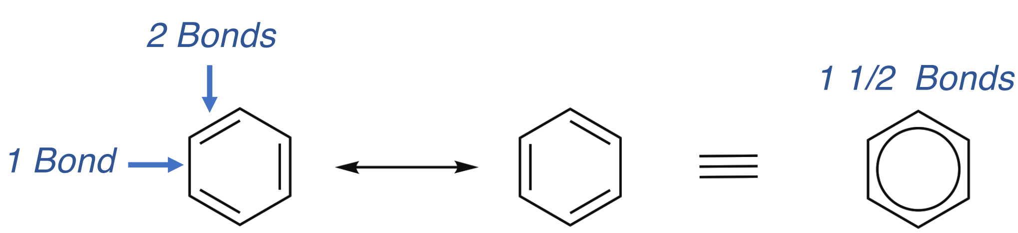


Nitrite Ion

Resonance Contributors *Resonance Hybrid*



Carbonate Ion



Benzene