

[TP] Which molecule is more polar? ($\chi_H = 2.1$, $\chi_B = 2.04$, $\chi_N = 3.04$, $\chi_F = 3.98$)

27% 1. NH_3 (trigonal pyramid)
58% 2. BF_3 (trigonal planar)
15% 3. Polarity is the same

Lecture 16 CH101 A2 (MWF 11:15 am)

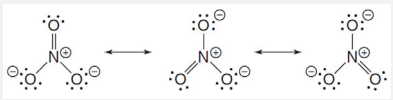
Tuesday, October 15, 2019

- Resonance hybrids
- Exceptions to octet rule
- Electronegativity and bond character
- Bond polarity
- Molecular geometry

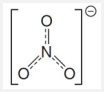
Next: Molecular polarity; Begin ch9: Covalent bonding

Lewis formula of NO_3^- (nitrate)

Alternative equivalent formulas are known as resonance forms.



Bonding is an equal mixture of each resonance form, known as a resonance hybrid.

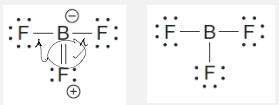


The shared electrons are said to be delocalized across the four atoms, represented as a resonance hybrid. The mixture does not vary with time.

Each bond is 1/3 of the way between single and double.

Exceptions to the octet "rule"

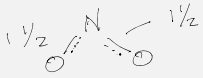
Octet deficient: BF_3



Single bonds more stable, based on formal charge.

Exceptions to the octet "rule"

Odd number of electrons: NO_2



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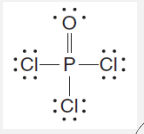
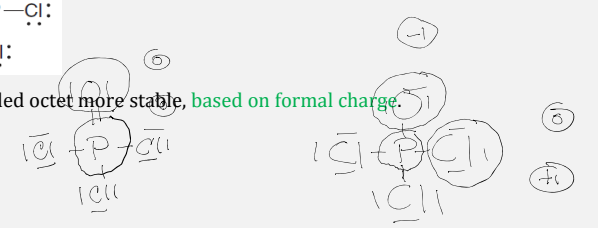
Exceptions to the octet "rule"

Expanded octet (period 3 onward): $POCl_3$



Expanded octet more stable, based on formal charge.



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Electronegativity

Formal charge assumes electrons between atoms are shared equally.

Unless two connected atoms are identical, sharing always favors one atom.

Electronegativity is a relative measure the tendency of an atom to attract electrons shared with another atom in a covalent bond.

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Electronegativity, χ (Greek letter chi, "hee")

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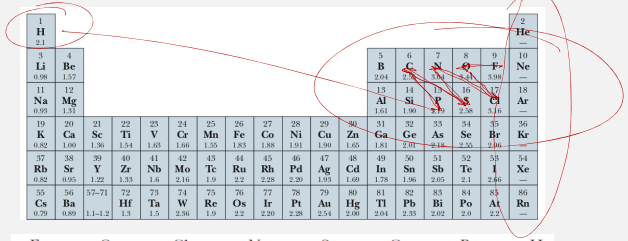

F	>	O	>	Cl	>	N	>	S	>	C	>	P	>	H
3.98		3.44		3.16		3.04		2.58		2.55		2.19		2.1

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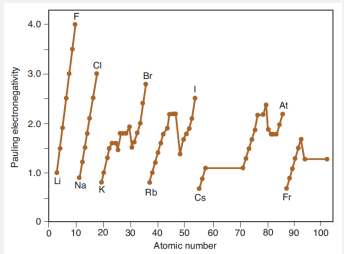
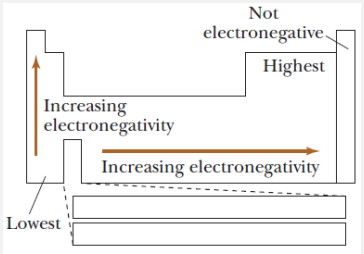
Electronegativity, χ (Greek letter chi, "hee")

Electronegativity is a relative measure the tendency of an atom to attract electrons shared with another atom in a covalent bond.





Bond polarity

The greater the electronegativity difference of two covalently bonded atoms, the more unequal the sharing of the electrons forming the covalent bond.

Bond character:	Covalent	Polar covalent	Ionic
Electronegativity difference:	≈0 – 0.3	≈0.4 – 2.0	≈2.1 – 4.0

BrI: 2.96 − 2.66 = 0.30, covalent

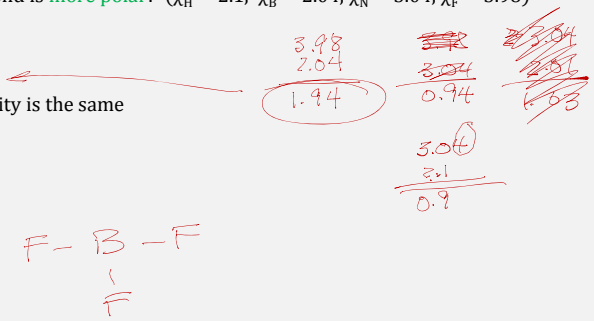
HCl: 3.16 − 2.1 = 1.0, polar covalent

NaCl: 3.16 − 0.93 = 2.23, ionic

Please keep in mind that these definitions are qualitative, since sharing is always unequal unless the bonded atoms are identical.

[TP] Which bond is more polar? ($\chi_H = 2.1$, $\chi_B = 2.04$, $\chi_N = 3.04$, $\chi_F = 3.98$)

18% 1. N−H
80% 2. B−H
2% 3. Polarity is the same



Predicting molecular geometries

How atoms are arranged in three dimensions around their central atom is determined by the steric number (SN) the central atom.

SN = attached atoms + lone pairs

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What is SN of C in CO_2?

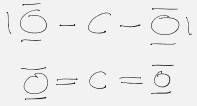
SN = 2: Two attached atoms and zero lone pairs

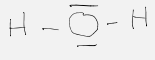
What is the SN of O in H_2O?

SN = 4: Two attached atoms and two lone pairs

What is the SN of N in NO_2^-?

SN = 3: Two attached atoms and one lone pair





SN = attached atoms + lone pairs

What is the SN of B in BF_3?

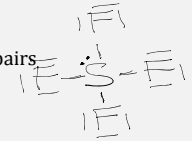
SN = 3: Three attached atoms and zero lone pairs

What is SN of S in SF_4?

SN = 5: Four attached atoms and one lone pair

What is the SN of S in SF_6?

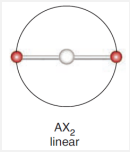
SN = 6: Six attached atoms and zero lone pairs



Predicting molecular geometries: SN = 2

What is SN of C in CO_2?

SN = 2: Two attached atoms and zero lone pairs

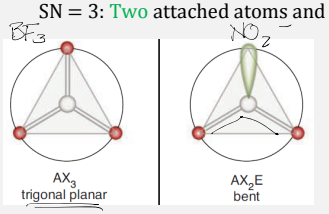


Shape is linear, bond angle is 180°

Predicting molecular geometries: SN = 3

What is the SN of N in NO_2^-?

SN = 3: Two attached atoms and one lone pair

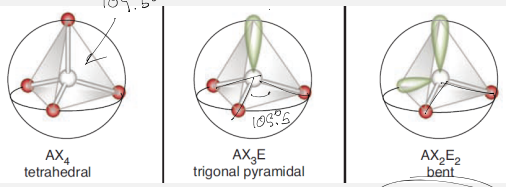


Shape is bent, bond angle a bit less than 120°

Predicting molecular geometries: SN = 4

What is the SN of O in H_2O?

SN = 4: Two attached atoms and two lone pairs



Shape is bent, bond angle a little less than 109.5°

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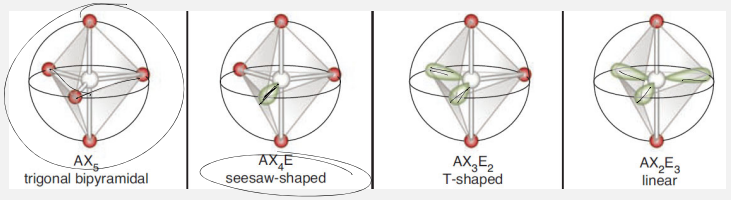
Predicting molecular geometries: SN = 5

What is SN of S in SF_4?

SN = 5: Four attached atoms and one lone pair



Shape is seesaw, bond angles are a little less than 180°, 120°, and 90°

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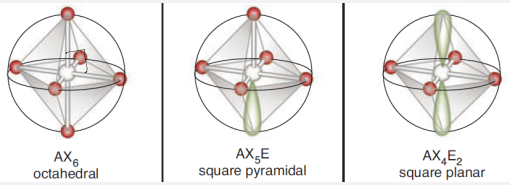
Predicting molecular geometries: SN = 6

What is the SN of S in SF_6?

SN = 6: Six attached atoms and zero lone pairs



Shape is octahedral, bond angles are 90°

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