Chem 111

Lecture 28

Announcement

- Recitation session, Wednesday 11/17 at HASA 126 (5-6pm).
- There will class Wednesday, before T-day
- Delay on lecture notes going up

Experience a NEW way of teaching science

"Bhopal Disaster: A Case Study"

An Exciting Workshop Presented by iCons Faculty

WHO: Majors from College of Natural Science and College of Engineering
WHEN: Thursday, Nov. 18 6:30-8:00 PM
OR
Tuesday, Nov. 23 6:30 – 8:00 PM
WHY: Because YOU can make a difference

Integrated Concentration in Science

- Free Pizza
- Space is limited!

Register Now by Email:
icons@cns.umass.edu

Homework

- Continue Reading Chapter 8

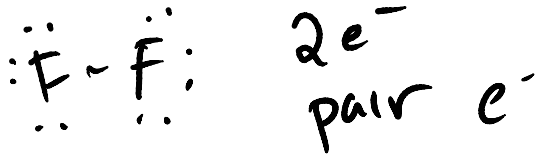
- Owl Homework

Recap

- Trends in Ions → take e^- smaller
  put e^- big
- Bonding ←
- Lewis Structures ← valence
- Covalent Bonds ← H – H :F – Fe:
- Octet ← p-s block

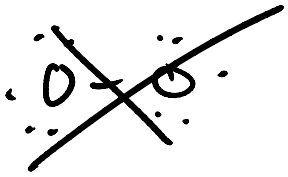
trends

Multiple Bonds



Single bond – refers to a pair of electrons being shared in a single covalent bond.

Double bond – refers to 2 electron pair being shared, two lines are drawn to represent a double bond:



Triple Bond – corresponds to the sharing of three pairs of electrons.

Bond	Bond Length
N-N	1.47 Å
N=N	1.24 Å
N≡N	1.10 Å

Lewis Structures Practice

PAGE – 353

1. **Determine the TOTAL number of valence electrons.**

→ Use the periodic table to help you.

→ If it is an anion, remember the extra electrons go in the valence shell. So add X electron for a X- charge

→ If it is a cation, remember the electrons are removed from the valence shell. So take away X electrons for a X+ charge.

PO_4^{3-}

P - 5

O - 6 x 4 = 24

e^- - 3

32 e^-

CO_2

C - 4

O - 6 x 2 = 12

e^- - 0

16

CO_2^+

C - 4

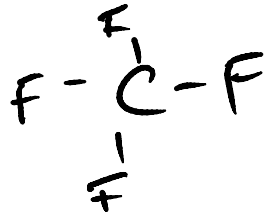
O - 6 x 2 = 12

e^- = -1

15

ClO4

CF4



Lewis Structures

2. Arrange the atoms and connect them with a single bond

→ In general, chemical formulas help depict connectivity. HCN

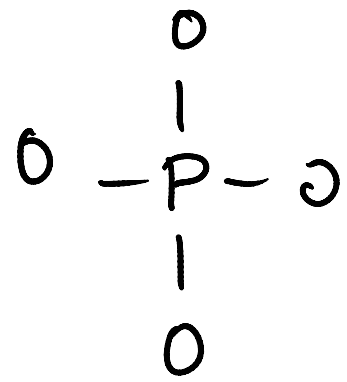
→ The central atom is usually written first.

→ C, N, P, S tend to be central atoms. ← trend

→ Halogens are often terminal (except when connected to O)

→ Hydrogen will often be terminal. ← -H

PO_4^{3-} 32e⁻



CO_2 16e⁻

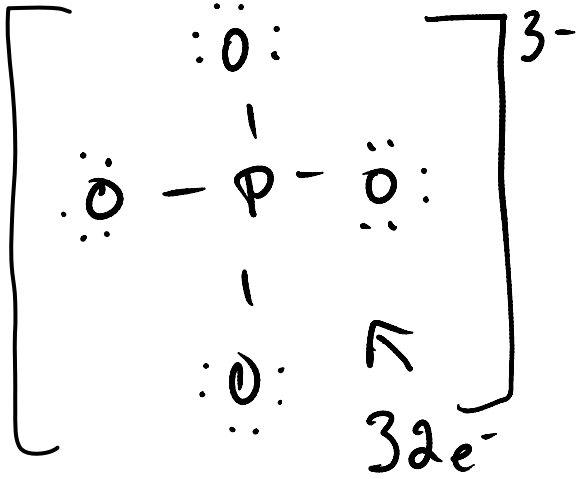
Lewis Structures

3. Complete the octets of atoms bonded to the central atom.

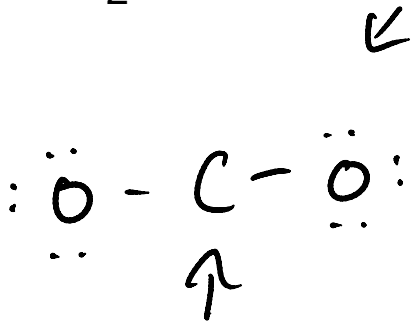
→ Remember hydrogen only need two electrons

→ Count the electron you used, if you have more place them on the central atom, even if it breaks the octet.

PO_4^{3-} 32 e⁻



CO_2 16 e⁻



Lewis Structures

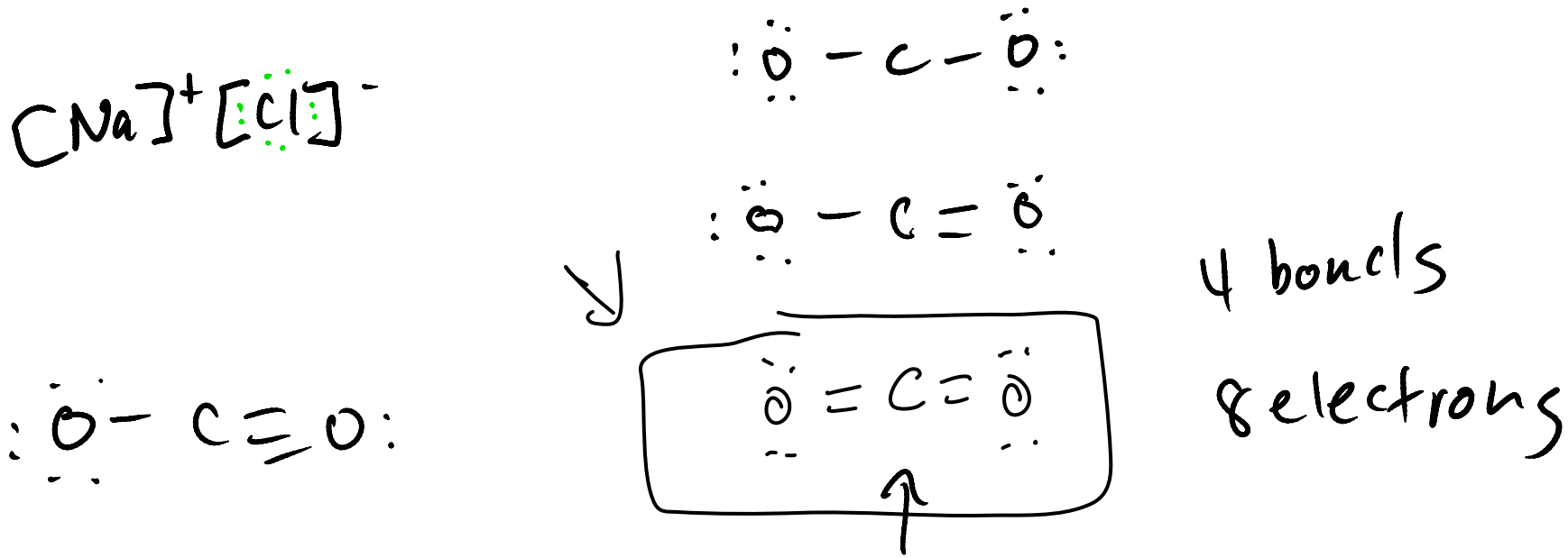
4. If you used too many electrons, try multiple bonds.

→ Multiple bonds are usually on the central atom

→ Change the lone pairs on terminal atoms to multiple bonds.

PO_4^{3-}

CO_2



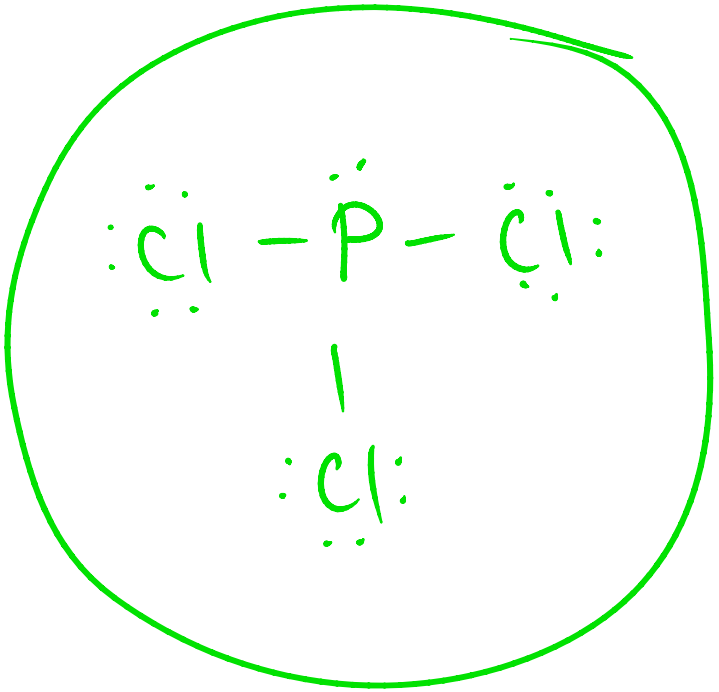
Let's Practice

Draw the Lewis Structure for phosphorus trichloride, PCl_3.

P - 5

Cl - 7 x 3 = 21

26 e⁻



24/26 e⁻

Let's Practice

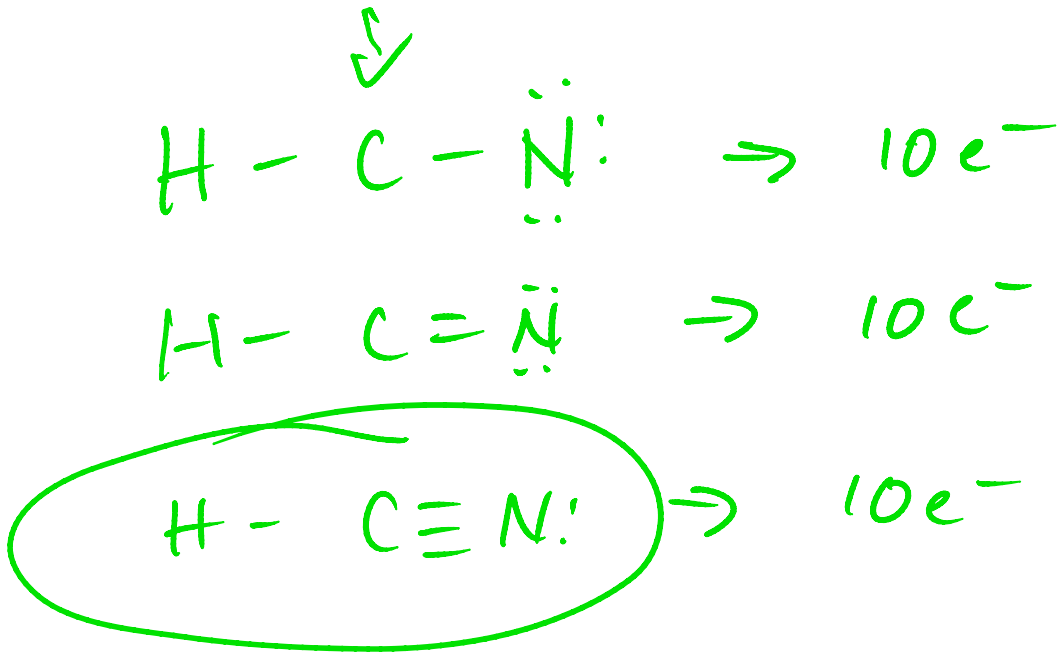
Draw the Lewis Structure for HCN.

H - 1

C - 4

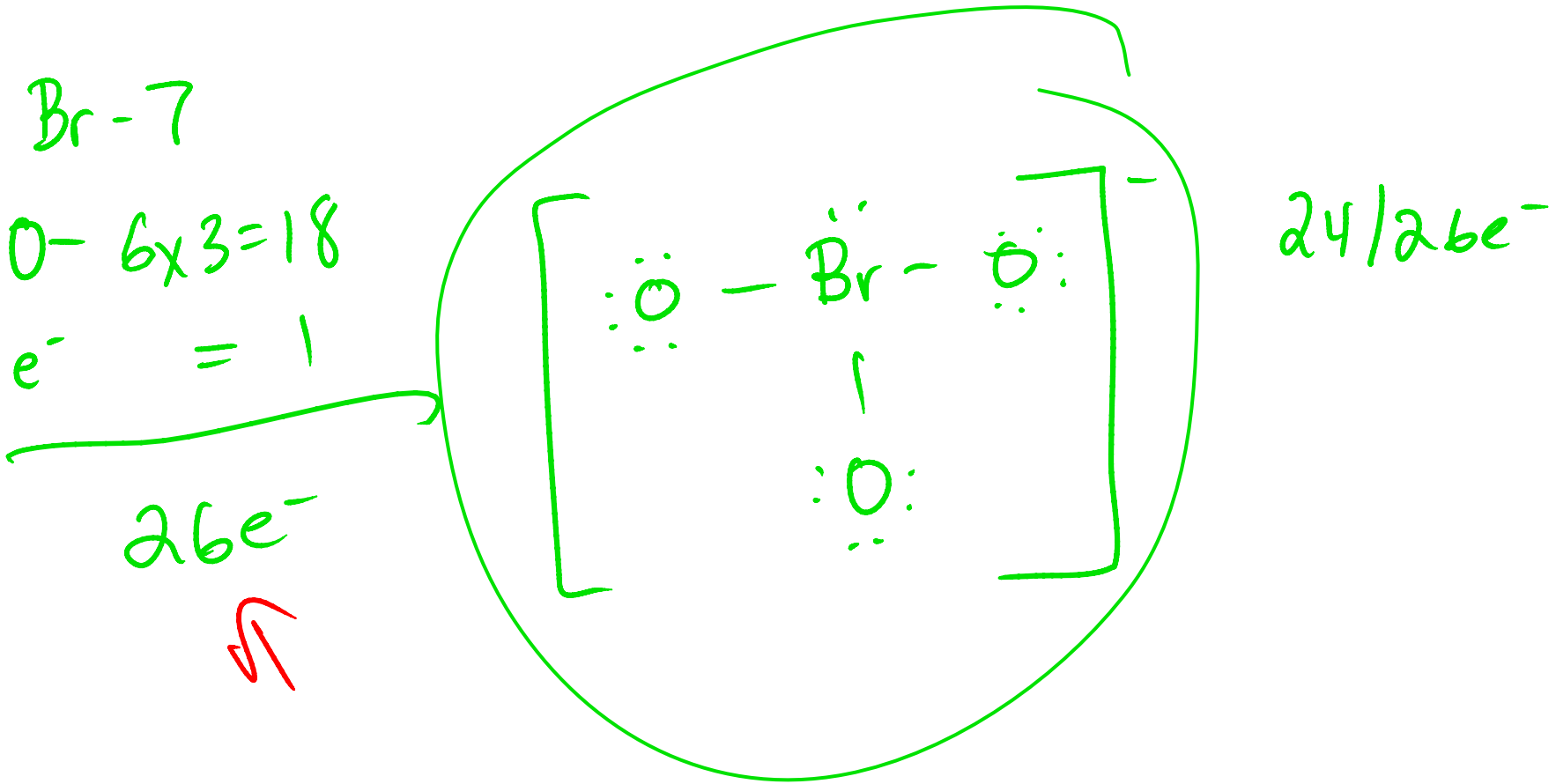
N - 5

10 e⁻



Let's Practice

Draw the Lewis Structure for the BrO_3^- anoion.

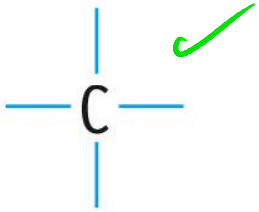


Some Tips

Practice

Trends

Group 4A



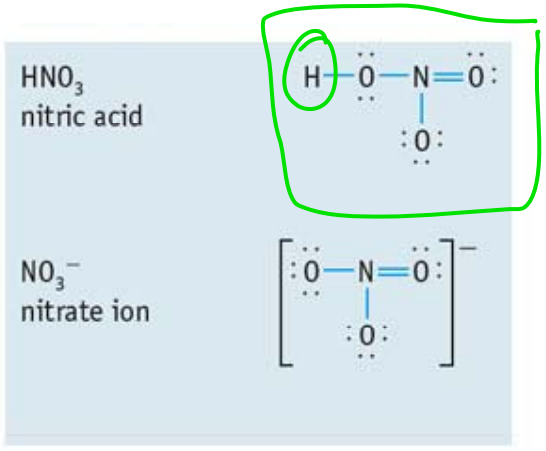
Group 5A

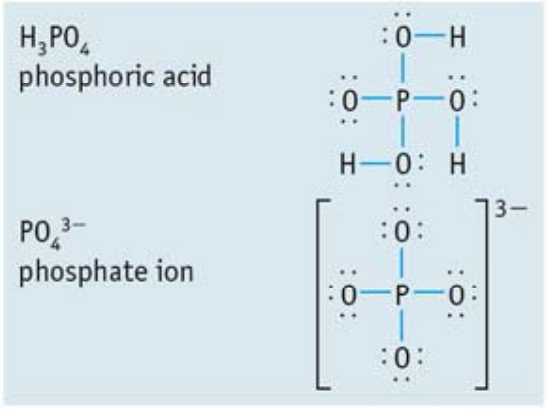
(5A) X_3

Group 6A

Group 7A

Oxoacids





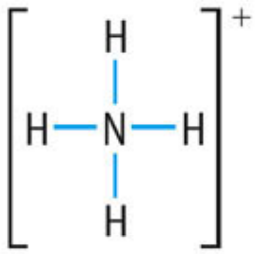
Isoelectronic Species

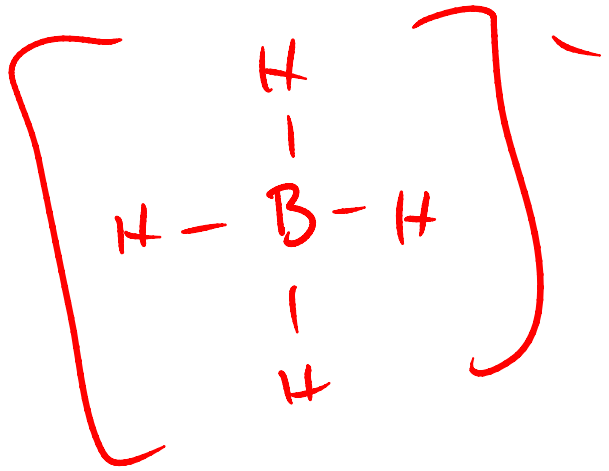
Same number of valence electronics.

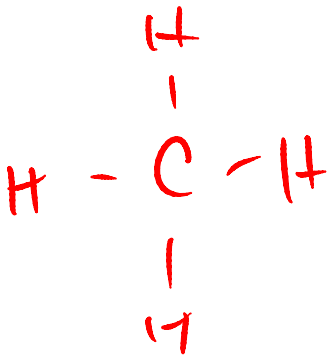
10 e^-

BH_4^-, CH_4, NH_4^+

Same e^-







Formal Charge

A form of bookkeeping, used to determine charge assigned to an atom in a molecule.

The formal charge of an atom equals the number of valence electrons in the isolated atom, minus the number of assigned to the atom in the Lewis Structure.

1. All of the unshared (non-bonding) electrons are assigned to the atom on which they are found.
2. Half of the bonding electrons are assigned to each atom in the bond.

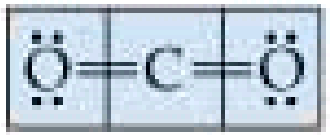
FC = Group Number – [Lone Pair e^- + ½ Bond Pair e^-]

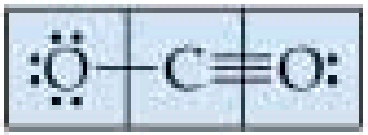
Formal Charge

FC = Group Number – [Lone Pair e^- + ½ Bond Pair e^-]

$[:C{\equiv}N:]^-$

Some of the formal charges will equal will equal the overall charge of the molecule.



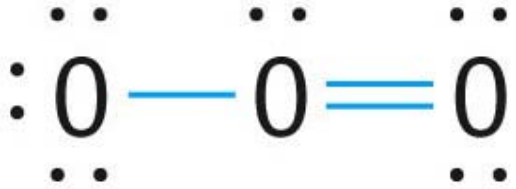


valence e^-:	6	4	6	6	4	6
$-(e^-$ assigned to atom):	6	4	6	7	4	5
formal charge:	0	0	0	−1	0	+1

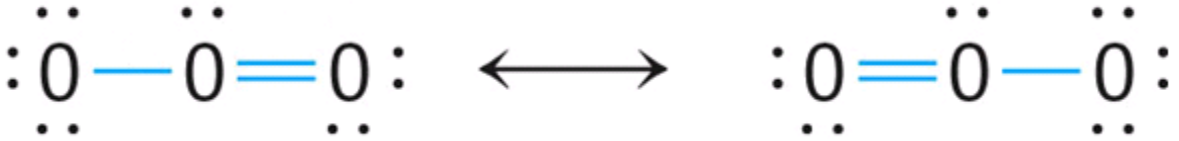
When several Lewis structures are possible, the more stable ones are the ones that bear the smallest formal charges.

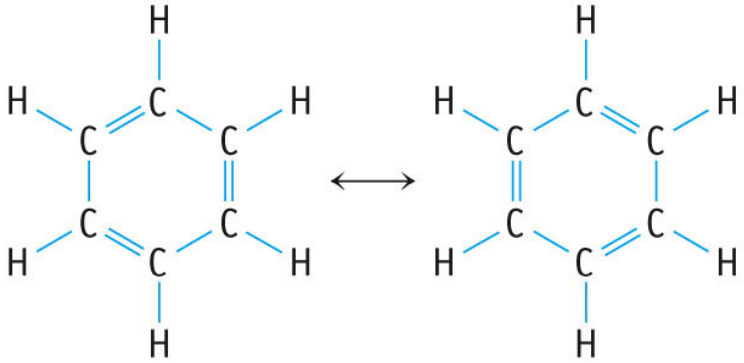
Resonance Structure

Consider O_3

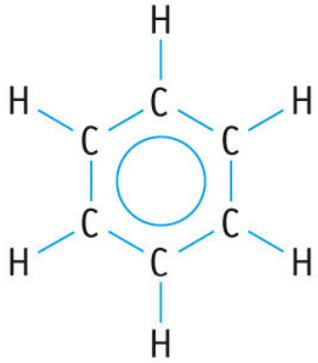


Real structure is the average of the two:





Resonance structures of benzene, C_6H_6



Abbreviated representation of

Resonance Structure

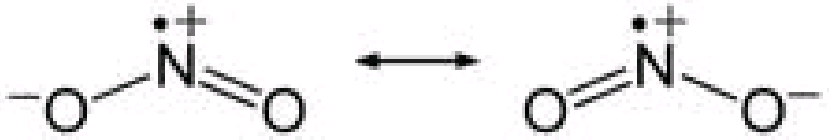
Which is predicted to have a shorter sulfur-oxygen bonds, SO_3 or SO_3^{2-}

Resonance Structure

Which is predicted to have a shorter sulfur-oxygen bonds, SO_3 or SO_3^{2-}

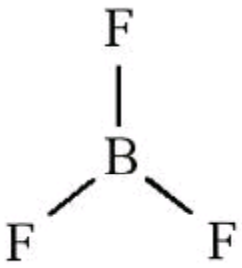
Odd Number of Electrons

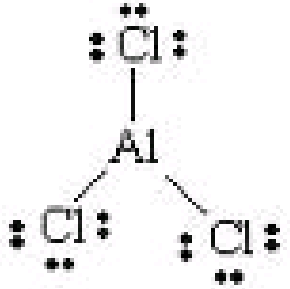
Some stable molecules such as ClO_2, NO and NO_2 have and odd number of electrons.

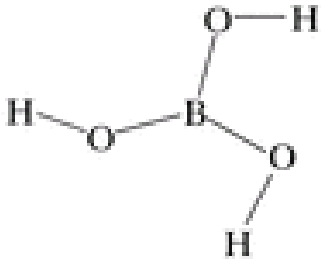


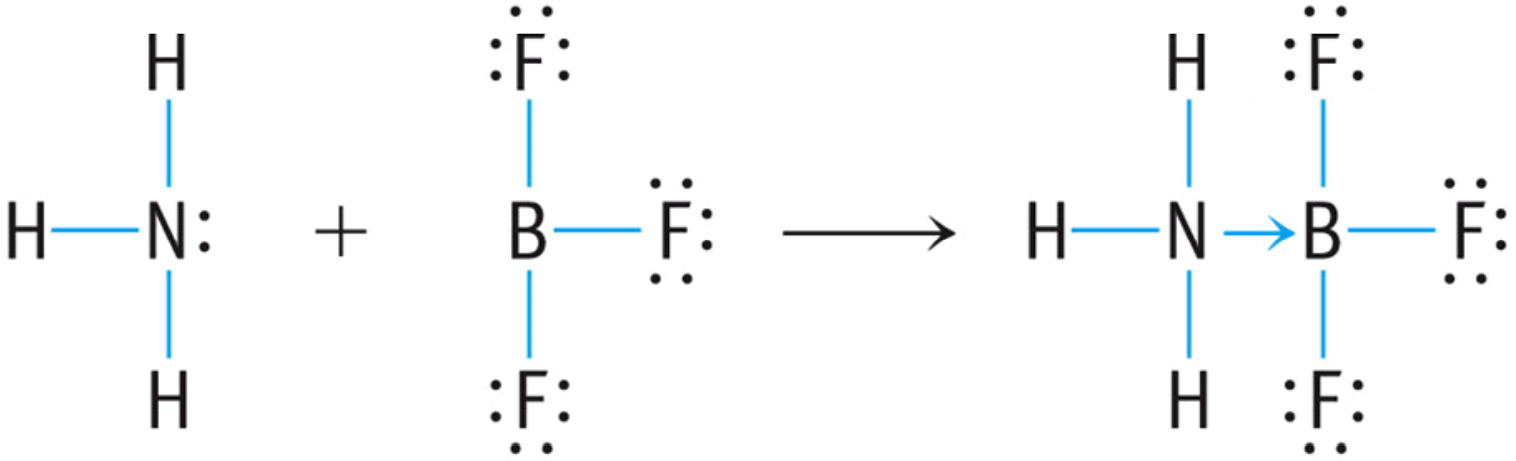
Less than an Octet

Rare case found in mainly boron, aluminum and beryllium compounds.









More than an Octet

Only happen with molecules where n =3 or greater

TABLE 8.6 Lewis Structures in Which the Central Atom Exceeds an Octet

Group 4A	Group 5A	Group 6A	Group 7A	Group 8
SiF_5^-	PF_5	SF_4	ClF_3	XeF_2
SiF_6^{2-}	PF_6^-	SF_6	BrF_5	XeF_4