

CHM 2120C  
Organic Chemistry II

Module 1 – Review

# Lewis Structure

- Gilbert Lewis has proposed *the octet rule*:
  - molecules are stable with eight electrons on their valence shell
  - atoms form bonds (*ionic or covalent*) to adopt a stable electronic configuration.
- Lewis Structures:
  - based on the stability of the complete octet
  - Show all the electrons on the valence shell of each atom

e.g. : azide anion,  $\text{N}_3^-$

- Count the nb of electrons  $(3 \times 5 \text{ for N}) + 1 \text{ for the charge} = 16 \text{ e}^-$

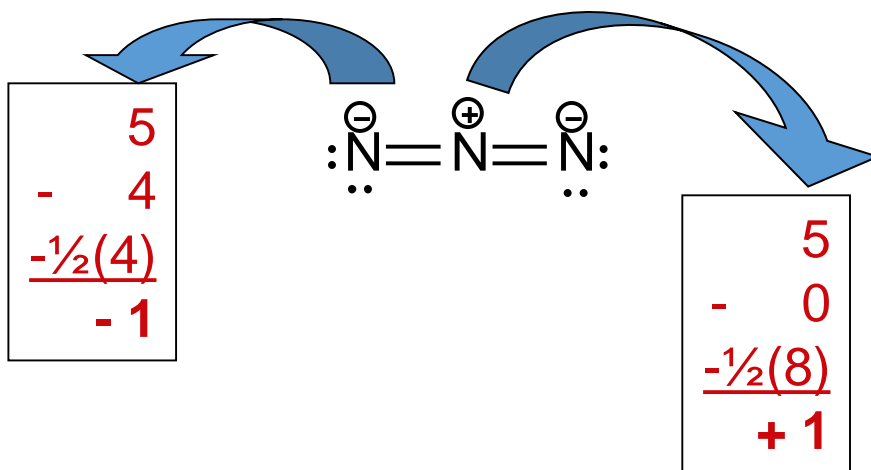
- Connect each atom with a pair of e-  $\text{N} : \text{N} : \text{N}$

- Add the remaining pair of e-  $\text{:}\ddot{\text{N}}::\text{N}::\ddot{\text{N}}\text{:}$  **FORMAL CHARGE ?**

# Formal Charge

- Charge for each atom

$$\begin{aligned} \text{Formal charge} &= (\text{number of valence electrons}) \\ &- (\text{number of non-bonding electrons}) \\ &- \frac{1}{2}(\text{number of bonding electrons}) \end{aligned}$$



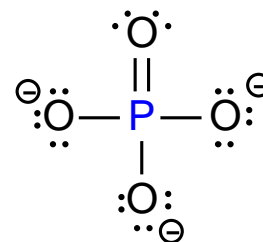
# Exceptions to the octet rule

- The octet rule apply to the 2<sup>nd</sup> period elements of the periodic table (C, N, O, etc.)

1 orbital  $2s$  + 3 orbitals  $2p$  = 8 electrons

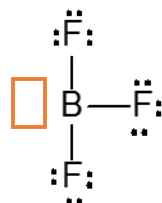
- Elements with ***d* orbitals** can have more than 8 electrons on their valence shell

e.g.: phosphate,  $\text{PO}_4^{3-}$



- Molecules with atoms from the group 3A elements

e.g. :  $\text{BF}_3$

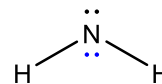
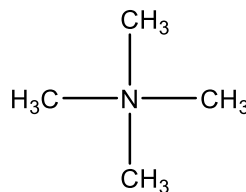
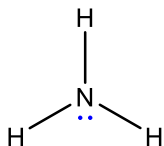
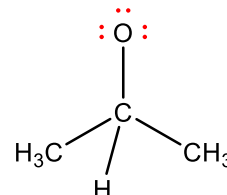
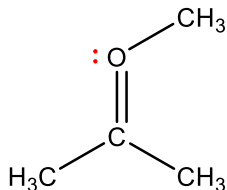
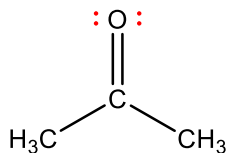


$\text{AlCl}_3$

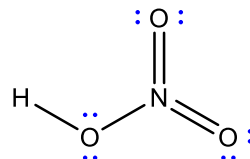
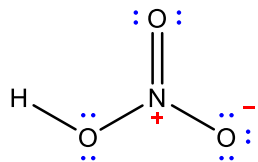




## Quickly predict the formal charge?

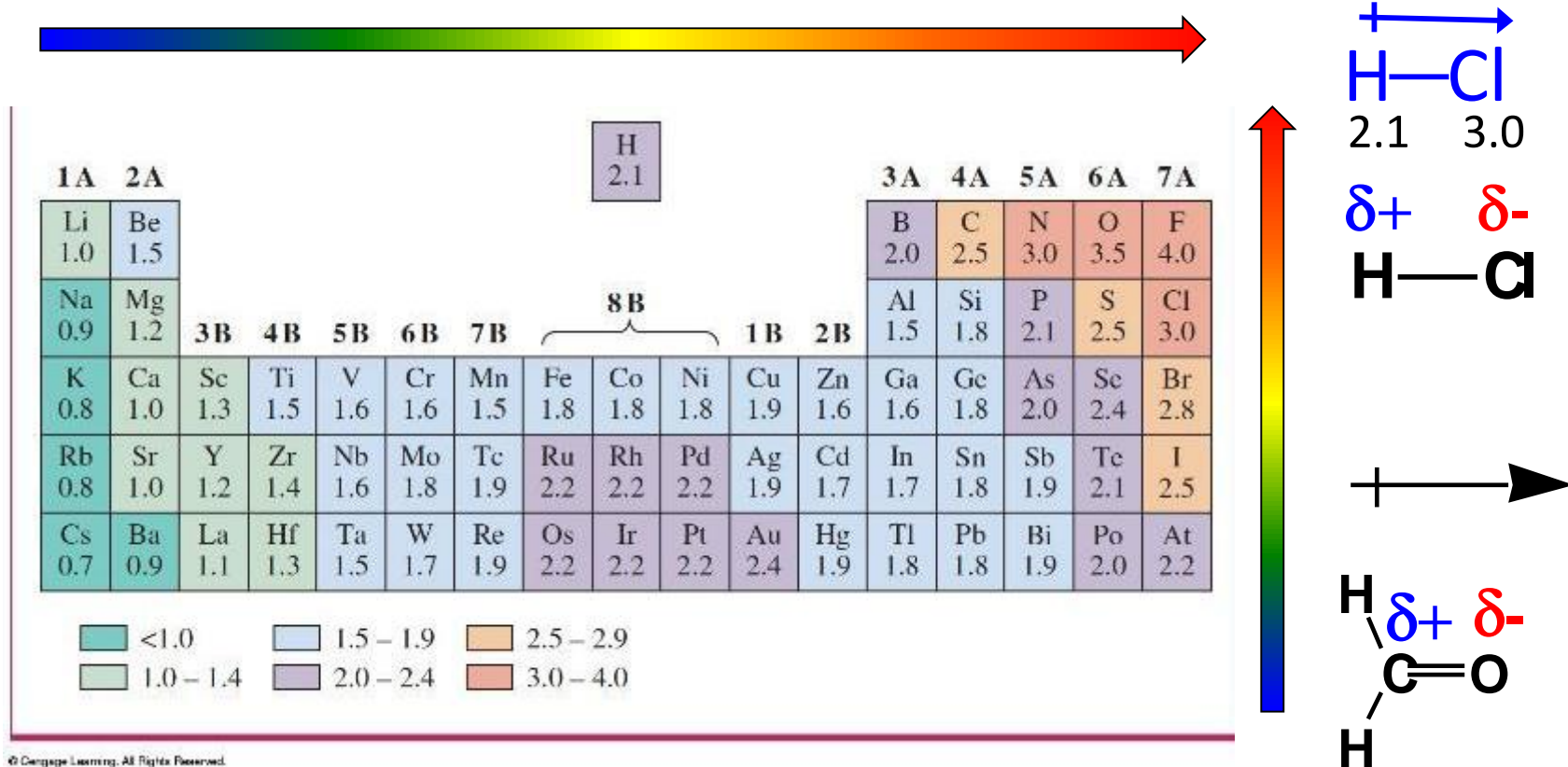


## Correct Lewis Structure (2<sup>nd</sup> period elements)



# Electronegativity

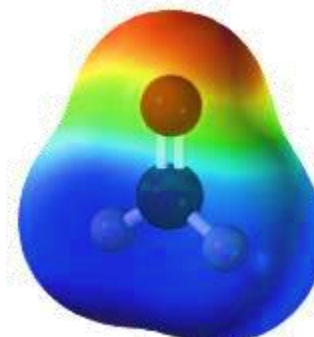
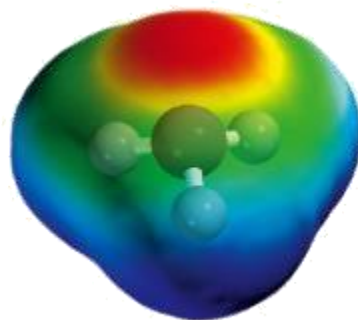
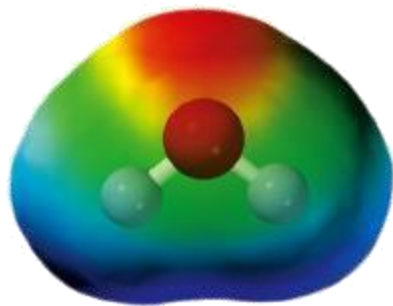
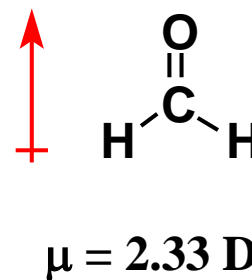
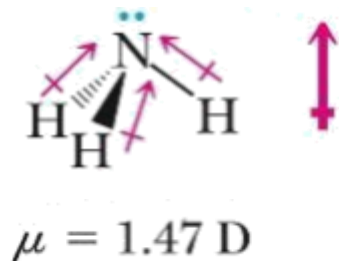
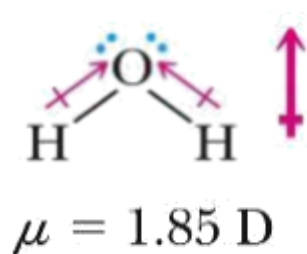
- Relative tendency of an element to attract shared electrons in a covalent bond
- influence the degree of polarization of a bond



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# Dipolar moment

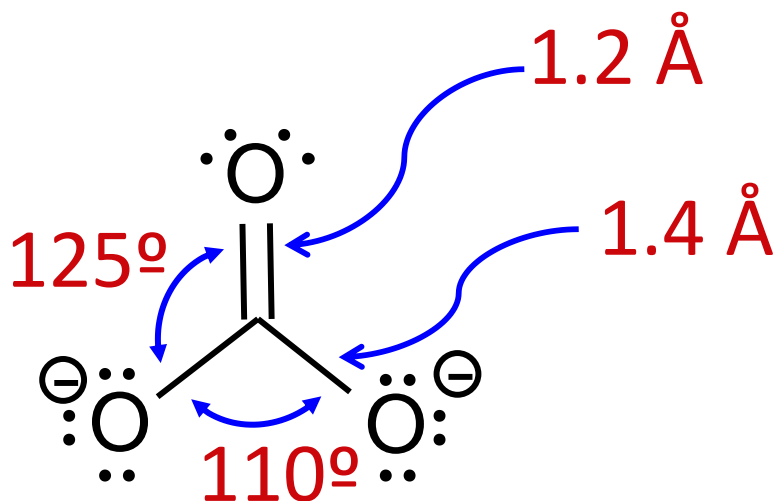
- Molecular dipolar moments
- Vector sum of bond dipole moments
- Relative distribution of the electron density in a molecule
- Identification of chemical reactivity sites.



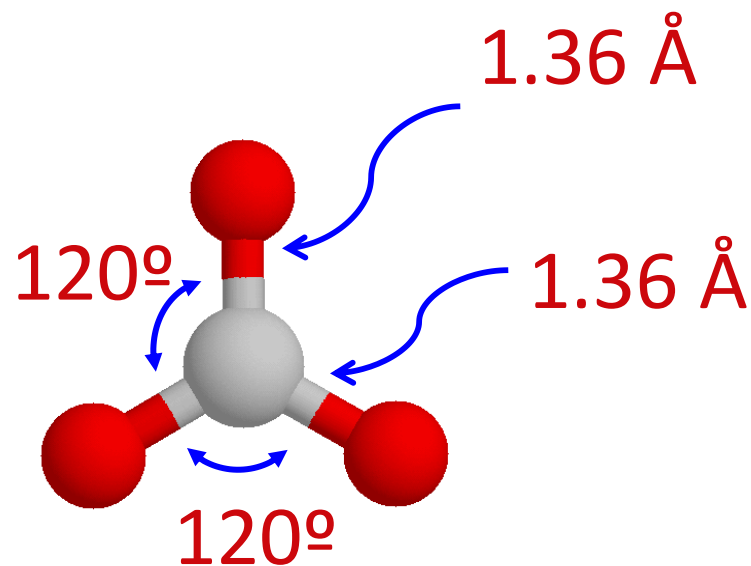
# Resonance

- Developed concept by Linus Pauling to explain the structures that can't be explained by simple Lewis structures

e.g.  $\text{CO}_3^{2-}$



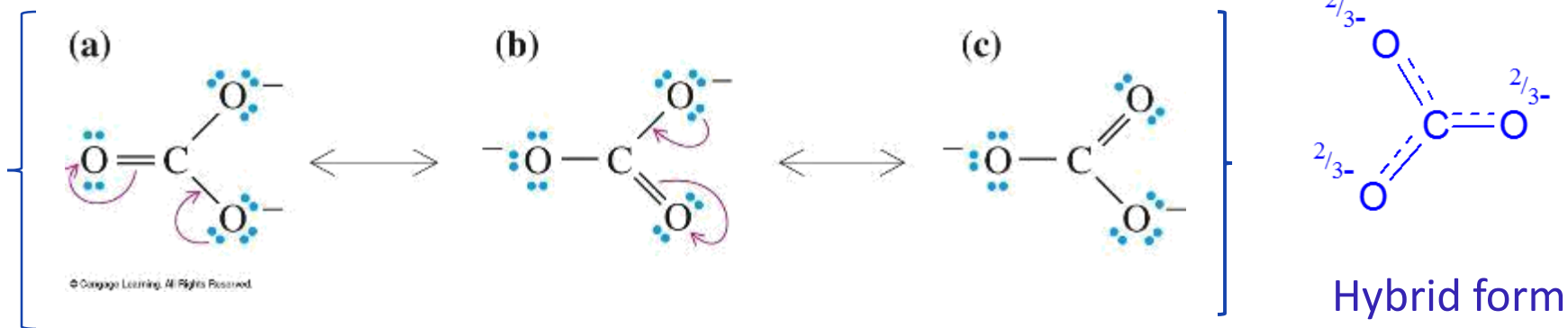
One of Lewis Structures



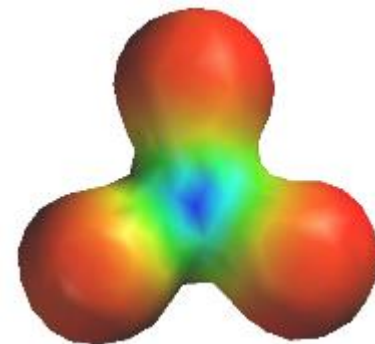
Resonance Structure: *reality*

## Hybrid resonance form : $\text{CO}_3^{2-}$


- The real structure corresponds to the hybrid form of the 3 equivalent structures, contributors to the resonance



Major resonance forms

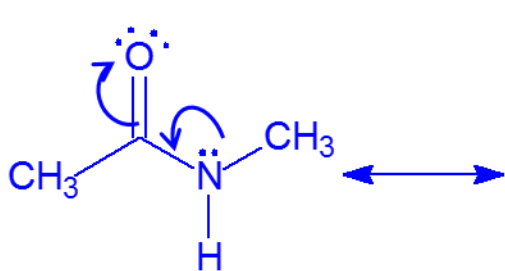


## Resonance structures' rules:

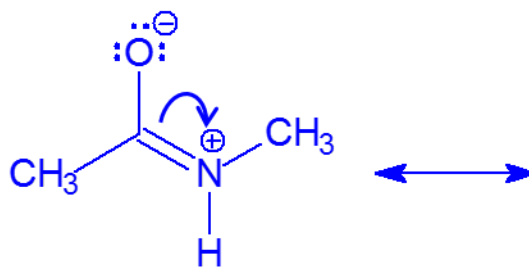
- All forms need to have the same number of valence electrons.
  - **Curved arrows** are used in the electrons' redistribution:
    - *from a bond to an adjacent atom*
    - or
    - *from a lone pair of an atom to an adjacent bond.*
- Same connectivity (no change in atoms' place)
- Double-headed arrows  are the type of arrows used to link the different forms of resonance.
- Contribution: major vs minor, points to consider:
  - *Incomplete octet*
  - *Charge*
  - *Electronegativity*

# Major and minor forms

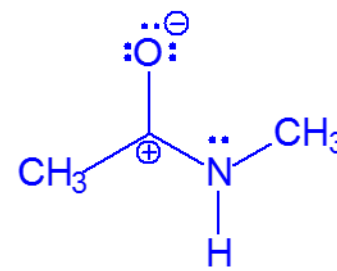
e.g.: *N*-methylacetamide,  $\text{CH}_3\text{NHCOCH}_3$



No charge,  
stable:  
MAJOR



With charge,  
Less stable:  
MAJOR



Incomplete octet,  
Least stable:  
MINOR

