“Its Bonding Time”

Chemical Bonds

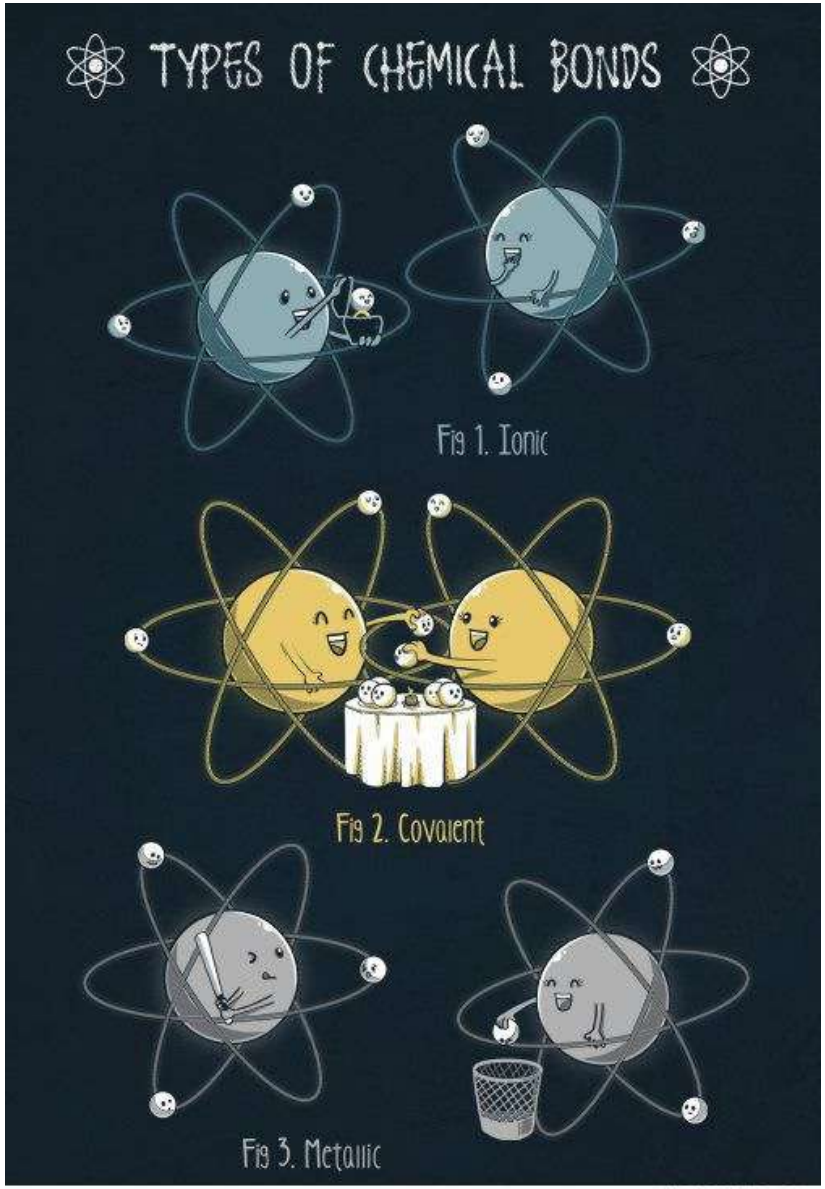
CH 12

What is a chemical bond?

- **Octet Rule**: Chemical compounds tend to form so that each atom, by gaining, losing, or sharing electrons, has an octet of electrons in its highest occupied energy level
- **Bond**- a force that holds groups of two or more atoms together and makes them function as a unit.
- Strength of a bond depends on **bond energy-** energy required to break the bond.

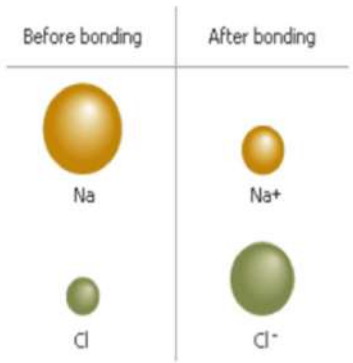
Types of Chemical Bonds

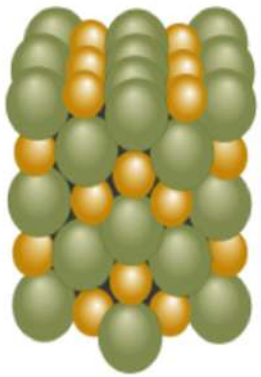
1. Ionic Bond- “electrons gained or lost”
2. Covalent Bond- “electrons shared”
3. Metallic Bond-

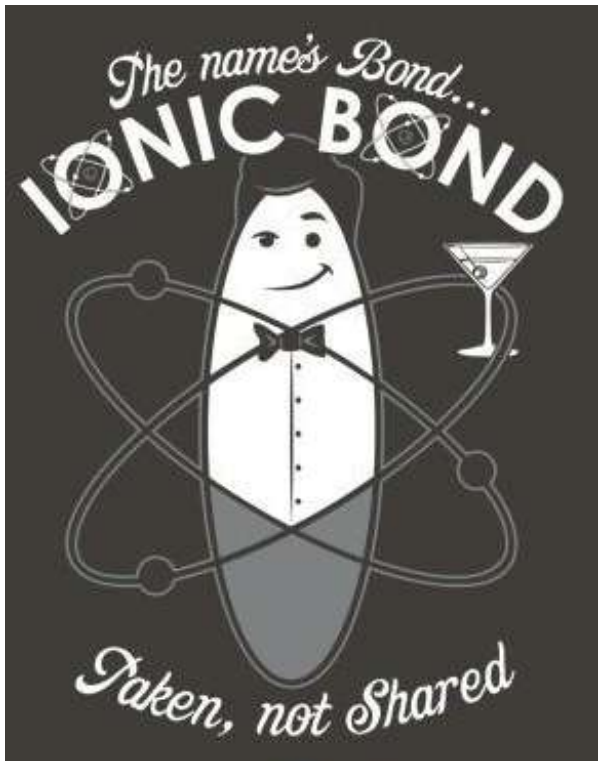


Ionic Bonds

- **Ionic bonds**- electrical attraction between cations and anions.
- Happens between metals and nonmetals
- Metal- looses e- cation (+)
- Nonmetal- gains e- anion (-)
- Forms an **ionic compound**

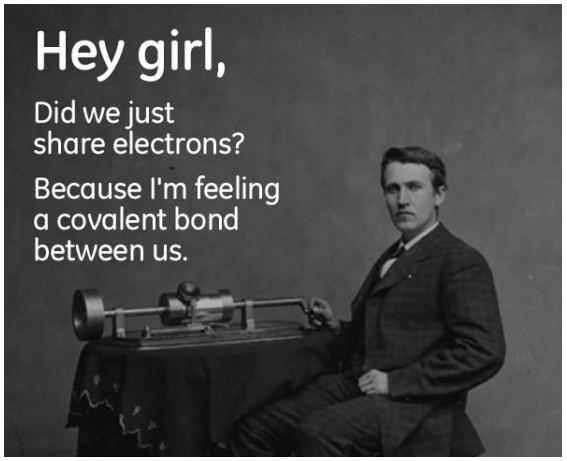




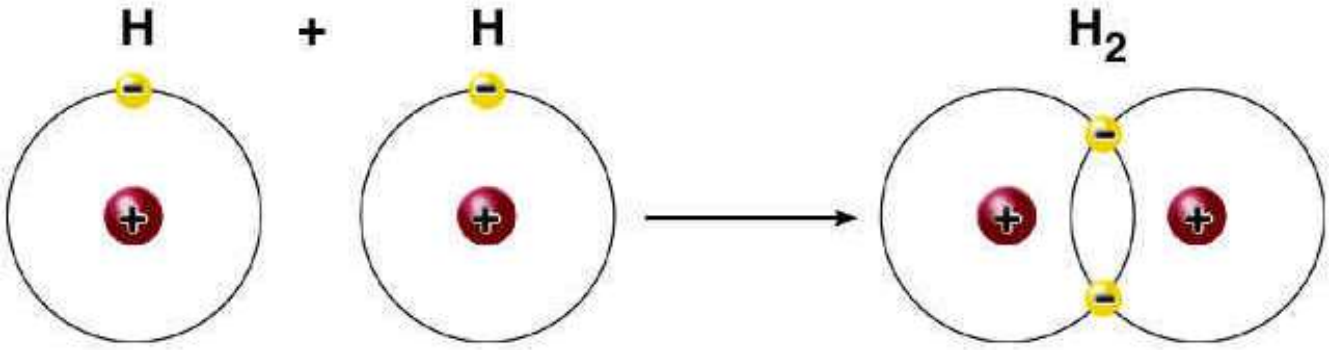


Covalent Bonds

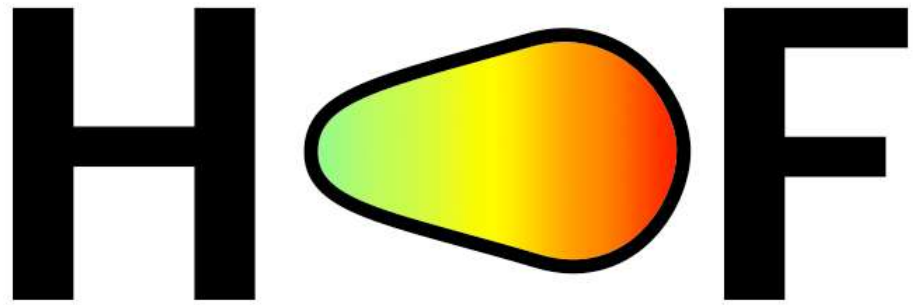
- **Covalent bond**: sharing electron pairs between atoms
- Happens between two non-metals
- Form molecules, diatomic molecule
- Types of Covalent bonds:
  - **Nonpolar covalent bond-** equal sharing of electrons between identical atoms (ex. H_2)
  - **Polar covalent bond-** unequal sharing of electrons between two atoms with different electronegativities (ex. HF)



Polar Vs Non-polar



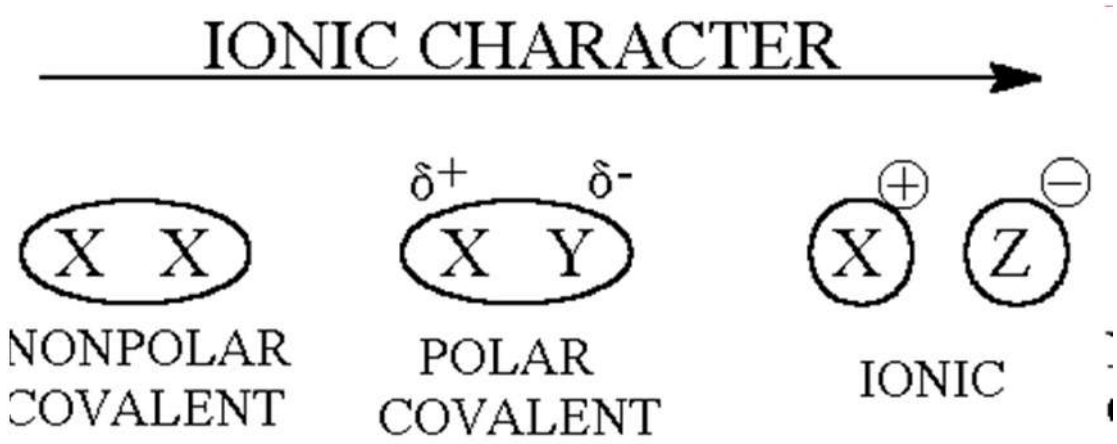
δ^+ δ^-



How do we know what type of bond will form??

- What elements involved (metals, nonmetals)
- Electronegativity(ability attract e) difference-

Electronegativity Difference	Bond Type
0.0-0.3	Non-polar Covalent
0.3-1.7	Polar Covalent
> 1.7	Ionic Bond

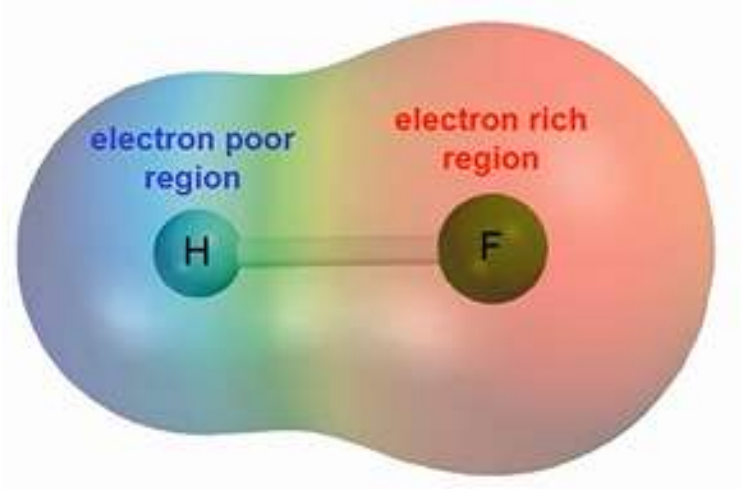


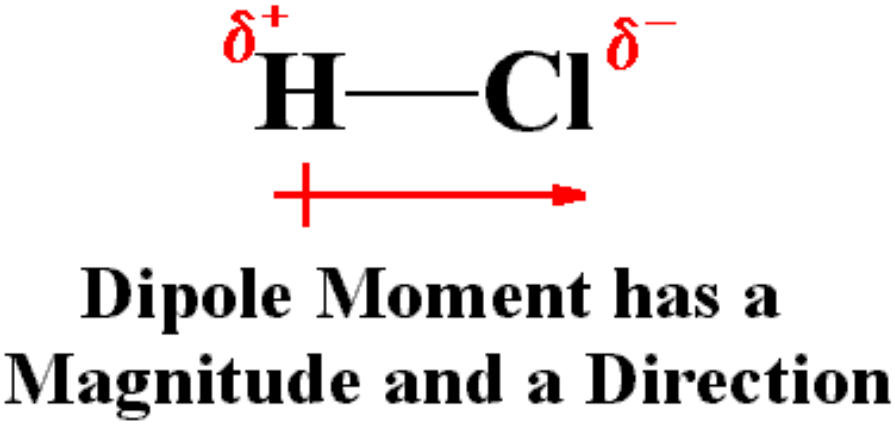
PRACTICE

Use electronegativity differences to classify bonding between sulfur, S, and the following elements: hydrogen, H; cesium, Cs; and chlorine, Cl. In each pair, which atom will be more negative?

Dipoles

- Polar Covalent Bonds lead to dipole moments- a molecule with a center of positive charge and center of negative charge- partial charges





Electron Configurations of Ions

1. Representative (main-group) metals form ions by losing enough e to achieve configuration of previous noble gas (ex. Ne-noble gas before Na, Mg)
2. Nonmetals form ions by gaining electrons to achieve configuration of the next noble gas (Ne follows O, F)

- In almost all stable chemical compounds of representative elements, all of the atoms have achieved a noble gas electron configuration.

Electron Configurations & Bonding

- When a nonmetal & a Group 1,2, 3 metal react to form binary ionic compound, e transferred so that both the cation and anion achieve electron configuration of a noble gas.
- When two nonmetals react to form covalent bond, share electrons in way to complete valence-electron configurations of both atoms (both noble gas)

Predicting Formulas of Compounds

- Ca: [Ar] $4s^2$

$Ca \rightarrow Ca^{2+} + 2e$

$[Ar]\ 4s^2 \rightarrow [Ar] + 2e$

- O: [He] $2s^2 2p^4$

$O + 2e \rightarrow O^{2-}$

$[He]2s^2 2p^4 + 2e \rightarrow [He]\ 2s^2 2p^6$, or [Ne]

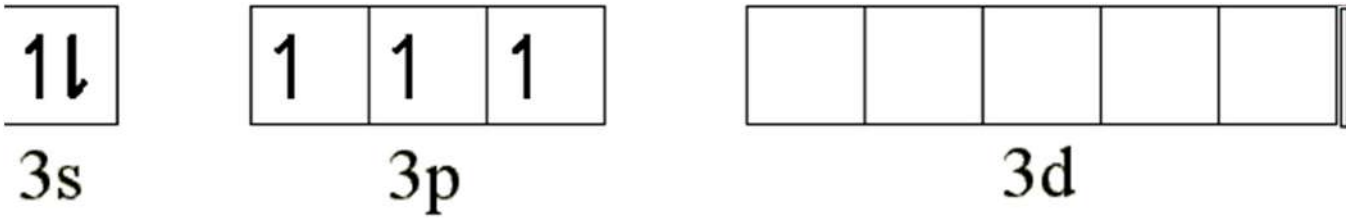
Exceptions to the Octet Rule

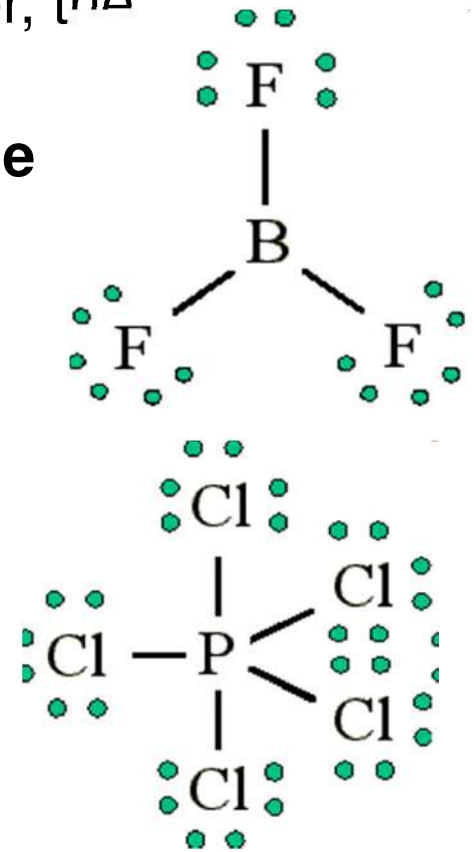
1. The 'octet' rule is based upon available n*s* and n*p* orbitals for valence electrons

   (2 e- in the *s* orbitals, and 6 in the *p* orbitals)

2. Beginning with the n=3 principle quantum number, the d orbitals become available (*l*=2)

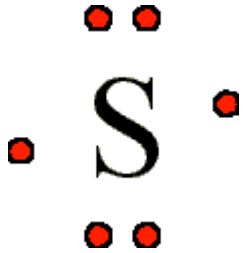
3. **Third period elements occasionally exceed the octet rule by using their empty d orbitals to accommodate additional**





Lewis Dot Structures

- Electron dot notation: e^- configuration notation in which only the valence e^- of an atom of a particular element are shown
- e^- dot notation used to represent molecules
  - Lone pair: pair of e- that is not involved in bonding and that belongs exclusively to one atom
  - Lewis Dot structures:
    - atomic symbols represent nuclei and inner shell e-
    - Dot pairs or dashes represent covalent bonds
    - Dots adjacent to only one atomic symbol represent unpaired e-



Steps of Drawing Lewis Dot Structures

1. Determine the type and number of atoms involved.
2. Write the electron dot diagram for each type of atom involved
3. Determine the total number of valence electrons in the atoms to be combined
4. Arrange the atoms to form a skeleton structure for the molecule; least electronegative atom is central, H is never central
5. Connect atoms by electron pair bonds
6. Add unshared pairs of e- so each is surrounded by 8 e-
7. Count e- in structure to be sure the number used equals number available; central atom should have an octet

CH_3I

C H H H C I (3)

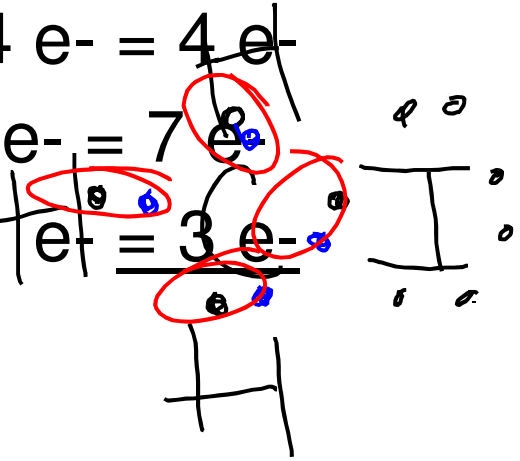
= 14

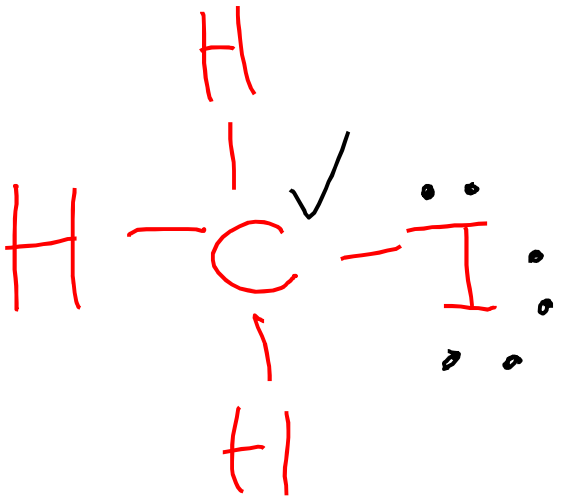
C 1 x 4 e- = 4 e-

I 1 x 7 e- = 7 e-

H 3 x 1 e- = 3 e-

14 e-





H

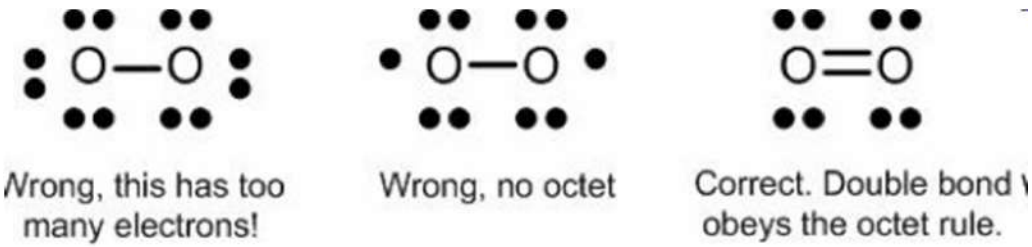
H C I

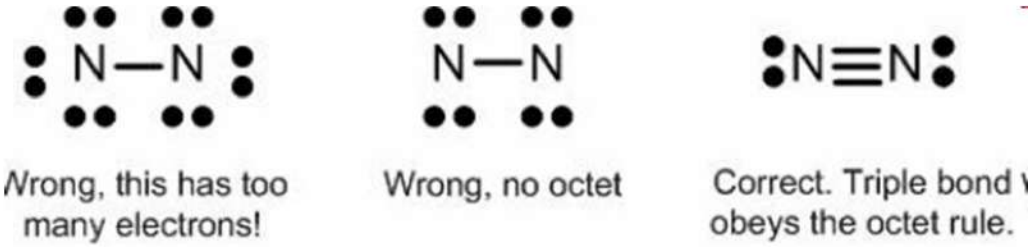
H

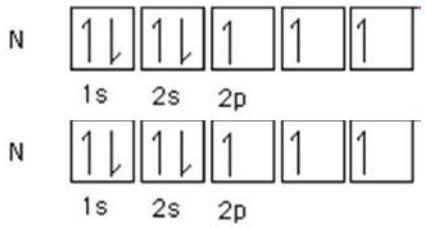
14

1. Lewis Structures – multiple bonds

1. Double bonds: covalent bond produced by the sharing of two pairs of e- between two atoms
2. Triple bonds: covalent bond produced by the sharing of three pairs of e- between two atoms
3. Bond lengths & energies
    1. Shorter bonds, higher energy
    2. Longer bonds, lower energy
    3. Multiple bonds, shorter, higher energy



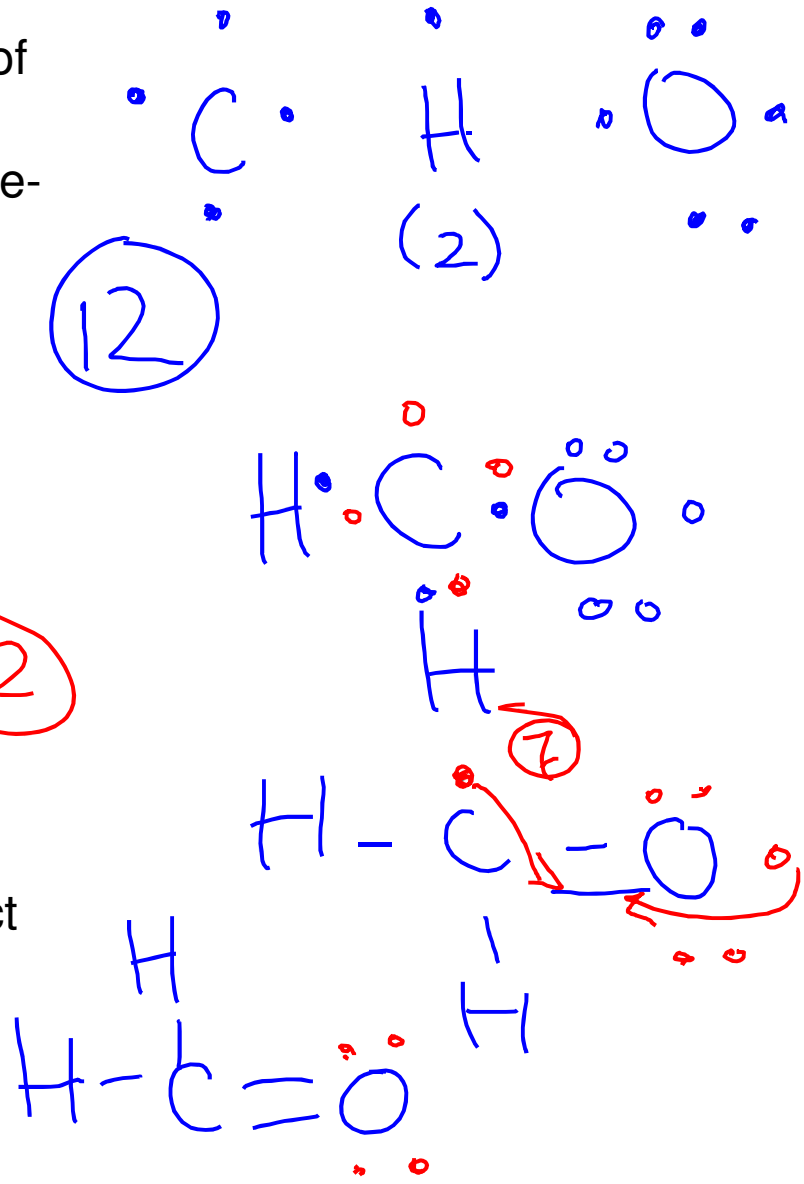




1. Drawing Lewis Structures

1. Determine the type and number of atoms in the molecule
2. Write the e- dot notation for each type of atom in the molecule
3. Determine the total number of valence e- in the atoms to be combined
4. Arrange the atoms to form a skeleton structure for the molecule; least electronegative atom is central, H is never central
5. Connect atoms by electron pair bonds
6. Add unshared pairs of e- so each is surrounded by 8 e-
7. Count e- in structure to be sure the number used equals number available; central atom should have an octet
8. If too many e- have been used, subtract one or more lone pairs until the total number of valence e- is correct

CH_2O



1. Polyatomic Ions

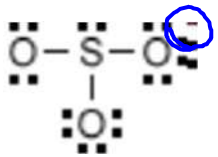
1. Charged group of covalently bonded atoms
2. Charge results from excess of electrons or shortage of electrons
   1. Ion negatively charged, add the # e- to total number of valence electrons
   2. Ion positively charged, subtract the # e- from total number of valence electrons

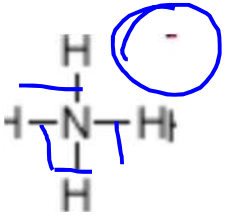
What is the Lewis structure of the following ions?

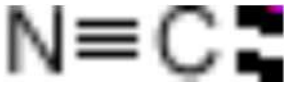
SO_3^{2-}

NH_4^+

CN^-







X. Resonance Structures

Bonding in molecules or ions that cannot be correctly represented by a single Lewis structure