SCIENCE COMMITTEE

# Materials

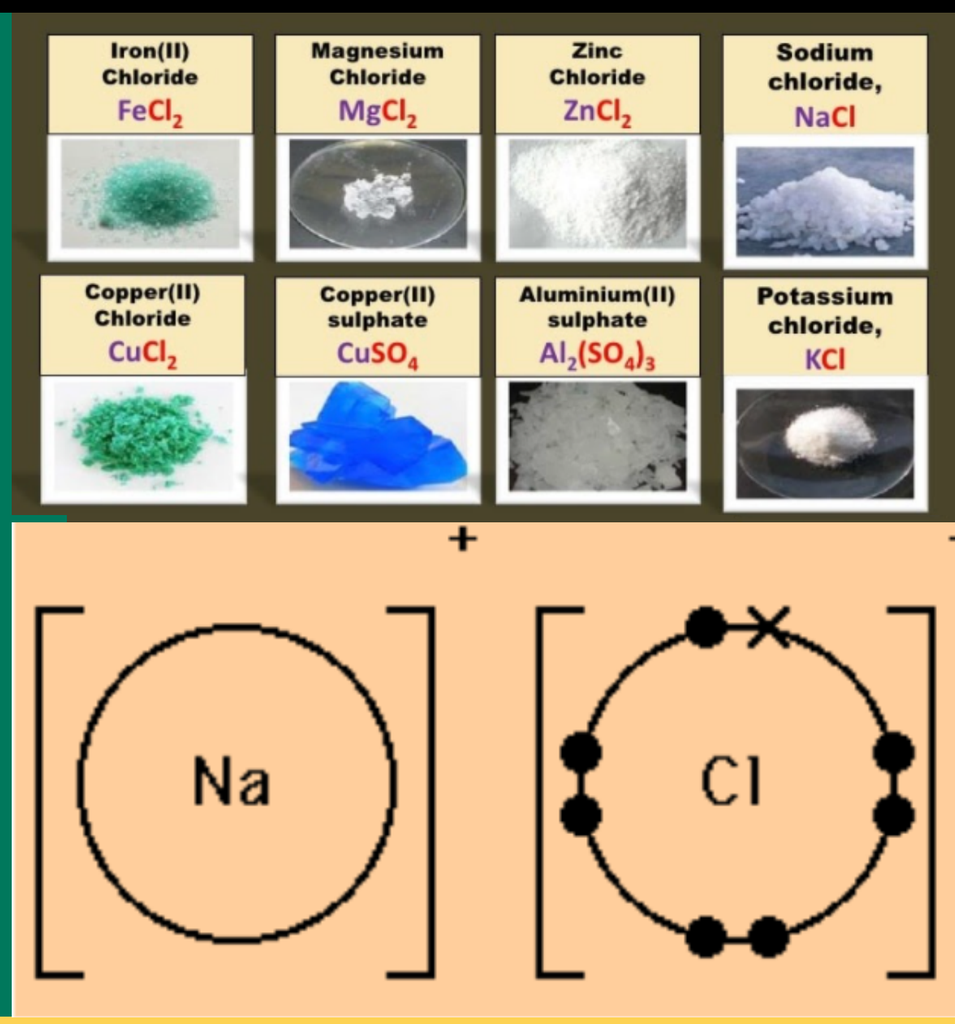
## Ions and Ionic Bonding

Ionic bonding is a type of chemical bonding that involves the electrostatic attraction between oppositely charged ions.

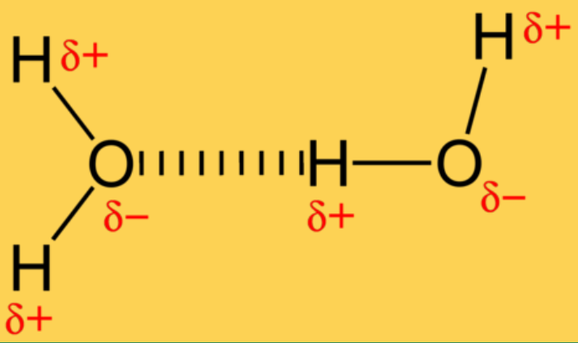
Example of an ionic compounds we use: salt(NaCl), sodium fluoride (NaF) ingredient in toothpaste.

$$F = k\frac{q_1 q_2}{r^2}$$

where F represents the force of attraction in Newtons, q1 and q2 represents the charges of the two ions in coulombs, d represents the distance between the ions' nuclei in meters and k is a proportionality constant of 8.99 x 109 Newton square meters per square coulomb.

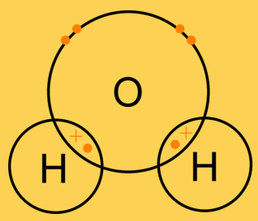



| Ionic Compound | Covalent Compound |
|---|---|
| Non-metal + Metal | Non-metal + Non-metal |
| Transfer electrons (metal to non-metal) | Sharing electrons |
| Positive and negative charges | No charges |
| Naming with Greek Prefixes | Naming with Roman Numerals |
| Solid at room temperature (25℃) | Solid, liquid or gas at room temperature |
| High melting and boiling points | Low melting and boiling points |
| High attraction between particles | Weak attraction between molecules |




A covalent bond is a chemical bond that involves the sharing of electron pairs between atoms.
Covalent compounds in real life: water(H2O), sugar(C6H12O6)

In covalent bond the atoms are held together by the electrostatic attraction between the positively charged nuclei of the bonded atoms and the negatively charged electrons they share.

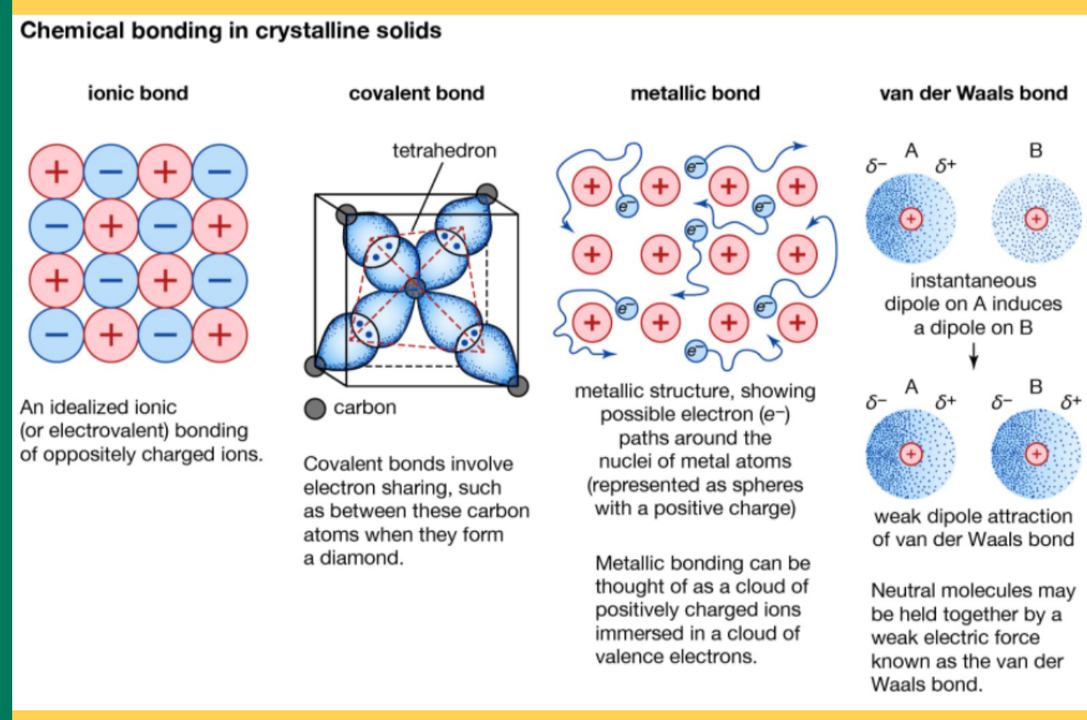



Hydrogen bond in the water: what is hydrogen bond?
When many water molecules form hydrogen bonds with other water molecules, they form a lattice of water molecules, which is strong and flexible. This creates a high surface tension.

## Metals

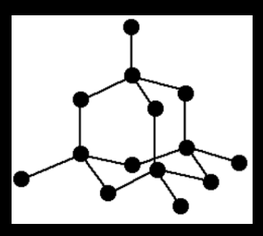
Metals: solids with high melting and boiling points, malleable and good conductors of heat and electricity.

Metallic bond: A metallic bond is a type of chemical bond formed between positively charged atoms in which the free electrons are shared among a lattice of cations. In contrast, covalent and ionic bonds form between two discrete atoms. Metallic bonding is the main type of chemical bond that forms between metal atoms.




## Macromolecules

A macromolecule is a very large molecule, such as a protein. They are composed of thousands of covalently bonded atoms. Eg. protein, diamonds, graphite



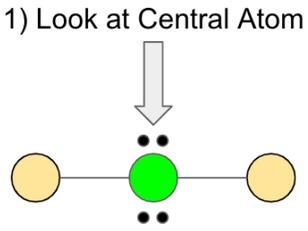
Uses of macromolecules in the body:

| Biological macromolecule | Building blocks | Functions |
|---|---|---|
| Proteins | Amino acids | Provide cell structure, send chemical signals, speed up chemical reactions, etc |
| Nucleic acids | Nucleotides | Store and pass on genetic information |

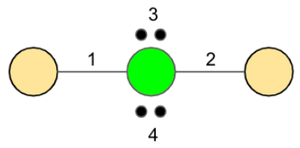
# Covalent Bond Structures: What shape/structure does a molecule take?

***Ever wondered why some molecules are drawn differently, like $H_2O$ is bent and $CO_2$ is straight? Here, Lewis Structure is used***

1) Look at Central Atom



2) Count the number of $e^-$ domain




Number of bonds: 2
Number of lone $e^-$ pairs: 2
Sum: 2+2=4

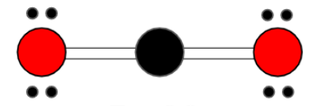
*Note: Double bonds like in $CO_2$ count as 1 bond

Assumes configuration of least repulsion, $e^-$ and atoms are furthest apart from each other.

When looking at Bond Angles, Lone pairs of $e^-$ repels more than atoms, causing smaller bond angles in some instances

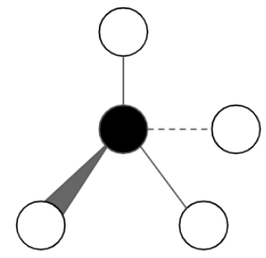
## Electron Domain Geometry: Only Sum is taken into account ($e^-$ counts) (SL)

Sum = 1, 2: Linear



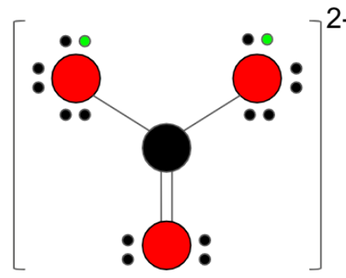
Eg: $CO_2$

Sum = 4: Tetrahedral
Bond Angle: 109.5°



Eg: $CH_4$

Sum = 3: Trigonal Planar
Bond Angle: 120°

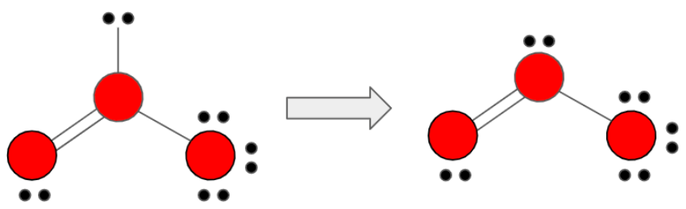



Eg: $CO_3^{2-}$

These Molecules have identical Electronic and Molecular Structure

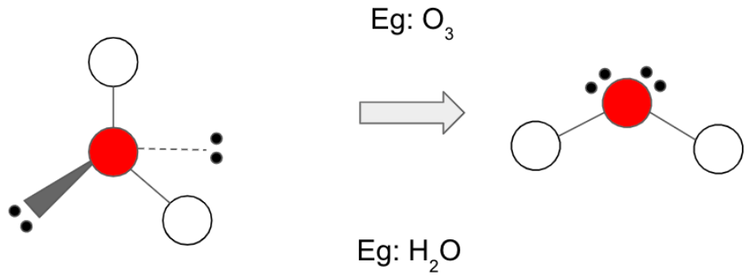
## Molecular Geometry: Both Sum and Number of Bonds are Looked At (SL)

Sum = 3, # of Bonds = 2:
Electron Domain Geometry: Trigonal Planar
Molecular Geometry: Bent/V-shaped
Bond Angle: 119°-118°



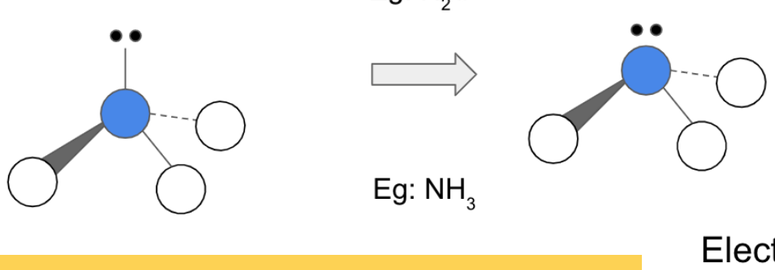
Eg: $O_3$

Sum = 4, # of Bonds = 2:
Electron Domain Geometry: Tetrahedral
Molecular Geometry: Bent/V-shaped
Bond Angle: 107°-105°



Eg: $H_2O$

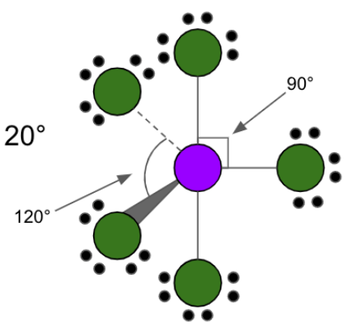
Sum = 4, # of Bonds = 3:
Electron Domain Geometry: Tetrahedral
Molecular Geometry: Trigonal Pyramidal
Bond Angle: 108°-107°



Eg: $NH_3$

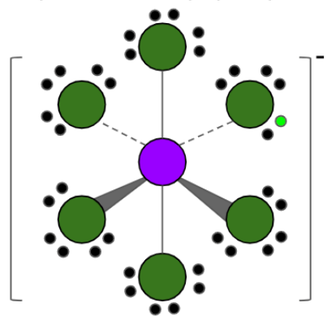
## Electron Domain Geometry: Only Sum is taken into account ($e^-$ counts) (HL)

Sum = 5: Trigonal Bipyramidal
Bond Angle: 90°, 120°




Eg: $PCl_5$

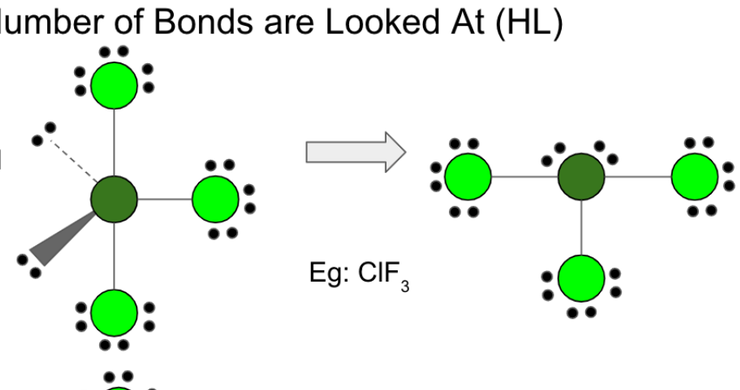
Sum = 6: Octahedral
Bond Angle: 90°



Eg: $PCl_6^-$

## Molecular Geometry: Both Sum and Number of Bonds are Looked At (HL)

Sum = 5, # of Bonds = 3:
Electron Domain Geometry: Trigonal Bipyramidal
Molecular Geometry: T-shaped
Bond Angle: 90/89°

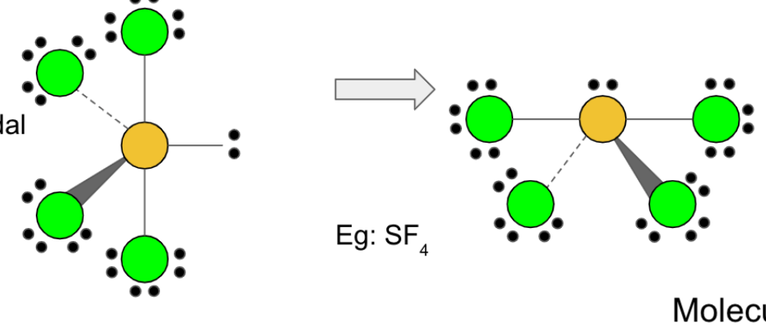


Eg: $ClF_3$

These Molecules have identical Electronic and Molecular Structure

Note: The Central Atom for these 2 structures have more than 8 $e^-$ in its outer shell, making it HL only

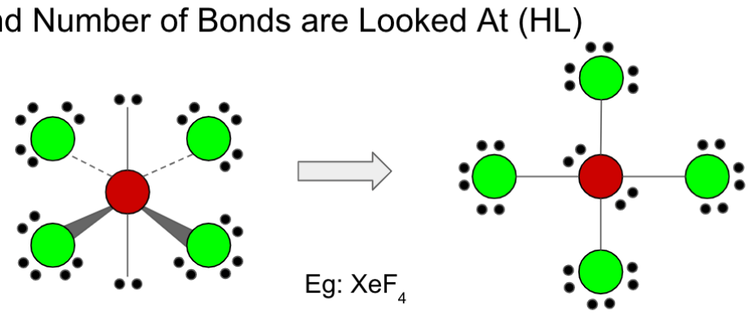
Sum = 5, # of Bonds = 4:
Electron Domain Geometry: Trigonal Bipyramidal
Molecular Geometry: See-Saw Shaped
Bond Angle: 89°, 119°



Eg: $SF_4$

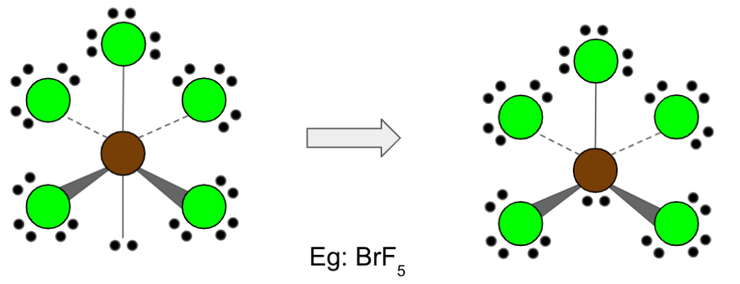
## Molecular Geometry: Both Sum and Number of Bonds are Looked At (HL)

Sum = 6, # of Bonds = 4:
Electron Domain Geometry: Octahedral
Molecular Geometry: Square Planar
Bond Angle: 90°



Eg: $XeF_4$

Sum = 6, # of Bonds = 5:
Electron Domain Geometry: Octahedral
Molecular Geometry: Square Pyramidal
Bond Angle: 89°



Eg: $BrF_5$