Chemical Bonding: Fundamental Concept

Designed by

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Chemistry Affinity

Conceptual, Real World, Happy Learning

Overview

1. Lewis dot or Electron dot structure
2. Ionic bond
3. Covalent bond
4. Coordinate bond

Octet rule

Gilbert N. Lewis formulated the "octet rule"

This rule refers to the tendency of atoms to have eight electrons in the *valence shell*. This is stable electronic configuration

When atoms have fewer than eight electrons in their valence shell, they tend to react with same element or other element to form more stable compounds by fulfilling the eight electrons in valence shell

Important Points: Octet rule

Only the s and p electrons are involved in the octet rule but d and f electrons do not follow octet rule

When s and p block elements follow octet rule, their electronic configuration become s^2p^6

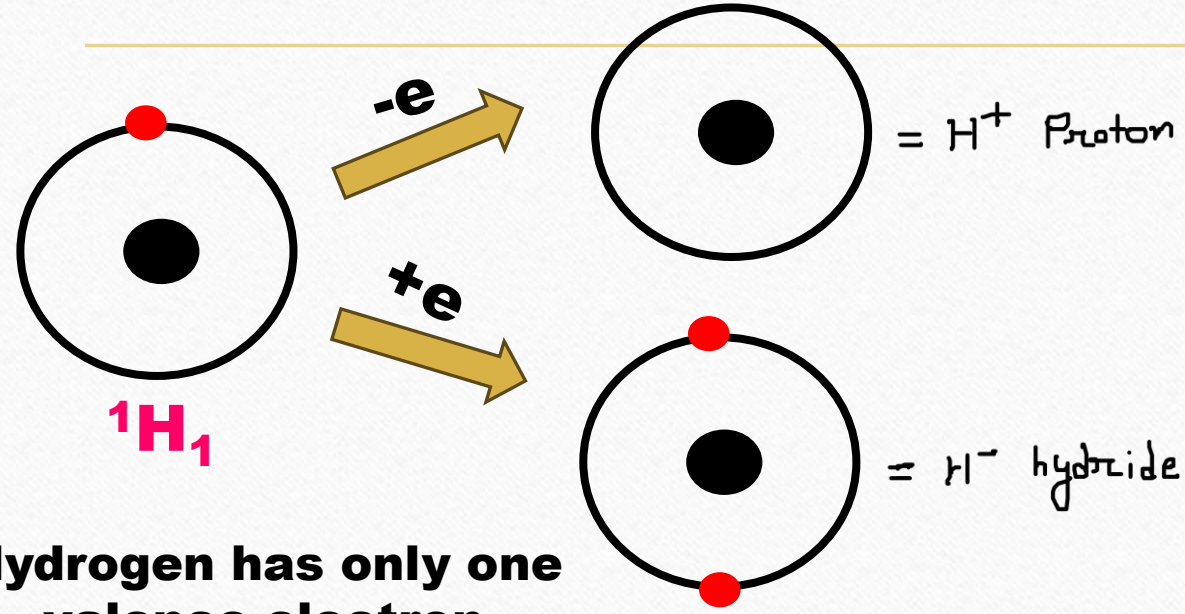
Open Octet or Expanded Octet

When one of these atoms has less than eight valence electrons it is called open octet

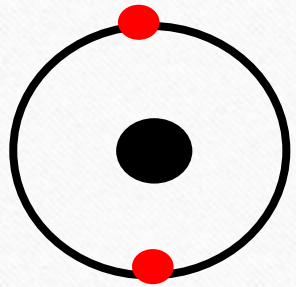
A valence shell electron count that exceeds eight electrons are expanded octet

For introduction of chemical bonding follow this below link

Hydrogen and helium do not follow octet rule



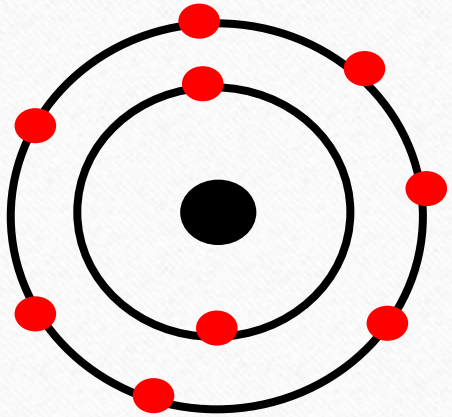
Hydrogen has only one valence electron



$^4He_2$

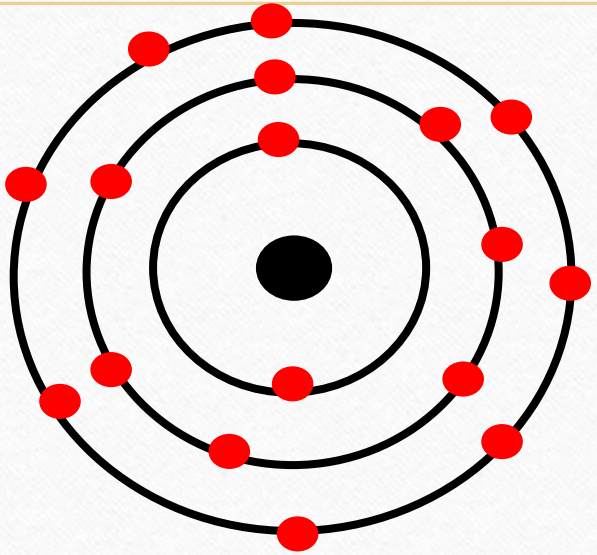
He is noble gas but valence shell contains only two electrons

Noble gas Ne and Ar follow octet rule but Kr, Rn, Xe do not follow octet rule



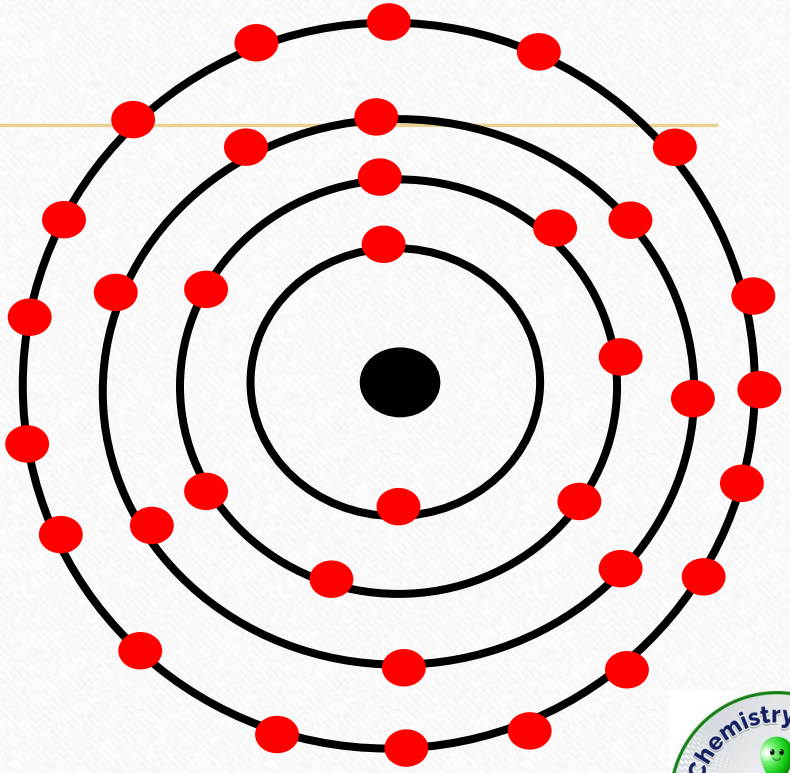
$_{10}Ne^{20}$

Valence electrons: 8



$_{18}Ar^{40}$

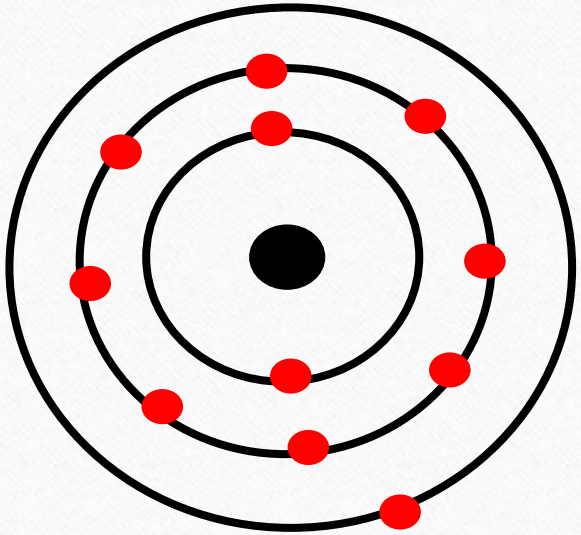
Valence electrons: 8

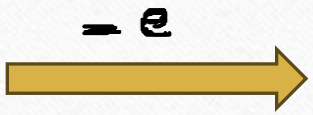


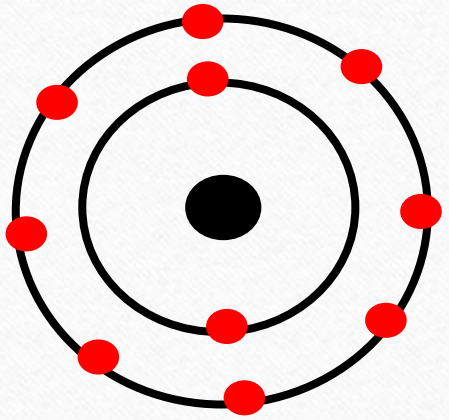
Valence electrons: 18

$_{36}Kr^{84}$

Formation of cation: Octet Rule follows by elements to get stable configuration



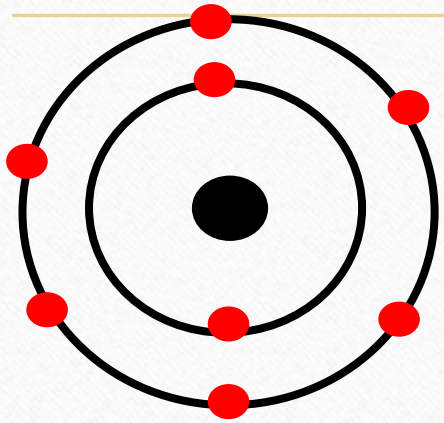




$^{23}Na_{11}$

Na^+ : valence shell has eight electrons

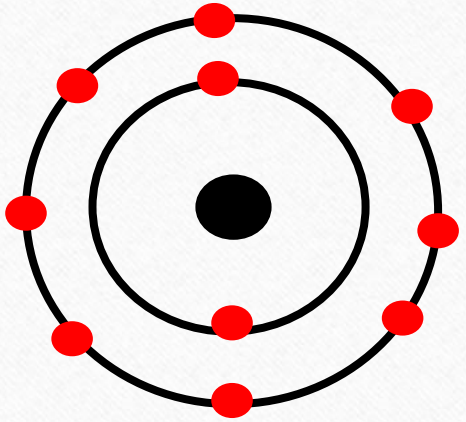
Formation of anion: Octet Rule follows by elements to get stable configuration



O: Six VE

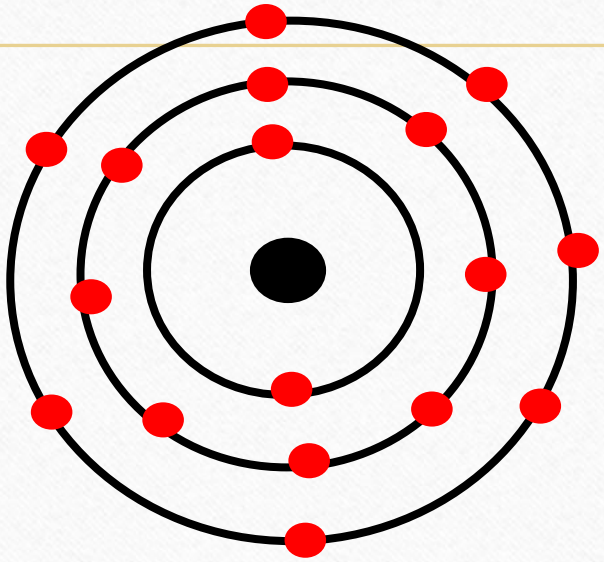
O can accept two electrons to get Ne configuration

+2e

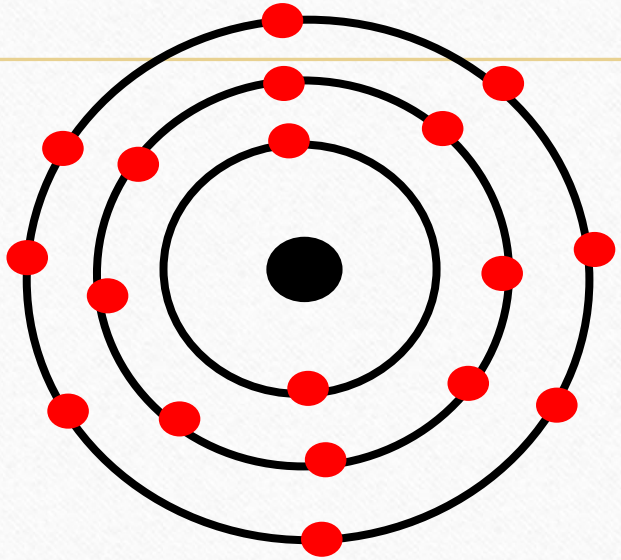


O^{2-}: oxide ion
Obeying octet rule

Formation of anion: Octet Rule follows by elements to get stable configuration



+e



Cl: seven VE

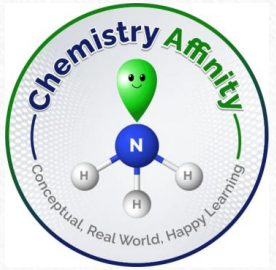
Cl can accept one electrons to get Ar configuration

Cl^-: Chloride ion
Obeying octet rule

Key point

Elements follows "Octet Rule" to make different compounds ionic or covalent compounds

Lewis Dot Structure

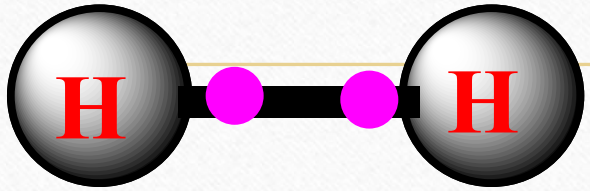


Lewis Structure

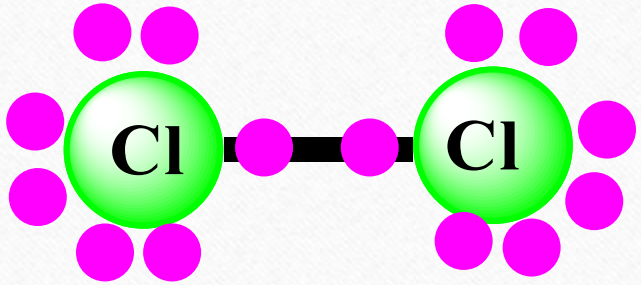
In Lewis dot structure, the electrons in the valence shell of an atom or ions are represented by dots around the symbol of the element. Each dot represent one electron

Hydrogen	$1s^1$	$H\cdot$
Oxygen	$1s^2\,2s^2\,2p^4$	$\cdot\ddot{O}\cdot$
Chlorine	$1s^2\,2s^2\,2p^6\,3s^2\,3p^5$	$:\ddot{C}l\cdot$
Chloride ion	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6$	$:\ddot{C}l:$

Shape of the Molecules: Predicted by Lewis dot Structure



Molecular shape: Linear

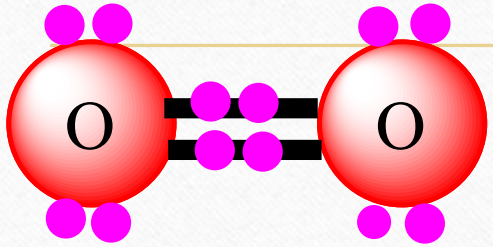


Molecular shape: Linear

Each hydrogen atom is sharing one electron to make a bond. These electrons are called bonding electrons. We can say one electron pair molecule

Each chlorine atom is sharing one electron to make a bond. These electrons are bonding electrons. Each Cl atom has three lone pairs which are not taking part in Cl-Cl bond. This molecule has two bonding electrons and total six lone pairs. This molecules also can be said one electron pair molecule

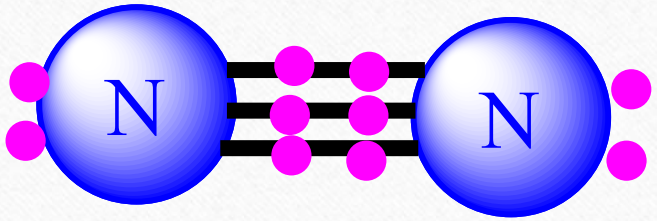
Lewis dot Structure



Molecular shape: Linear

Each oxygen atom is sharing two electrons to make a double bond. These electrons are bonding electrons

Each oxygen atom has two lone pairs which are not participating in chemical bonds of O_2 molecule



Molecular shape: Linear

Each nitrogen atom is sharing three electrons to make a triple bond. These electrons are bonding electrons

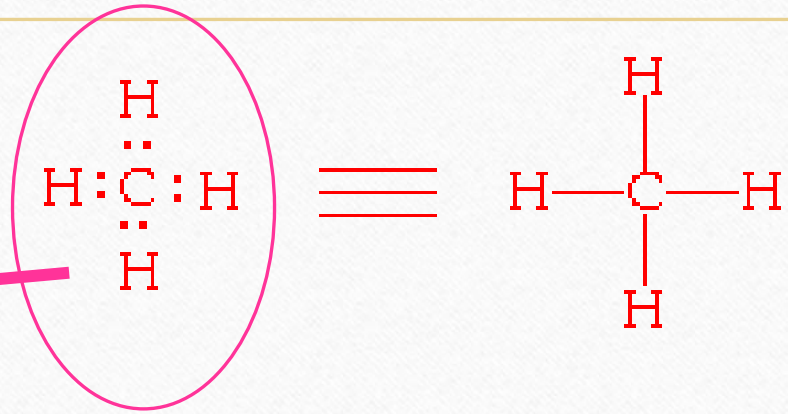
Each nitrogen atom has one lone pair which are not participating in chemical bonds of N_2 molecule

https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch8/vsepr.html

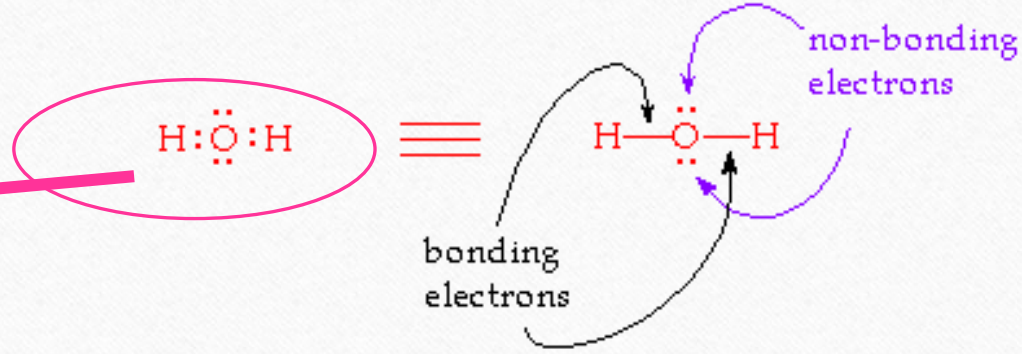
Lewis Dot Structure: Covalent Bond

A covalent bond is a chemical bond formed by the sharing of a pair of electrons between two atoms

Lewis Structure

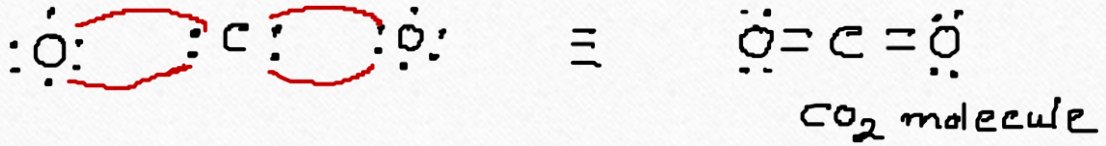


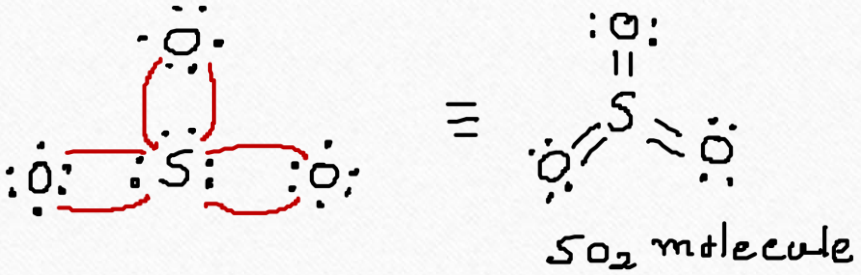
Lewis Structure



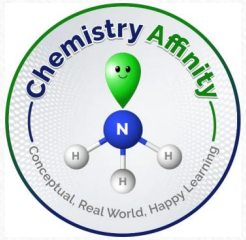
How to draw Lewis Dot structure of CO_2, and SO_2

Determine the numbe$_r$ of electrons to be used to connect the atoms. This is done by simply adding up the number of valence electrons of the atoms in the molecule

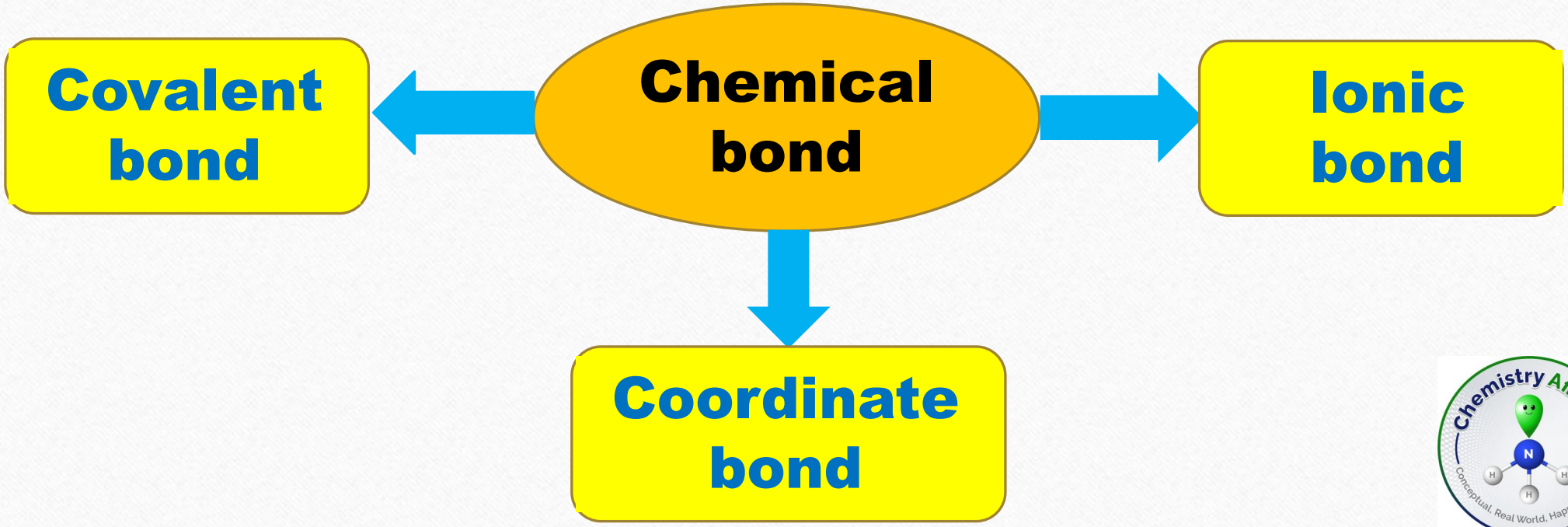




Chemical Bonds: Friendship between atoms/molecules



A chemical bond is attraction between atoms, ions or molecules that enables the formation of chemical compounds



Ionic bond → **The bond may result from the electrostatic force of attraction between oppositely charged ions as in ionic bonds**

Covalent bond → **Chemical bond can form through the sharing of electrons as in covalent bonds**

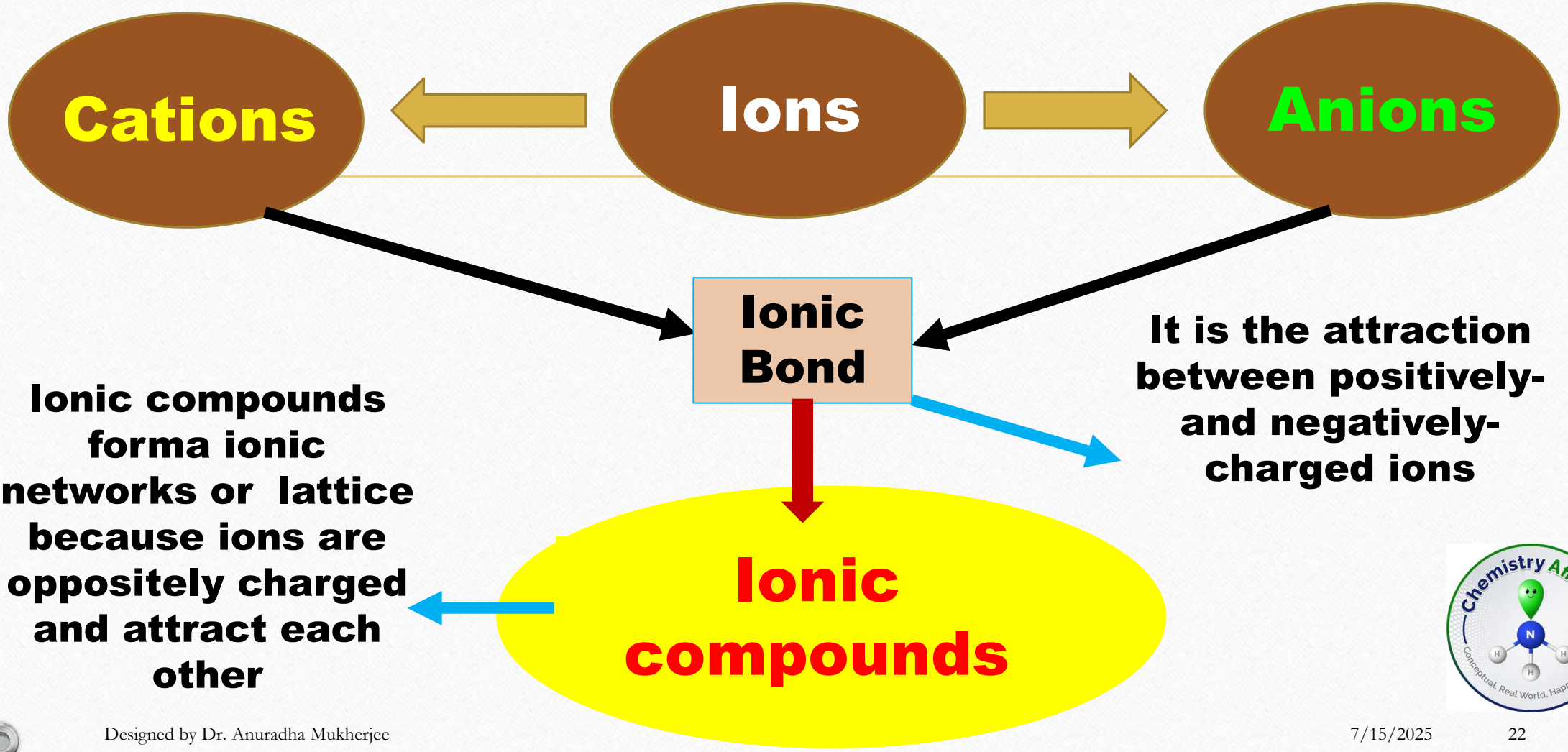
Coordinate bond,/dative covalent bond → **A coordinate bond is also a covalent bond, where a pair of electrons come from the same atom**

Formation of Ionic Bonds

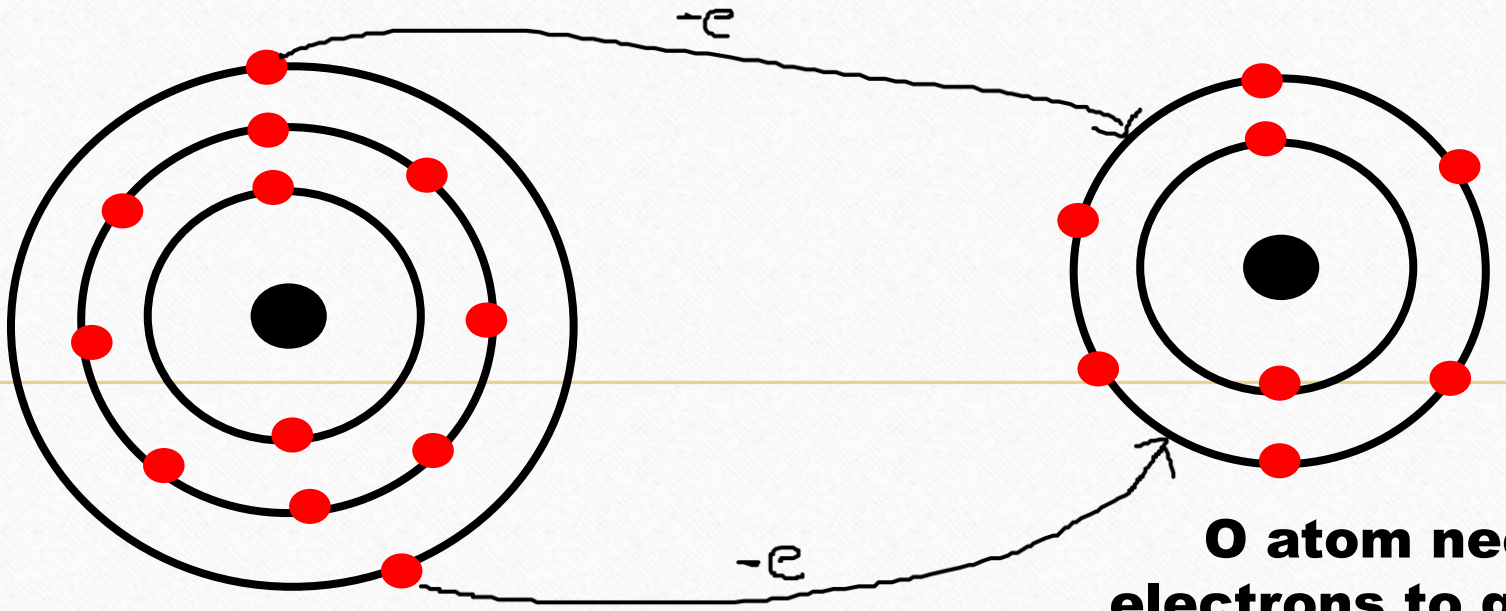
Ionic compounds form by ionic bonds

Ionic bonds are electrostatic interaction between cation and anion

Ionic Bond

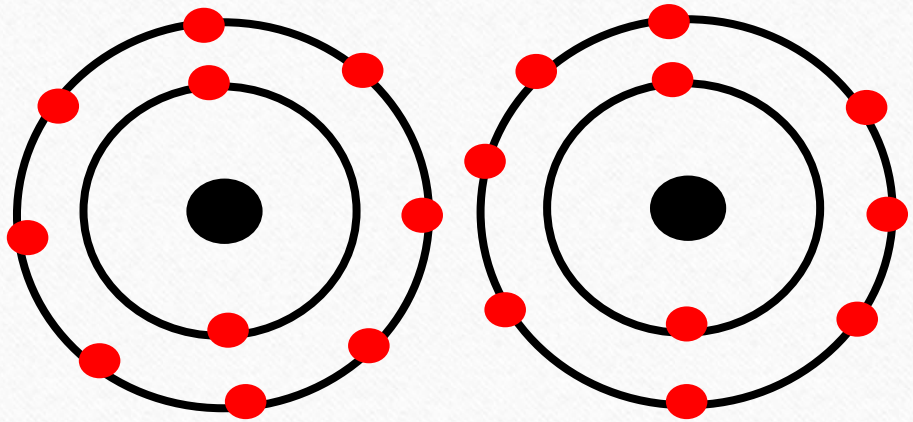

Cations
Ions
Anions
Ionic Bond
It is the attraction between positively- and negatively-charged ions
Ionic compounds forma ionic networks or lattice because ions are oppositely charged and attract each other
Ionic compounds

Formation of magnesium oxide



Mg atom: 2 VE

O atom needs 2 electrons to get noble gas configuration

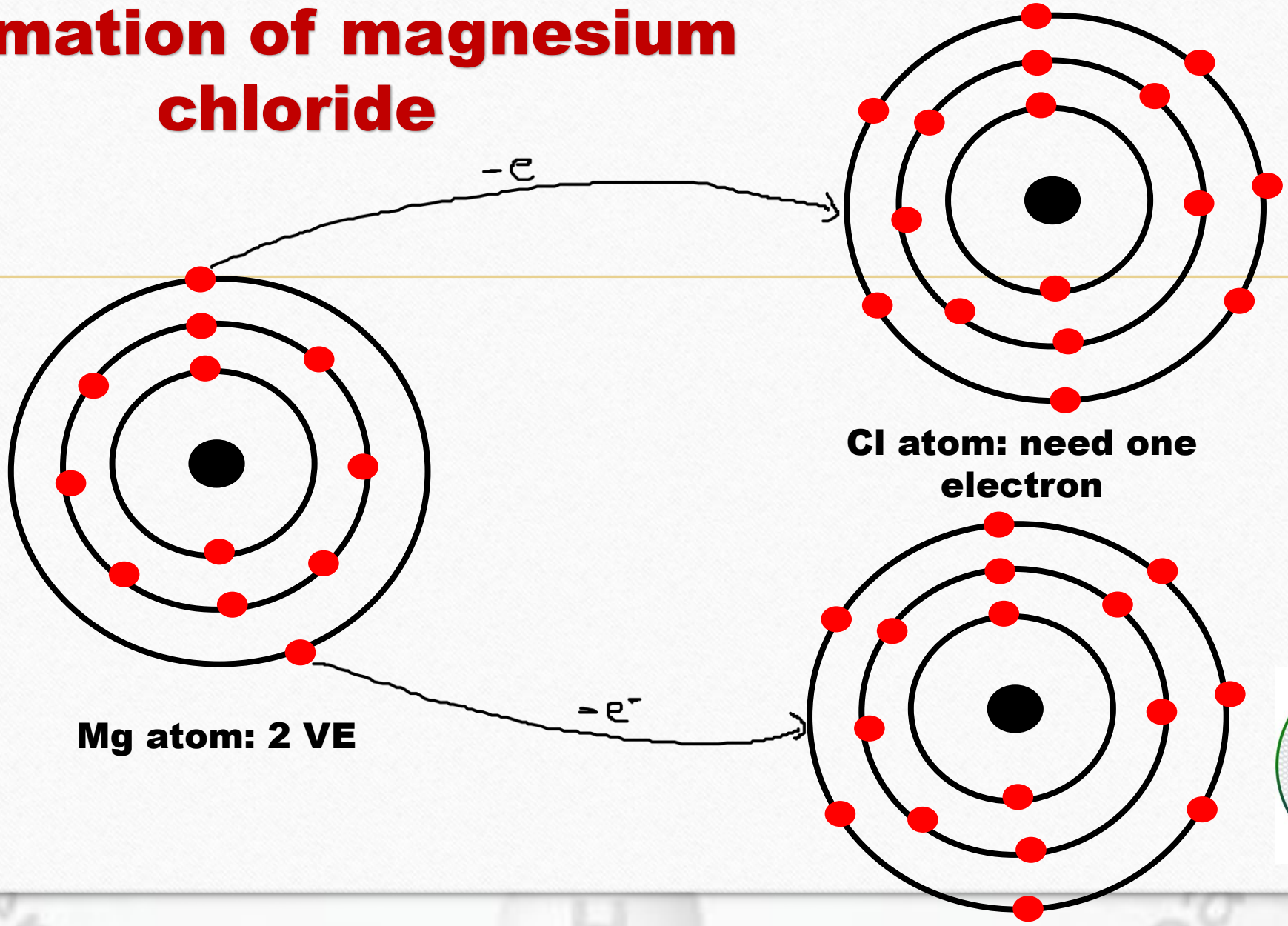


Mg^{2+}

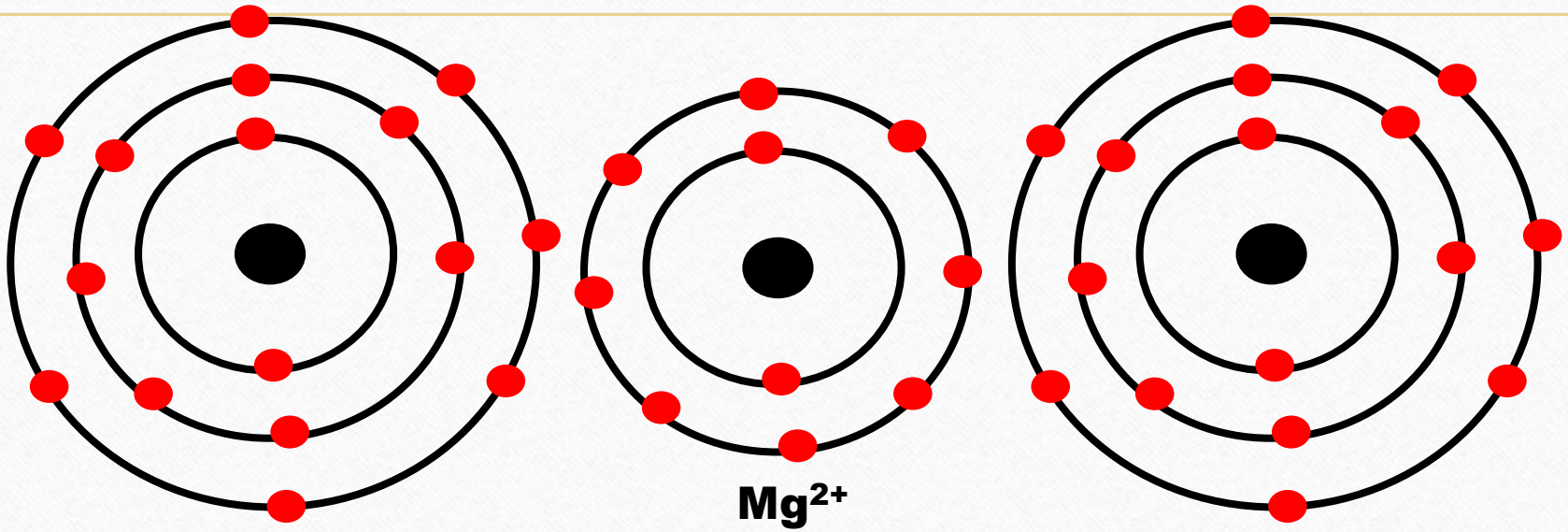
O^{2-}

MgO
Magnesium Oxide

Formation of magnesium chloride



Formation of magnesium chloride



$MgCl_2$

Formation of Covalent Bonds

Covalent compounds form by covalent bonds

Covalent bonds are formed by the sharing of electrons

Covalent bond

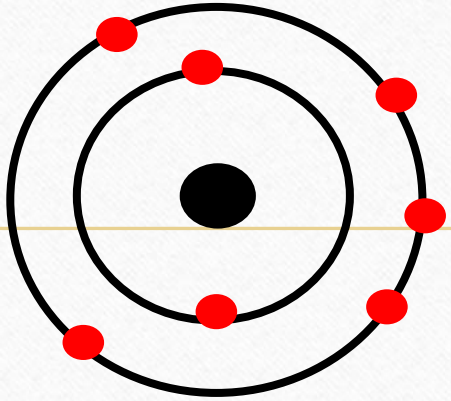
- Covalent bonds form between two nonmetal atoms with identical or relatively close electronegativity values

- This type of bond may also be found in other chemical species, such as radicals and macromolecules

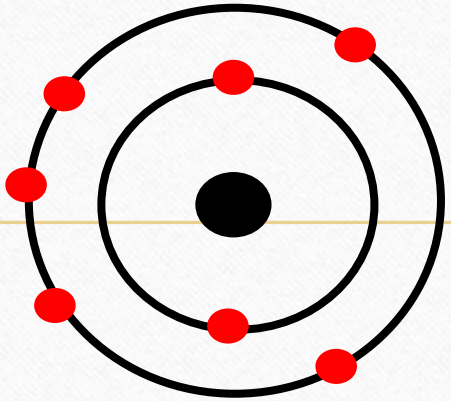
- The electron pairs that participate in a covalent bond are called bonding electrons

- Bonding electrons allow each atom to achieve a stable outer electron shell

Formation of N_2 molecule: Follows octet rule



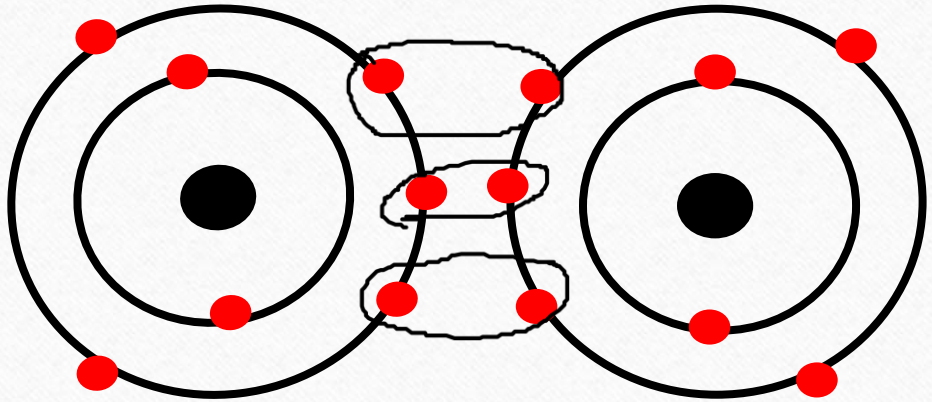
N atom



N atom

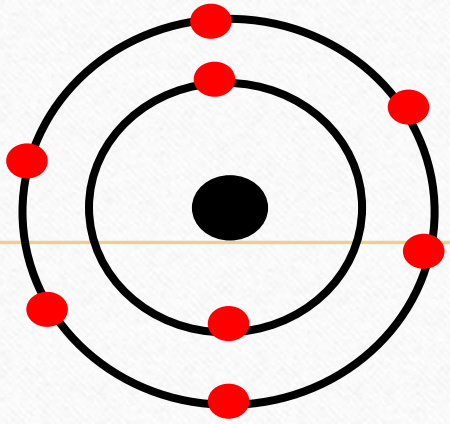
N≡N

N_2 molecule

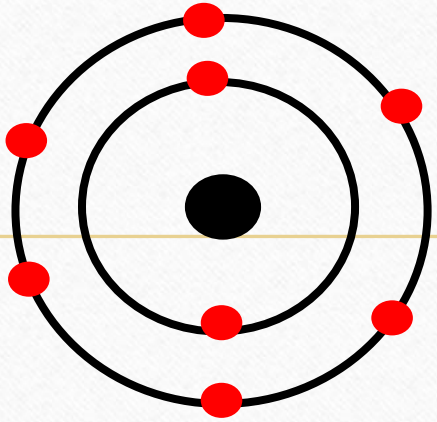


N_2 molecule

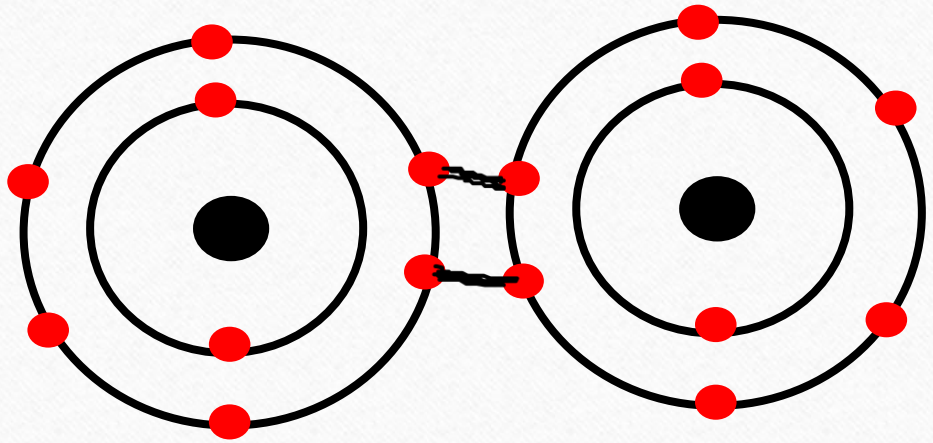
Formation of O_2 molecule



O atom



O atom

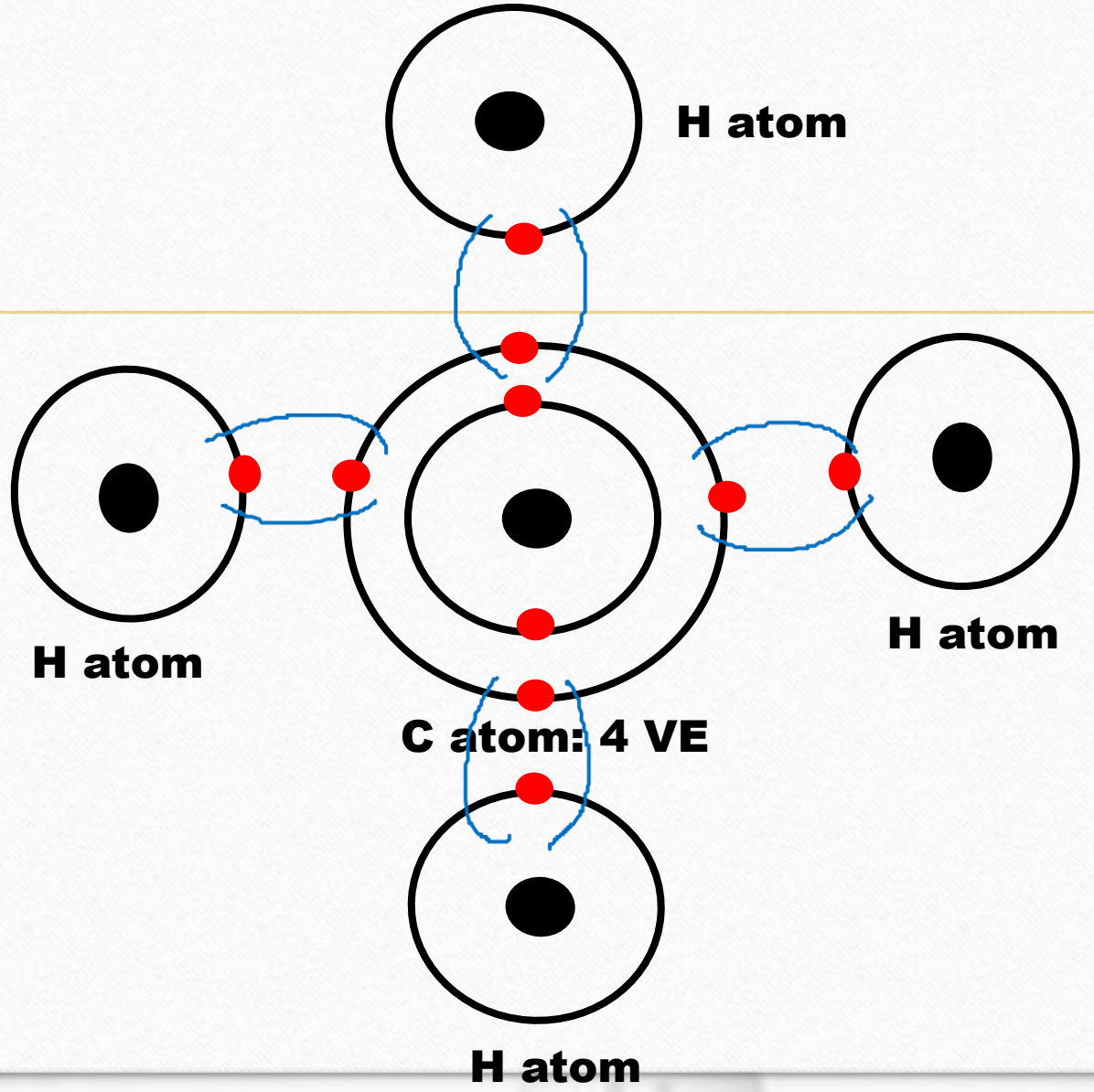


O_2 Molecule

≡ O = O

O_2 molecule

Formation of methane: Follows octet rule



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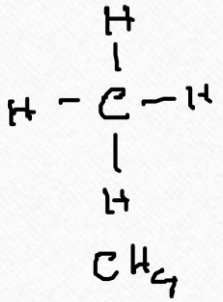
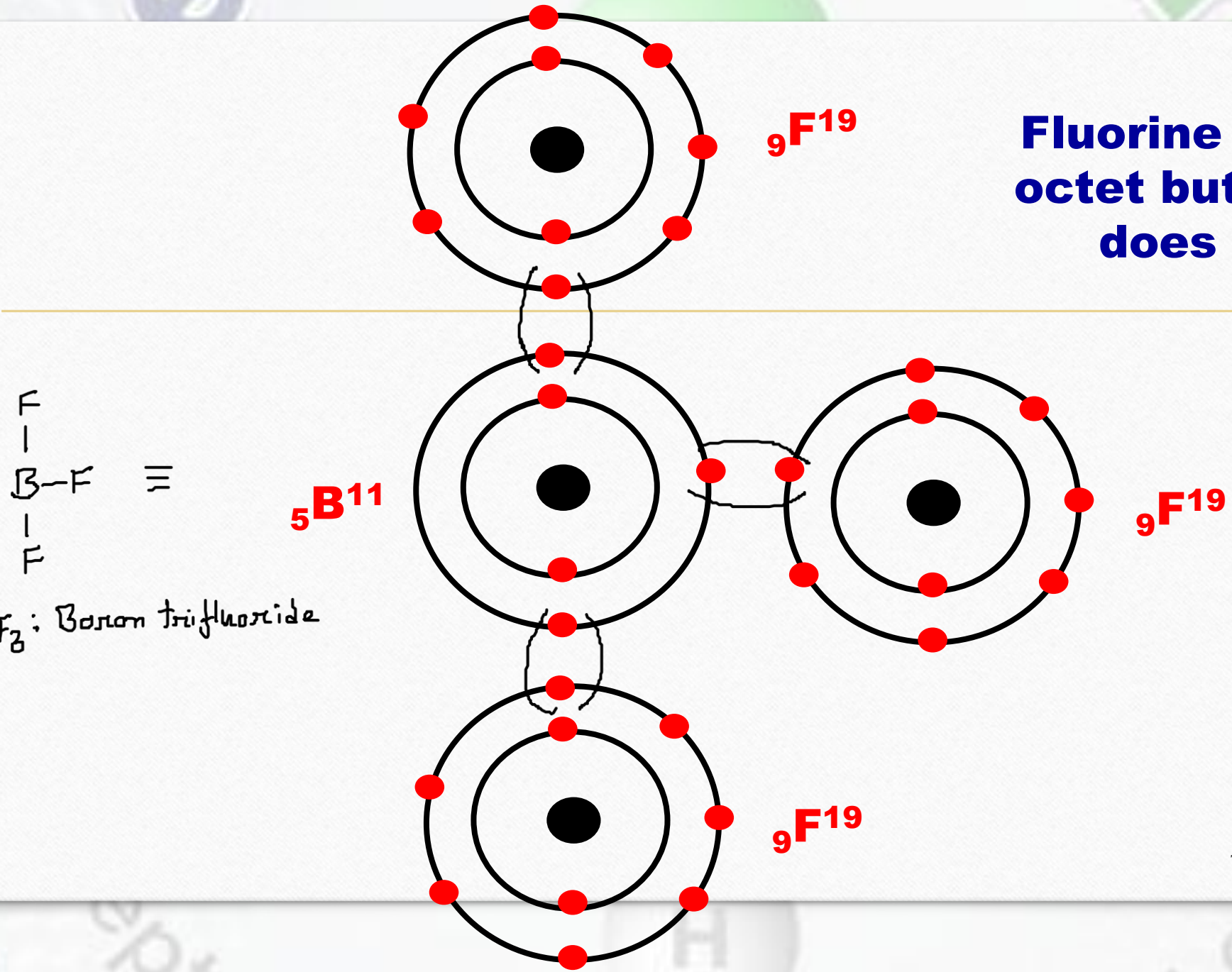


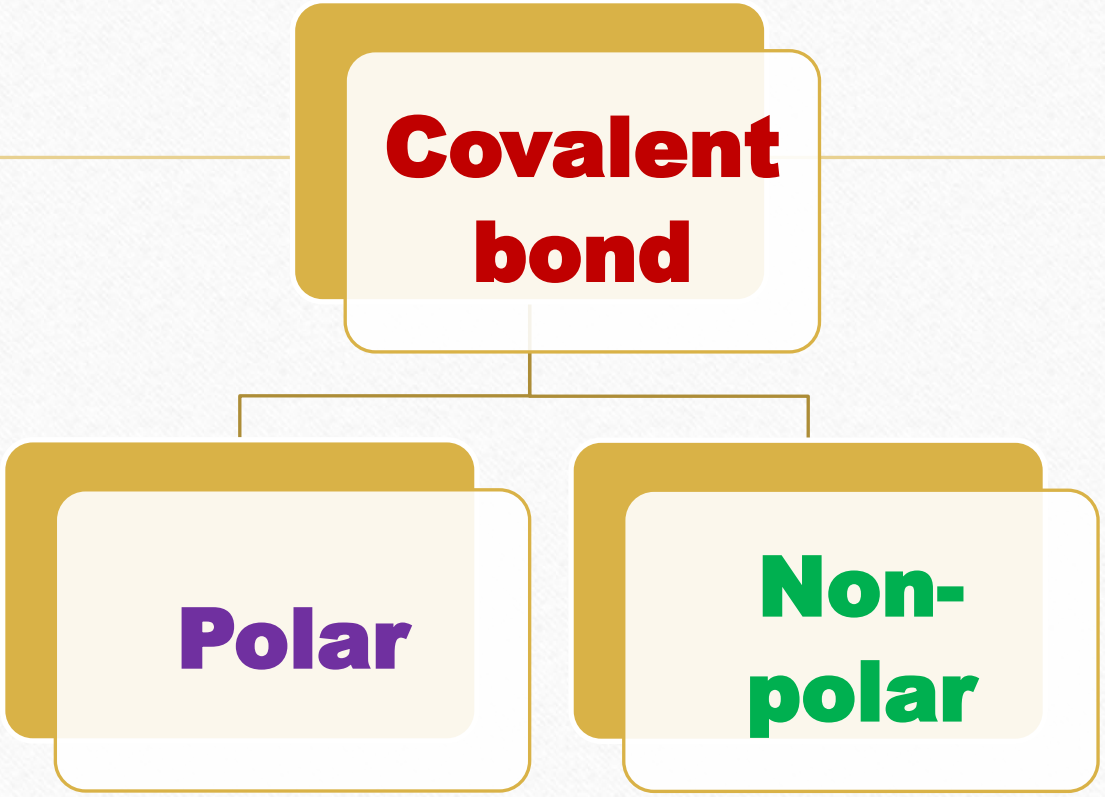
CH_4

Fluorine fulfills octet but boron does not

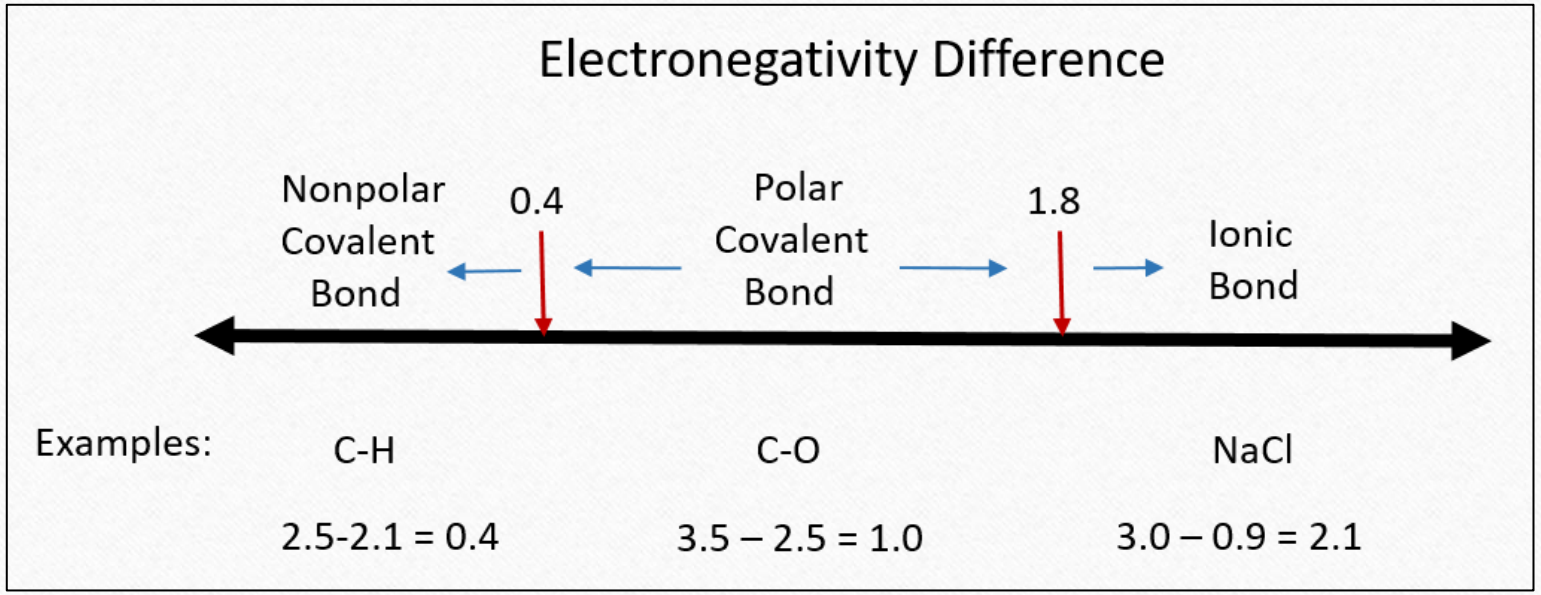


BF_3 : Boron trifluoride

Polar and Nonpolar Covalent bond



Electronegativity difference between atoms decide compounds will be polar or non-polar covalent compounds or ionic compounds



Nonpolar Covalent bond

Only identical atoms having the same electronegativity. They engage in equal sharing

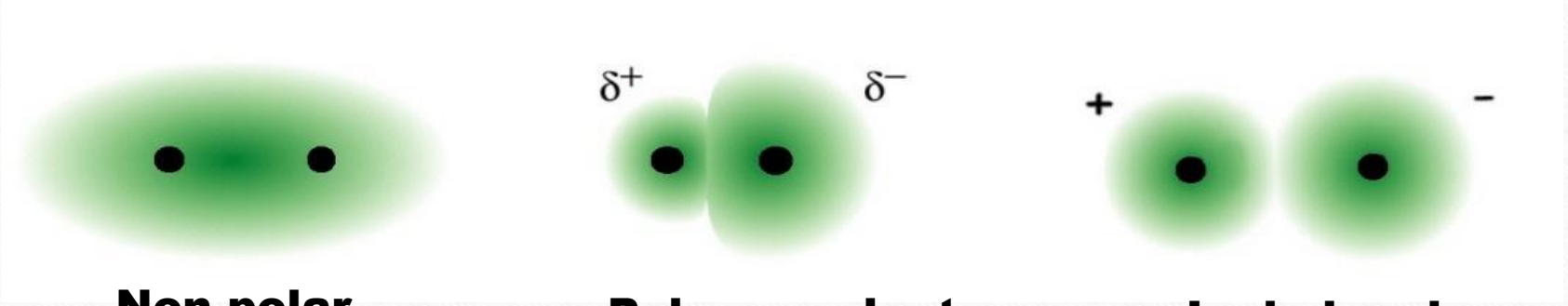
The electronegativity difference between two atoms are less than 0.4

Polar Covalent bond

As the electronegativity difference increases, the electron pair in a bond is more closely associated with one nucleus than the other

When electronegativity difference between two atoms are in the range of 0.5 to 1.7, the bond is polar

Arrangement of electrons cloud: Types of Bonds



Non-polar covalent bond

Polar covalent bond

Ionic bond

Coordinate Bonds

Covalent compounds form by coordinate bonds too

Coordinate bonds also a type of covalent bonds

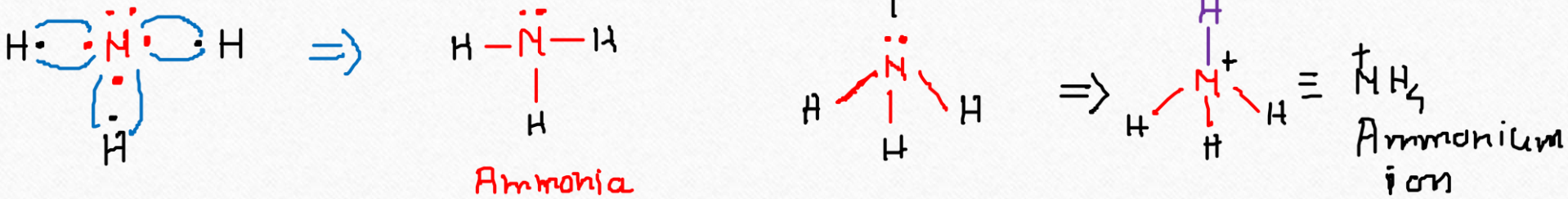
Coordinate Bond/ Dative Covalent Bond

We know a covalent bond is formed by two atoms share a pair of electrons and the atoms are held together because the electron pair is attracted by both of the nuclei

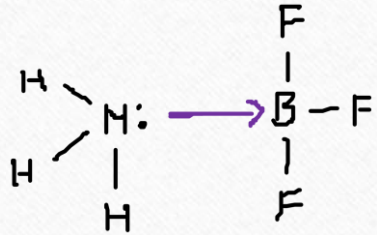
In the formation of a simple covalent bond, each atom supplies one electron to the bond - but this is not the case for covalent bond

Coordinate bond is a type of covalent bond in which both electrons come from the same atom

Coordinate Bond/ Dative Covalent Bond:



Reaction between ammonia and BF_3 molecule



Follow all detail notes to strengthen the concept on chemical bonding