Electromagnetic Radiation

Wavelength

distance between two consecutive wave peak.

frequency

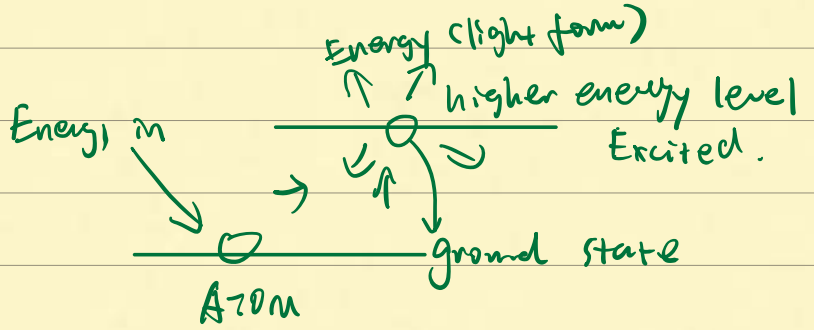
how many wave peak passed in the unit

Energy by atoms

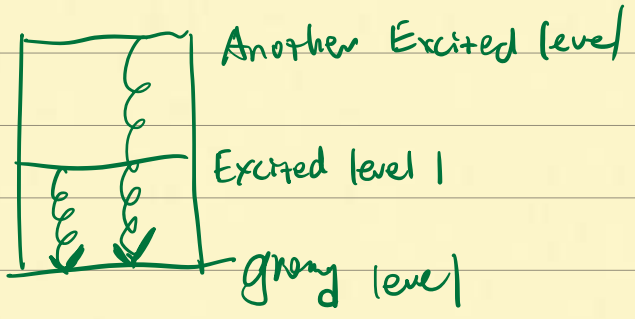
When atom get energy, they become excited and then emit energy by form of light

↑ Energy ↓ shorter wavelength

Red have shorter λ than blue → blue have more energy

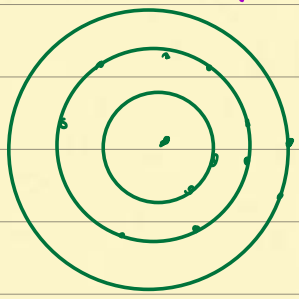


Quantized energy level



Also called discrete energy but not continously

Bohr Model



Only Apply in H_2.

Wave mechanical

Combine character of both wave and particle.

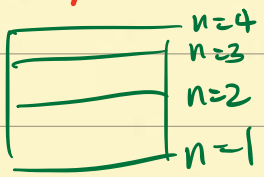
electron move in certain orbital but not in circular orbits

Character of Light:

we can never know the electrons motion, but just follow probability map as above.

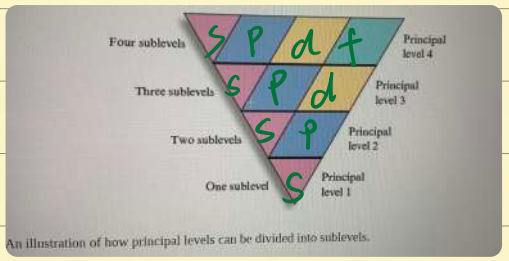
~~differen~~ Energy state → different orbital → diff shape

Energy level



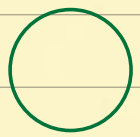
In each of the level, they have sublevel

And sublevel have orbit



An illustration of how principal levels can be divided into sublevels.

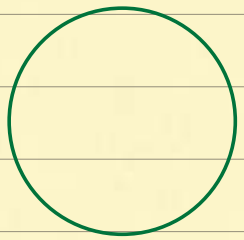
s	1
p	3
d	5
f	7



1s

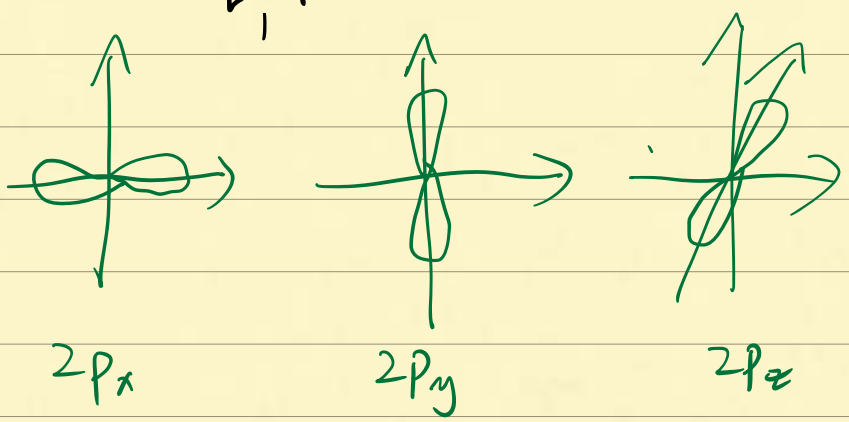
Energy Level 1

Shape



2s

bigger but same size



$2p_x$ $2p_y$ $2p_z$

As level Num increases, the averge distance in that orbital from nucleus also increased.

electron Spin

↑ : describe how spin in one direction

↓ : how spin in opposite direction.

Two electron MUST have opposite spin to occupied the same orbits.

Pauli exclusive principle: An atomic orbital can hold a maxium of two electrons, and those two electron must have oppoite spin.

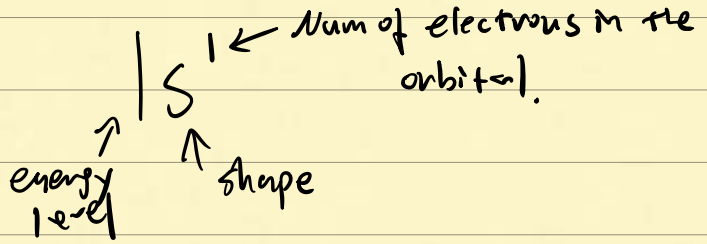
Electron Arrangment

- For the first 18 elements, the indivitual sublevels fills the following order: 1s, then 2s, then 2p, then 3s, then 3p
- The most attractive orbital is alway 1s
- As n get larger, the orbit size get larger.

eg. H: $1s^1$ ← electron configuration.

1s

↑ ← box diagram / orbital diagram.

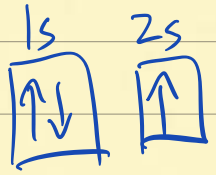


eg. helium. $1s^2$

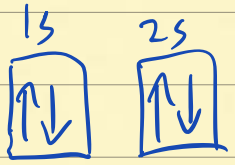
1s

↑↓

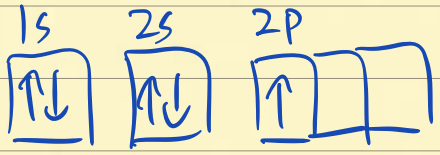
eg. Li: $1s^2 2s^2$



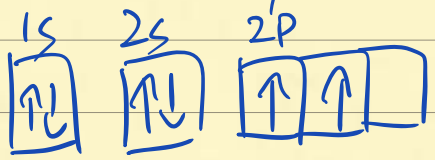
eg. Be: $1s^2 2s^2$



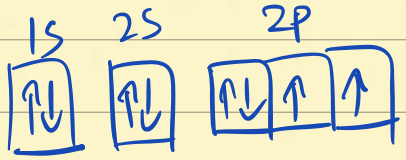
eg. B $1s^2 2s^2 2p^1$



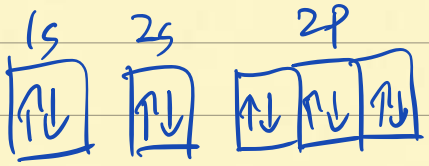
eg. C $1s^2 2s^2 2p^1 2p^1$ / $1s^1 2s^2 2p^2$



eg. O $1s^2 2s^2 2p^4$



eg. Ne $1s^2 2s^2 2p^6$



eg. Sodium. $1s^2 2s^2 2p^6 3s^1$

Valence electrons

The electron in the outer most principle energy level of an atom

eg. $1s^2 2s^2 2p^3$ Valence: electron in 2s and 2p

$1s^2 2s^2 2p^6 3s^1$ Valence: electron in 3s

- Evolved in chemical Reaction.

Configuration VS Table

energy level 4 begin to fill before level 3 has been completed. Ar, K, Ca

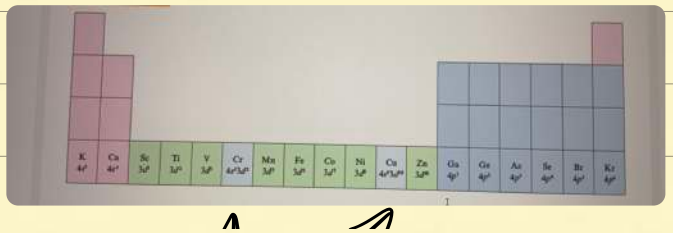
eg. K: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ or $[Ar]\ 4s^1$

↑

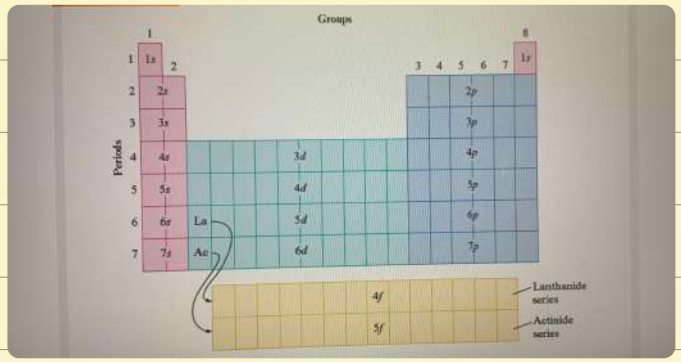
Not $3d^1$

And Ca : $[Ar]\ 4s^2$

After Ca, turn to fill 3d, they are called transitional Metal



Reason is complex



Summary: ① The (n+1)s orbits always fill before the nd orbits.

② Lanthanide Series: After lanthanum. A group of 14 elements, The series of elements corresponds to the filling of the seven 4f onbitals.

③ Actinide Series: After actinium, the 14 elements filling seven 5f onbitals.

④ Except helium, the group member indicate the sum of electrons in the ns and np onbitals in the highest principal energy level. that contains electrons. which called valence electrons.

Atomic Properties

Meter: loss electron

Nonmeter: gain electron.

As go down the group, metal become more likely to lose electron.

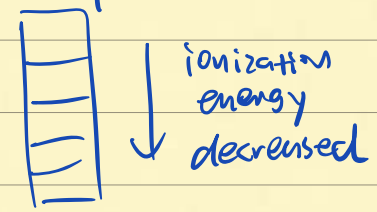
Ionization Energy

The energy required to remove an electron from an individual atom in the gas phase

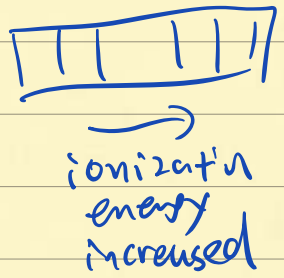
$$M_{(g)} \longrightarrow M^+ + e^-$$

↑ ionization energy

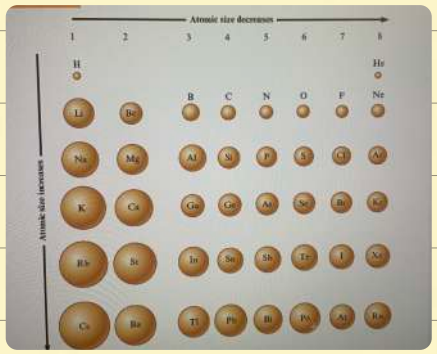
Group



Nonmetal have larger ionization energy than metal



Atomic Size.



decrease because stronger positive charge tend to attract electron and become smaller

↓ increase because more energy level

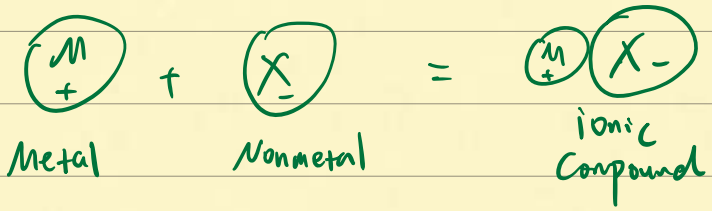
Chemical bounding

Type of chemical bond

bond: a force that holds groups of two or more atoms together and makes them function as an unit.

bond energy: The energy need to break the bond.

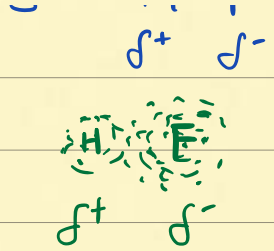
ionic bonding: atom which loss electron with atom gain electron.
/ metal + nonmetal



Covalent bonding: electrons are shared by nuclei.
/ two identical atom. eg. H–H

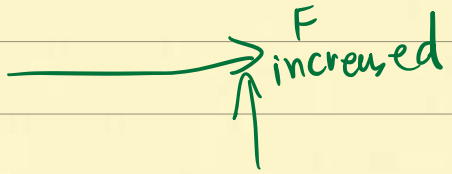
polared covalent bonding: unequal share electron.

eg. H–F

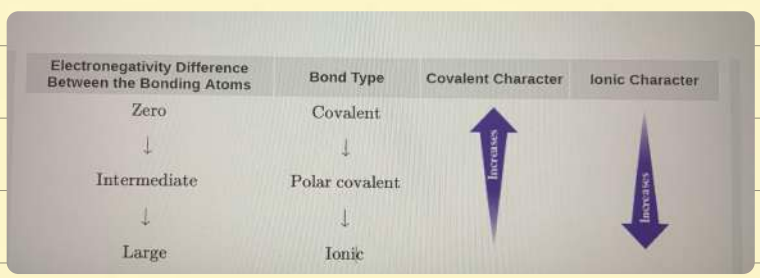


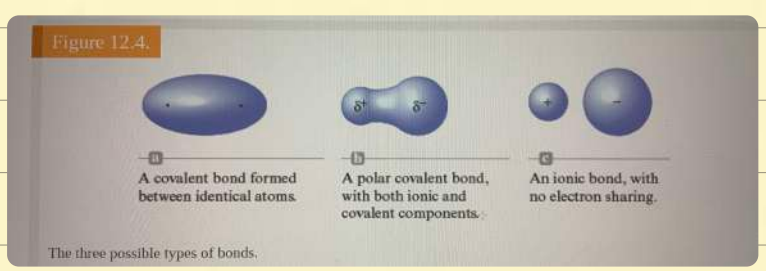
Electronegativity

The unequally shared electrons, the relative ability of an atom in a molecule to attract shared electrons to itself.



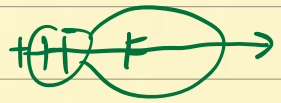
- Polarity of a bond depends on the difference between the electronegativities.





Bond polarity and Dipole Moment

Dipole moment: A molecule that has a center of positive charge and a center of negative charge.

Represent by arrow: 

Arrow to negative charge

Stable electron configuration and charges on ions.

Almost all stable chemical compounds of the representative element have achieved a noble gas electron configuration.

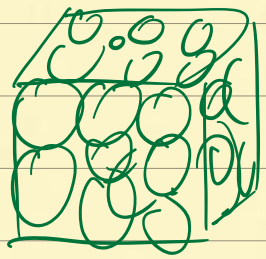
prediction formulas of ionic compounds.

eg. Ca $[Ar]4s^2$

O $[He]2s^22p^4$

Structure

- Cation are smaller, Anion are bigger.

 ← Structure !!

polyatomic ions

More than three atoms

Contain both ionic bond and colvalent bond.

eg. Ammonium Nitrate have NH_4^+ and NO_3^- ions

And for each NH_4^+ and NO_3^-

they're connect by covalent bond.

Lewis Structure

show how the valence electron are arrangied among atoms

eg. KBr where K^+ and Br^-

K^+ noble gas config [Ar]

$[:\ddot{Br}:]^-$ Config [Kr]

Ionic situation

No dot on K because it loss its only valence electron.
dot on Br because it fill its shell

eg. When it is covalent bond.

① duet rule: share two electron.
eg. H:H

② For not form bond.
eg. He:

③ octet rule.
eg. :F· → :F:F: ← ·F:

bonding pair : electron that shared between atoms

lone pairs / unshared pair

Steps:

① obtain the sum of the valence electrons

② use one pair of electron to form a bond (line)

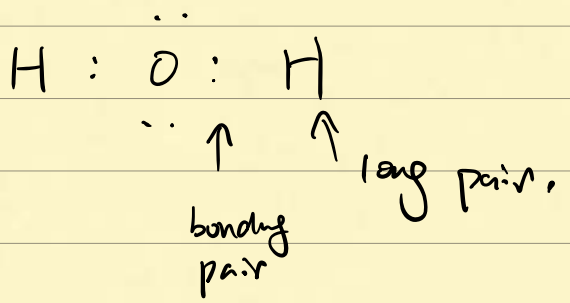
③ arrange the remaining electrons to satisfied the duet rules and octet for each second-row element

eg. Lewis Structure for water molecule.

① Sum of valence = 1+1+6 = 8

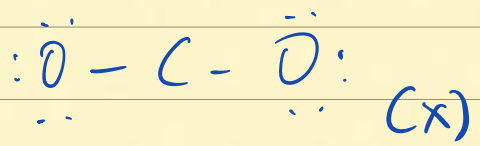
② pair $H - O - H$

③ Arrage remained electron



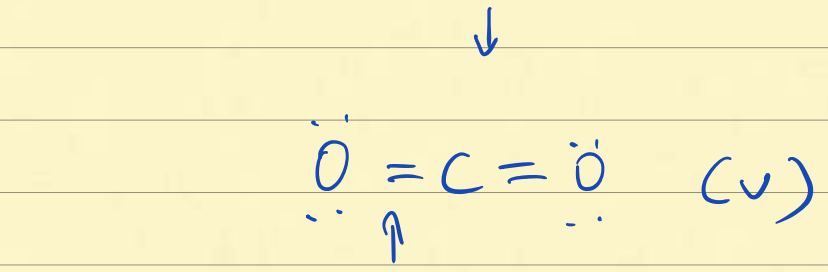
Lewis structure for multi bond

eg. CO_2

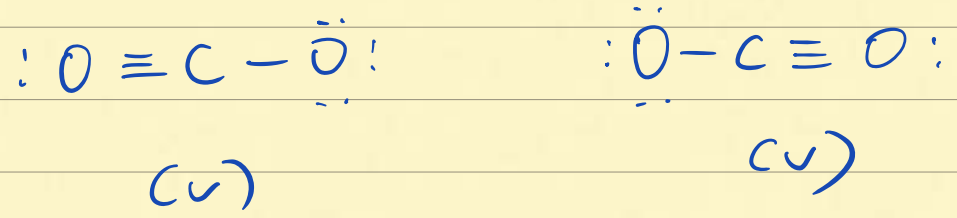


(X)

incorrect because C doesn't satisfied octete rule



or

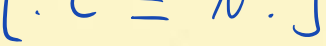


Resonance Structure: A molecule show this attribute when more than one Lewis Structure can be drawn.

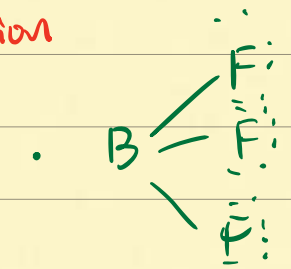
Lewis for ions

eg. CN^-

- Sum of valence = $4+5+1=10$



Exception



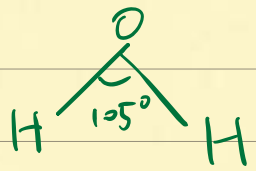
B doesn't follow octave rule

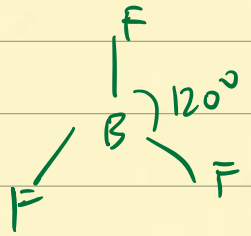
- Cannot draw odd number of electrons
- Cannot fully explain O_2

Molecular Structure

3D arrange of Lewis structure.

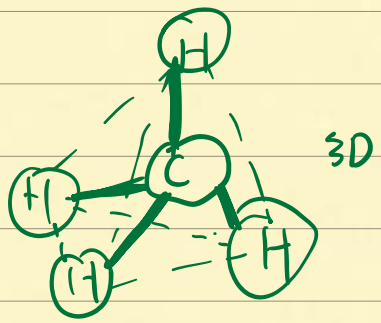
bond angle:





trigonal planar Structure

linear Structure:

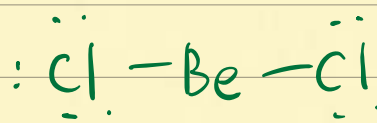


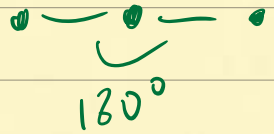
Tetrahedral Structure / tetrahedron

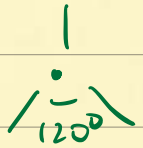
The VSEPR Model

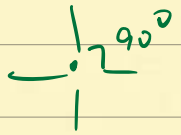
valence shell electron pair repulsion model

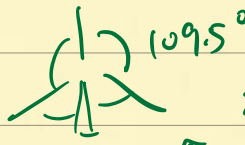
Main Idea: the structure around a given atom is determined by minimizing repulsion between electron pairs







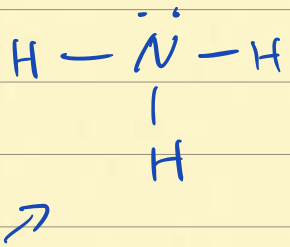




3D model

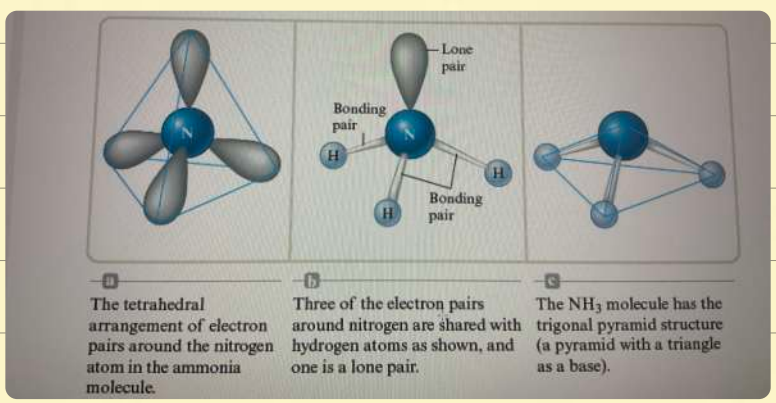
(tetrahedral)

eg. NH_3

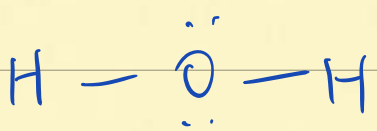


$5+3=8$

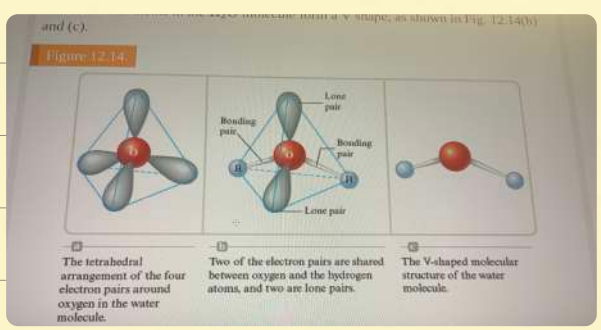
Tetrahedral pyramid

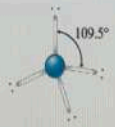
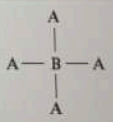


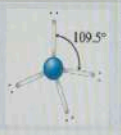
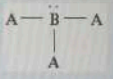
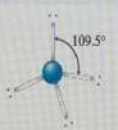
eg. H_2O



use tetrahedral arrangement



Number of Electron Pairs	Bonds	Electron Pair Arrangement	Ball-and-Stick Model	Molecular Structure	Partial Lewis Structure	Example Ball-and-Stick Model
2	2	Linear		Linear	A—B—A	
3	3	Trigonal planar (triangular)		Trigonal planar (triangular)		
4	4	Tetrahedral		Tetrahedral		

Number of Electron Pairs	Bonds	Electron Pair Arrangement	Ball-and-Stick Model	Molecular Structure	Partial Lewis Structure	Example Ball-and-Stick Model
4	3	Tetrahedral		Trigonal pyramid		
4	2	Tetrahedral		Bent or V-shaped		

Molecule with double bond

Same as single bond (VSEPR model)