

# Periodic Table & Periodic Properties

→ The arrangement of all the known elements according to their properties in such a way that elements of similar properties are grouped together in a tabular form is called periodic table.

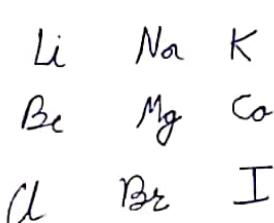
## Development of periodic table:-

1. Lavoisier - classification of elements
2. Döbereiner's - Triad rule
3. Newlands - Rule of octave
4. Lothar - Meyer curve
5. Mendeleev's - Periodic table
6. Moseley's - Experiment off and modern periodic table.

1. Lavoisier Classification - firstly he classified elements into 2 categories



2. Döbereiner's Triad rule - He made the group of 3 elements having similar chemical properties called ~~triple~~ triad.  
→ In Döbereiner's triad, atomic mass of central element is nearly equal to average atomic mass of 1<sup>st</sup> & 3<sup>rd</sup> element



Li	Na	Mg
7	23	39
$\frac{7+39}{2} = \frac{46}{2} = 23$	= Na	

K Rb Cs

S Se Te

Cl	Br	I
35.5	<del>81.25</del>	127
	81.25	

$$\begin{array}{c} \text{Ca Sr Ra} \\ \boxed{\text{F Cl Br}} \rightarrow \text{not following} \end{array}$$

$$\frac{127 + 35.5}{2} = \frac{162.5}{2} = 81.75 \approx \text{Br}$$

F	Cl	Br
19	35.5	<del>81.25</del> 80

$$\frac{80 + 19}{2} = 49.5 \neq \text{Cl}$$

Q1. Multi Correct

If three element  $X^{20} Y^{42} Z^{20}$   
 follow Dobereiner's triad. find atomic mass of Z

- A) 64      B) 38      C) 31      D) 29

3. Newland's law of octave - He arranged elements in order of increasing atomic mass and found that every eighth element showing similar properties to the 1st element like musical notes.

1	2	3	4	5	6	7	8
Sa	Be	Ca	Ma	Pa	Dha	Ni	
Sa							

Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	cl
<del>K</del>	Ca	(Xc)				

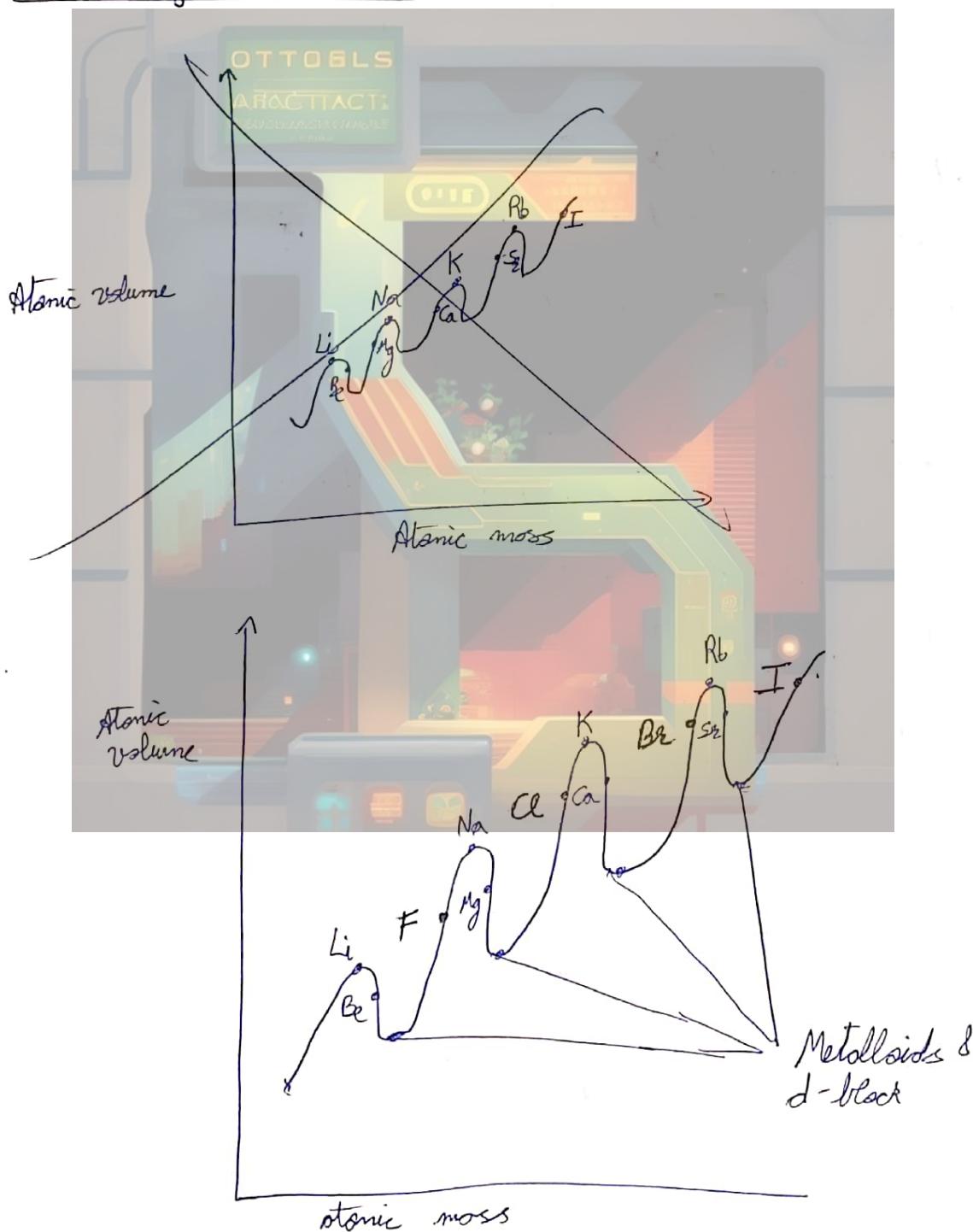
\* \* \* Noble gases were not discovered yet

merit:- He classified the known elements in tabular form.

demerit:- This rule is valid only upto calcium because after calcium due to filling of (d) electrons their orbitals is a difference of  $18^{\text{th}}$  element instead of  $8^{\text{th}}$  element.

- discovery of noble gases failed the ~~rule~~ rule.

#### 4. Lanthanide Moyer's curve -



Observation of curve - The following points can be observed

- similar properties of elements occupied similar portion of the curve.
- Alkali metals (Li, Na, K, Rb, Cs, ~~Fr~~) occupied peak portions of the curve.
- Alkaline earth metals (Be, Mg, Ca, Sr) occupied the descending portion of the curve.
- Halogens (F, Cl, Br, I) occupied ascending portion of the curve.
- Metals & transition elements occupied lower portions of the curve

Drawbacks → It is highly complex when further ~~rare~~ metals elements are plotted on the curve.

5. Mendeleev's Periodic Table :- Mendeleev's Periodic Table is based on Mendeleev's periodic law, which states that physical and chemical properties of elements are periodic function of their atomic mass.



1	Zero Group
2	He
3	Ne
4	Ar
5	Kr
6	Xe
7	Rn

1. Around 63 elements were arranged in order of increasing atomic weight into 7 horizontal rows (called periods)

and 8 vertical columns (called groups).

2. Each group except 8<sup>th</sup> group was further divided into 2 sub-

groups

3. Subgroup IA contains main elements while subgroup B contains transition elements.

4. At that time noble gases were not discovered and when they were discovered an extra column called zero group was added.

5. The elements of some group have similar properties.

~~Merits~~ - 1. Old known all known elements were arranged.  
Merits 2. He left spaces for undiscovered elements and the properties of these elements were accurately predicted.

Mendeleev's Name

Eka-Aluminium (Al)

Eka-Silicon (Si)

Eka-Boron (B)

Eka-Manganese ( $\mu$ n)

Modern Name

Calcium (Ca)

Germanium (Ge)

Scandium (Sc)

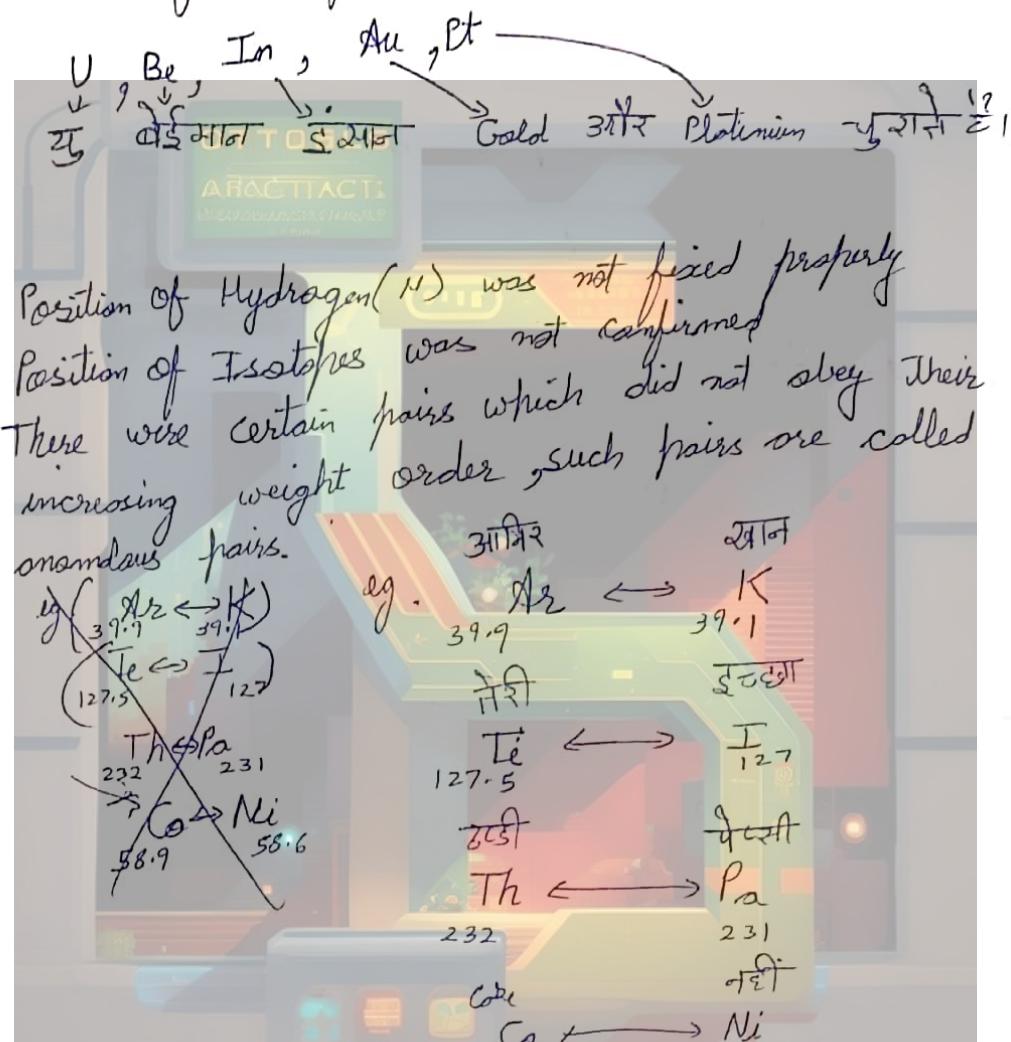
Technetium ( $\beta$ Tc)

Si - Ge      2-  
 शिला - ग्लास

He - Ge  
31 पर 31

B - Sc      Mn-Tc  
 B. Sc नहीं M. Tech वै

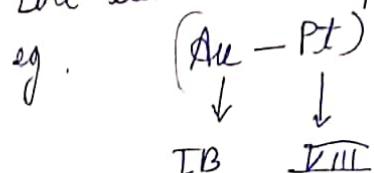
### 3. Correction of doubtful atomic weights



Demerits-

- Position of Hydrogen (H) was not fixed properly
- Position of Isotopes was not confirmed
- There were certain pairs which did not obey their increasing weight order, such pairs are called anomalous pairs.

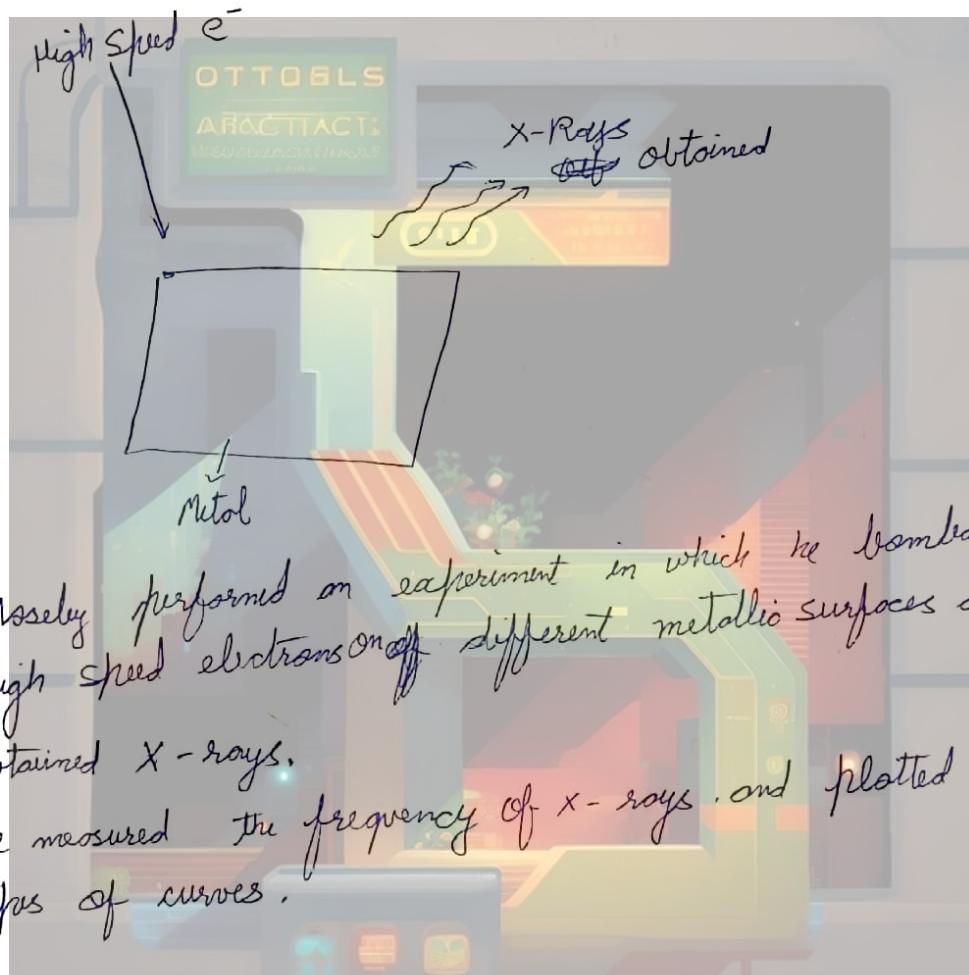
- Like elements were placed in different groups



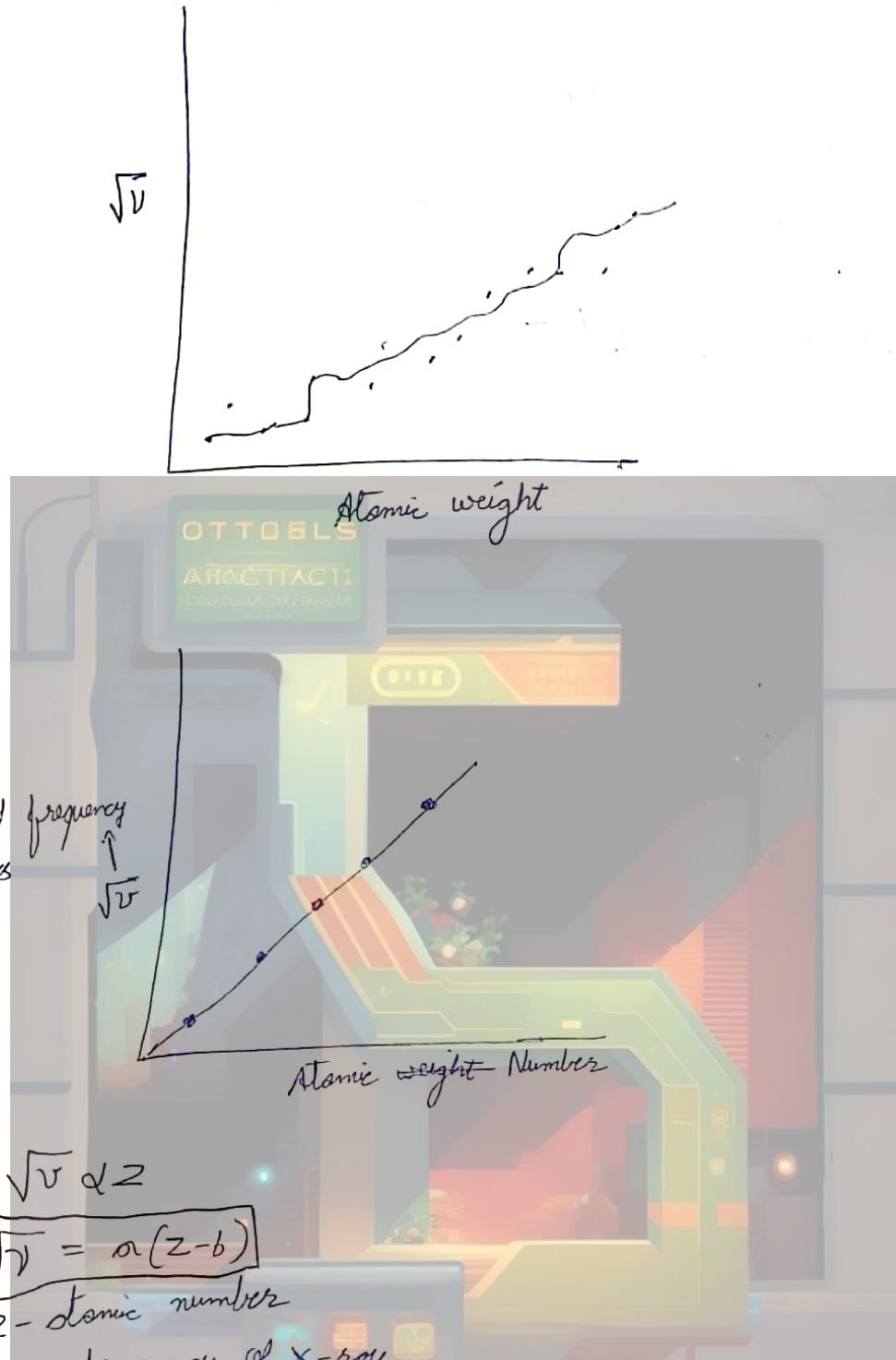
- Unlike elements were placed in same group.

g.	I-A	
Li		Highly reactive
Na		
K	IB	
Rb		Cu
Cs		Ag } coinage metals
		Ag } less reactive
		Au

## Moseley's Experiment -



- Moseley performed an experiment in which he bombarded high speed electrons on different metallic surfaces and obtained X-rays.
- He measured the frequency of X-rays and plotted various types of curves.



→ Moseley's experiment showed that the fundamental property of an element is not atomic mass but atomic number.

Q Identify the element for which Z-ray frequency is  
625 Hz. given ( $a=1$ ,  $b=2$ )

$$\sqrt{625} = 25$$

$$25 = \alpha(z-1)$$

$$25 = 1(z-1)$$

$$25 = z-1$$

$$\cancel{z=26}$$

$$z=27$$

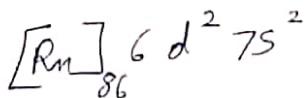
Cobalt (Co)

### Modern Periodic Table

- It is based on modern periodic law which states that the physical and chemical properties of elements are the periodic function of their atomic number.
- It consists of total 18 vertical columns called groups, and 7 horizontal rows called periods.

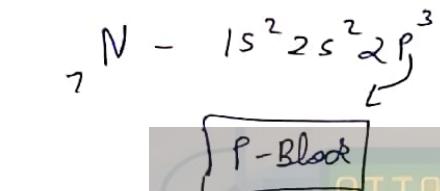
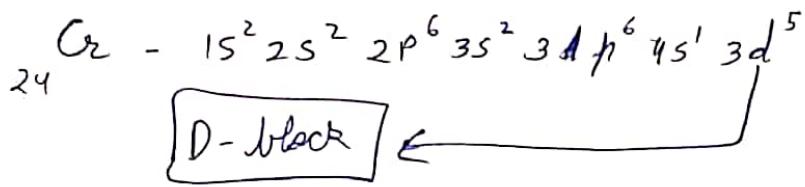
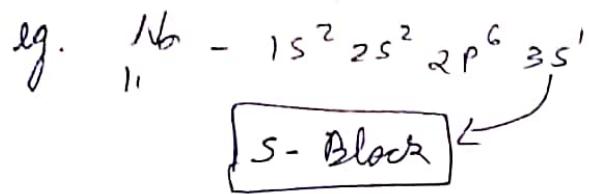
Deciding the block of an element -

- There are 4 blocks in a periodic table which are S, P, D & F.
- To decide the block we first write the electronic configuration of the element.
- The type of subshell in which last electron enters will give the information about block of that element. (Exception - Th (Thorium))



last electron enters in d subshell but Th is F block element

(67)



Group I (IA)  
Config.:  $ns^1$  (valence shell  $e^- = 1$ )

$1s^1$	H	Non-metal	सू
$2s^1$	Li		ली
$3s^1$	Na		ना
$4s^1$	K		की
$5s^1$	Rb		रब
$6s^1$	Cs		सी
$7s^1$	F <sub>2</sub>		फॉर्सियाद

Alkali metals  
(Highly reactive)

Group II (IIA)  
Config:  $ns^2$  (valence shell  $e^- = 2$ )

$2s^2$	Be	देटा
$3s^2$	Mg	मॉग्ने
$4s^2$	Ca	कॉर
$5s^2$	Sr	सैर्कुलर
$6s^2$	Ba	बॉय
$7s^2$	Rs	रासी

Alkaline earth metals

Note - Group I of Group II are s-block elements

Group 13 (III-A) (valence shell  $e^- = 3$ )

config -  $nP^1 nS^2 nP^1$

$2P^1 B$   
 $3P^1 Al$   
 $4P^1 Ga$   
 $5P^1 In$   
 $6P^1 Tl$   
 $7P^1$

$\rightarrow$  Boron family

बोरन फैमिली

बोरन  
आल  
गाल  
इन  
टीला

Group 14 (IV-A) (valence shell  $e^- = 4$ )

config -  $nS^2 nP^2$

$2P^2 C$   
 $3P^2 Si$   
 $4P^2 Ge$   
 $5P^2 Sn$   
 $6P^2 Pb$

- Carbon Family

कार्बन  
ग्रीष्म  
जीव  
सुख  
पारकी

Group 15 (V-A) (valence shell  $e^- = 5$ )

config -  $nS^2 nP^3$

$2P^3 N$   
 $3P^3 P$   
 $4P^3 As$   
 $5P^3 Sb$   
 $6P^3 Bi$

Nitrogen family (pnictogens)

Nepal  
Pakistan  
Australia  
Sol  
Bikhari

Group 16 (VI-A) (valence shell  $e^- = 6$ )

config -  $nS^2 nP^4$

$2P^4 O$   
 $3P^4 S$   
 $4P^4 Se$   
 $5P^4 Te$   
 $6P^4 Po$

Oxygen family (chalcogens)

old  
style  
पुरानी  
पुरानी

(69)

Group 17 (VIIIA) (valence shell  $e^- = 7$ )

config -  $ns^2 np^5$

$2P^5$	F	Halogen family	$\frac{F}{\text{F}}$
$3P^5$	Cl		$\frac{\text{Cl}}{\text{Cl}}$
$4P^5$	Br		$\frac{\text{Br}}{\text{Br}}$
$5P^5$	I		$\frac{\text{I}}{\text{I}}$
$6P^5$	At		$\frac{\text{At}}{\text{At}}$

Sulphur / Sulfur

Group - 18 (zero group) (valence shell  $e^- = 8$ )

config -  $ns^2 np^6$  (valence shell  $e^- = 8$ )

~~Group~~ 1s<sup>2</sup> He (s-block element)

$2P^6$  Ne  
 $3P^6$  Ar  
 $4P^6$  Kr  
 $5P^6$  Xe  
 $6P^6$  Rn

Noble gases  
(inert gases)  $\frac{\text{He}}{\text{He}}$

$\frac{\text{Ne}}{\text{Ne}}$   
 $\frac{\text{Ar}}{\text{Ar}}$   
 $\frac{\text{Kr}}{\text{Kr}}$   
 $\frac{\text{Xe}}{\text{Xe}}$   
 $\frac{\text{Rn}}{\text{Rn}}$

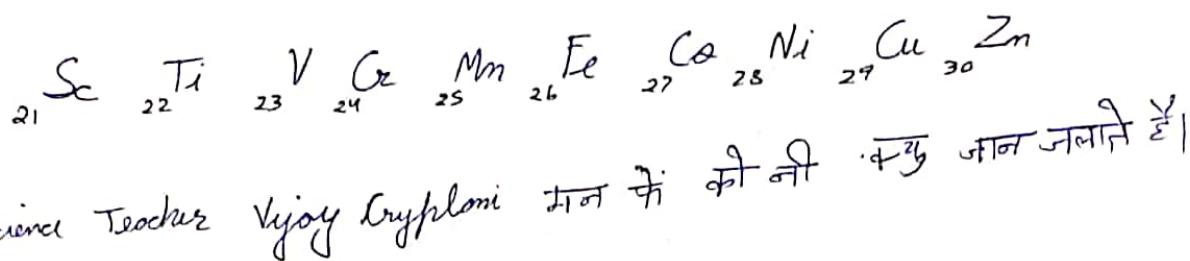
Note:- Group 13, 14, 15, 16, 17 & 18 are known as p-block elements.

1. Group 13, 14, 15, 16, 17 & 18 are known as p-block elements except (Helium)
2. Helium is s-block element.
3. 18 group is known as noble gases/inert gases.
4. Except group 18 elements all s-block and p-block elements are known as normal or representative elements.

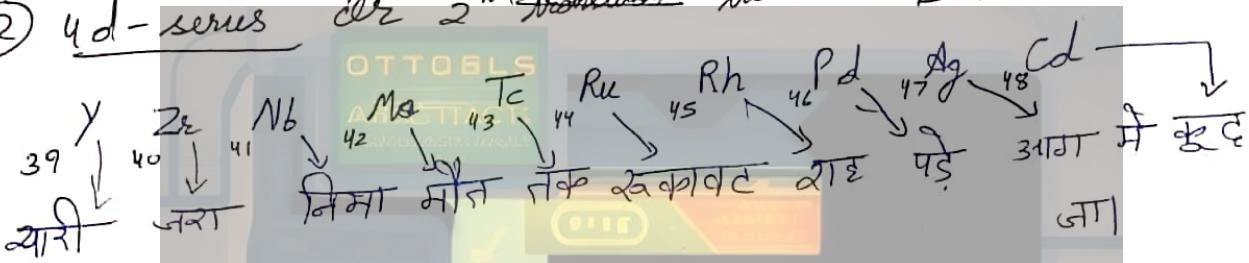
Representative elements - Outermost shell of these elements is incomplete.  
The number of  $e^-$  in outermost shell is less than 8.

## D-block elements :-

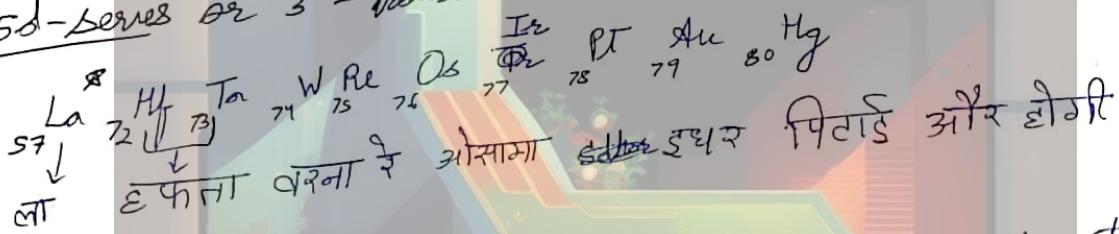
① 3d-series or I<sup>st</sup> transition series elements.



② 4d-series or 2<sup>nd</sup> transition transition series elements.



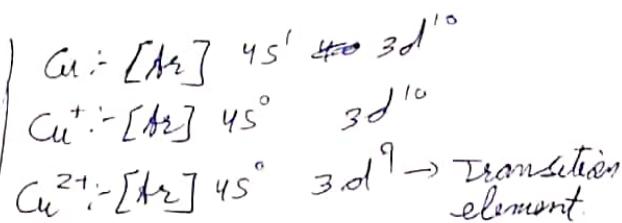
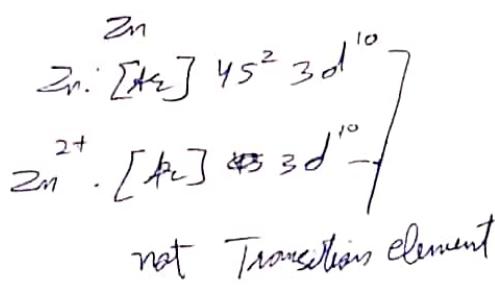
③ 5d-series or 3<sup>rd</sup> transition elements.



Note:-  
1. Elements of these blocks are called transition elements

2. Transition elements are those elements which have incompletely filled d subshell either in their ground state or any of their cationic state found in nature

3. Zinc, Cadmium (Cd) & Mercury (Hg) are not transition elements yet they are d block elements.



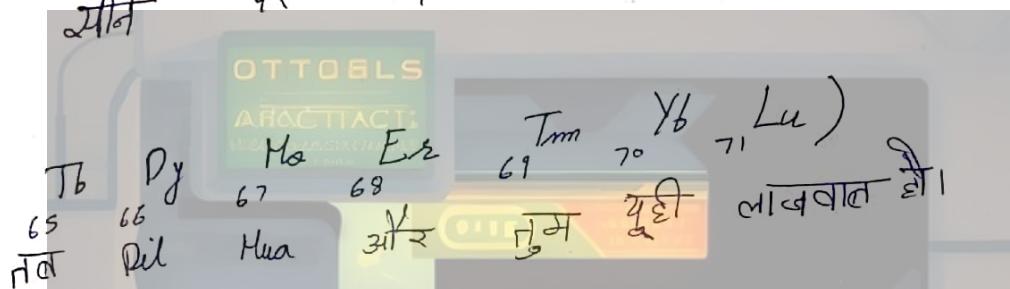
## F-Block elements

1. 4f-block element /, at inner transition elements / Lanthanides elements /

Lanthanoids / Rare earth metals

D-block element

${}_{57}^{7}\text{La}$	${}_{58}^{7}\text{Ce}$	${}_{59}^{7}\text{Pr}$	${}_{60}^{7}\text{Nd}$	${}_{61}^{7}\text{Pm}$	${}_{62}^{7}\text{Sm}$	${}_{63}^{7}\text{Eu}$	${}_{64}^{7}\text{Gd}$
লান্থানিড সমূহ	প্র	নেডিয়া	প্রেম	পিসাই	ব্রু	গুড়ি	গুড়ি



2. 5f-block elements / 2nd inner transition elements / & Actinides Elements / Actinoids.

${}_{89}^{90}\text{Ac}$	${}_{90}^{91}\text{Th}$	${}_{91}^{92}\text{Pa}$	${}_{92}^{93}\text{U}$	${}_{93}^{94}\text{Np}$	${}_{94}^{95}\text{Pu}$	${}_{95}^{96}\text{Am}$	${}_{96}^{97}\text{Cm}$	${}_{97}^{98}\text{Bk}$	${}_{98}^{99}\text{Cf}$	${}_{99}^{100}\text{Es}$
D-block element	টাইটান	পার	ব্রু	অন্তর্বৰ্তী অন্তর্বৰ্তী	পদ্মা	অন্তর্বৰ্তী পদ্মকা	কিলো	কিলো	কিলো	কিলো

Note:-

1. Lanthanum & Actinium (La & Ac) are D-block elements

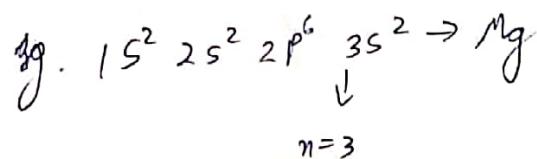
2. Lanthanide series elements & Actinide series elements are

F-block elements.

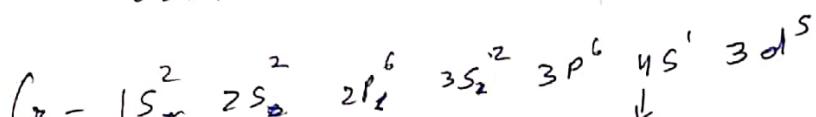
3. A Lanthanide series starts from  ${}_{57}^{7}\text{Ce}$  to  ${}_{71}^{7}\text{Lu}$

4. Actinide series starts from  ${}_{90}^{91}\text{Th}$  to  ${}_{103}^{103}\text{Lr}$

Description of Period - The highest value of  $n$  in electronic configuration of an element will give its period.



3<sup>rd</sup> Period



4<sup>th</sup> period

No. of elements in a specific period.

Period	Subshell	no. of element	Name
1 <sup>st</sup> Period	1s	2	Shortest
2 <sup>nd</sup> Period	2s 2p	10	Short
3 <sup>rd</sup> Period	3s 3p	10	Short
4 <sup>th</sup> Period	4s 3d 4p	18	long
	5s 4p	18	long
5 <sup>th</sup> Period	6s 4f 5d 6p	32	longest
6 <sup>th</sup> Period	7s 5f 6d 7p	32	elongated
7 <sup>th</sup> Period			

Note:- 1. Any Period start from 'ns' & end with 'np'

ms ...  $(n-3)g$   $(n-2)f$   $(n-1)d$   $n^p$  till  $n^l$

Q1. If each orbital is occupied by max  $3e^-$ , find total no. of elements in 2nd period.

In 2nd period  $2s, 2p$

$$2s - \boxed{111} - 3 e^- \rightarrow 3 \text{ elements}$$

$$2p - \boxed{111111} - 9 e^- \rightarrow 9 \text{ elements}$$

Total elements  $\rightarrow \boxed{12 \text{ elements}}$  find total no. of elements in 2nd period

Q2. If each orbital occupied by max  $3e^-$ , find total no. of elements in 6th period

6th Period -  $6s, 4f, 5d, 6p$

$$6s \rightarrow 3 e^-$$

$$4f \rightarrow 14 + 7 \rightarrow 21 e^-$$

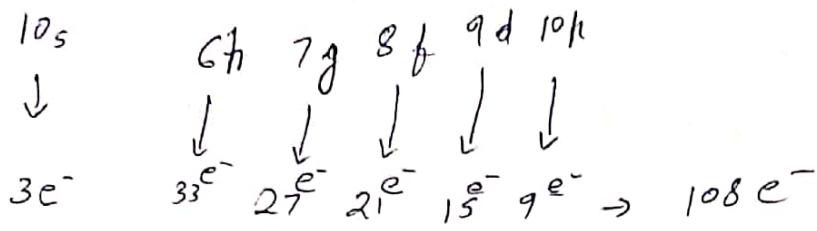
$$5d \rightarrow 10 + 5 \rightarrow 15 e^-$$

$$6p \rightarrow 6 + 3 \rightarrow 9 e^-$$

$$\text{Total } e^- = 48$$

$$\boxed{\text{Total elements} = 48}$$

Q3. If each orbital occupied by max  $3 e^-$ , find no. of elements in 10<sup>th</sup> period.



$\rightarrow 108$  elements

Q4. find atomic no. of element present in 8<sup>th</sup> period group 17.

$$118 + 17 = 135$$

7<sup>th</sup> period total = 118 elements

~~17<sup>th</sup> group = 17~~

~~$118 + 17 = \boxed{+35^{\text{th}} \text{ element}}$~~

~~= 153 element~~

18<sup>th</sup> group  $\rightarrow$  50<sup>th</sup> element of period  
17<sup>th</sup> group  $\rightarrow$  49<sup>th</sup> element of period

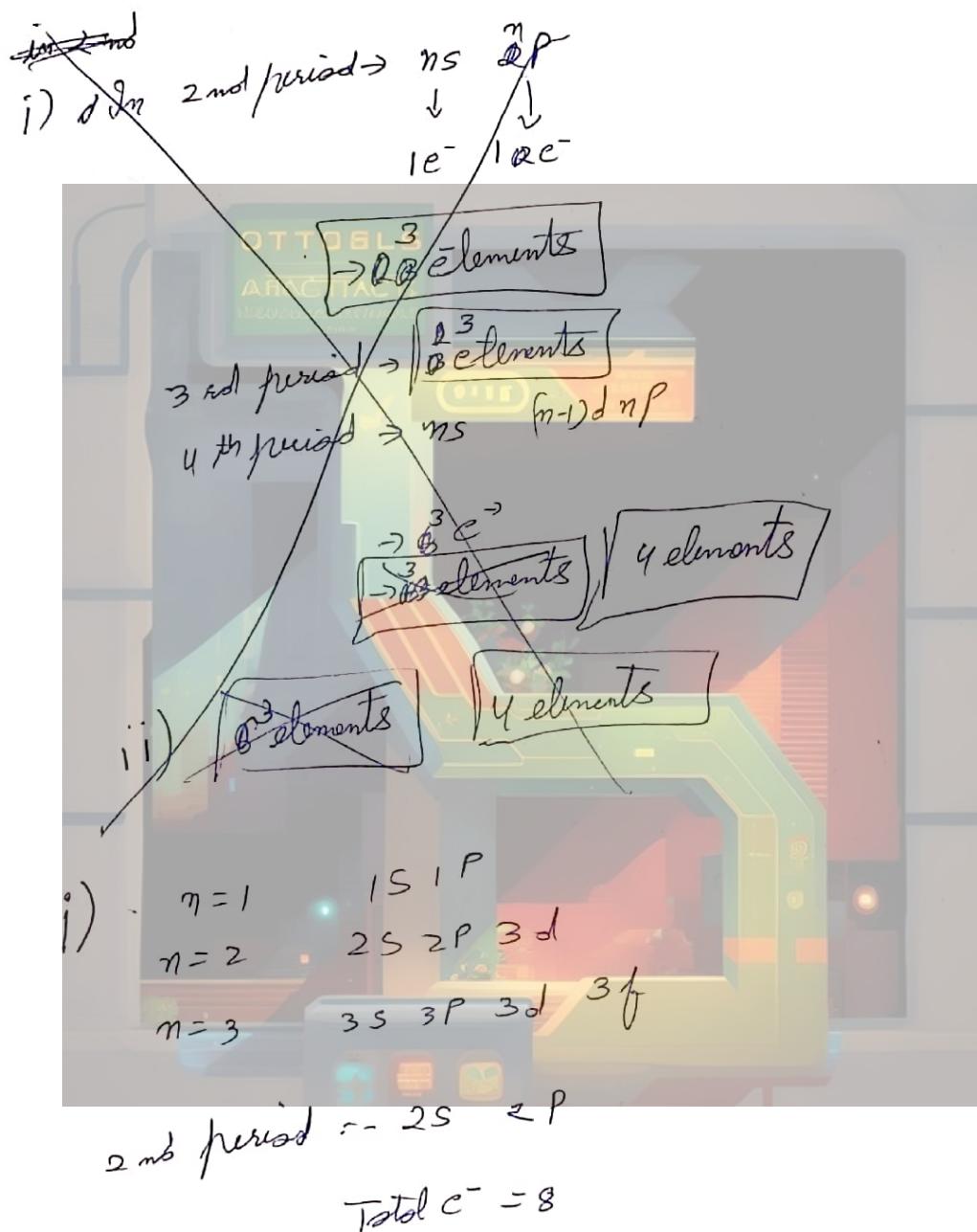
$$118 + 49 = 167$$

$Z = 167$

Q4. In other universe if all quantes nos. are same except  $l$ ,  $l = 0 \text{ to } n$

i) number of elements in period 2, 3, 4

ii) elements in 3rd shell



3rd period  $\rightarrow$  3s 2d 3p

$\rightarrow$  18 elements

4th period  $\rightarrow$  3s 3p  
4s 3d 4p

$\rightarrow$  18 elements

ii)

$n=3$

$\rightarrow$  3s 3p 3d 3f  
 $\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$   
2 6 10 14

$\rightarrow$  32 elements

Q 5. In other universe, if O. No. same except

$l \rightarrow Oto(n+1)$

$m \rightarrow -(l+1) \text{ to } +(l+1)$

$m_s \rightarrow -\frac{1}{2}, 0, +\frac{1}{2}$

Then, calculate

no. of elements in 2nd period

elements in 2nd shell

no. of

2nd period  $\rightarrow$  2s 1d 2p  
 $\downarrow \quad \downarrow \quad \downarrow$   
2s orbital 7 5  
 $\downarrow \quad \downarrow$   
 $3 \times 3 = 9 e^-$   $3 \times 7 = 21 e^-$   $3 \times 5 = 15 e^- = 45 e^-$

$\rightarrow$  45 elements

2nd Shell  $\rightarrow n=2$

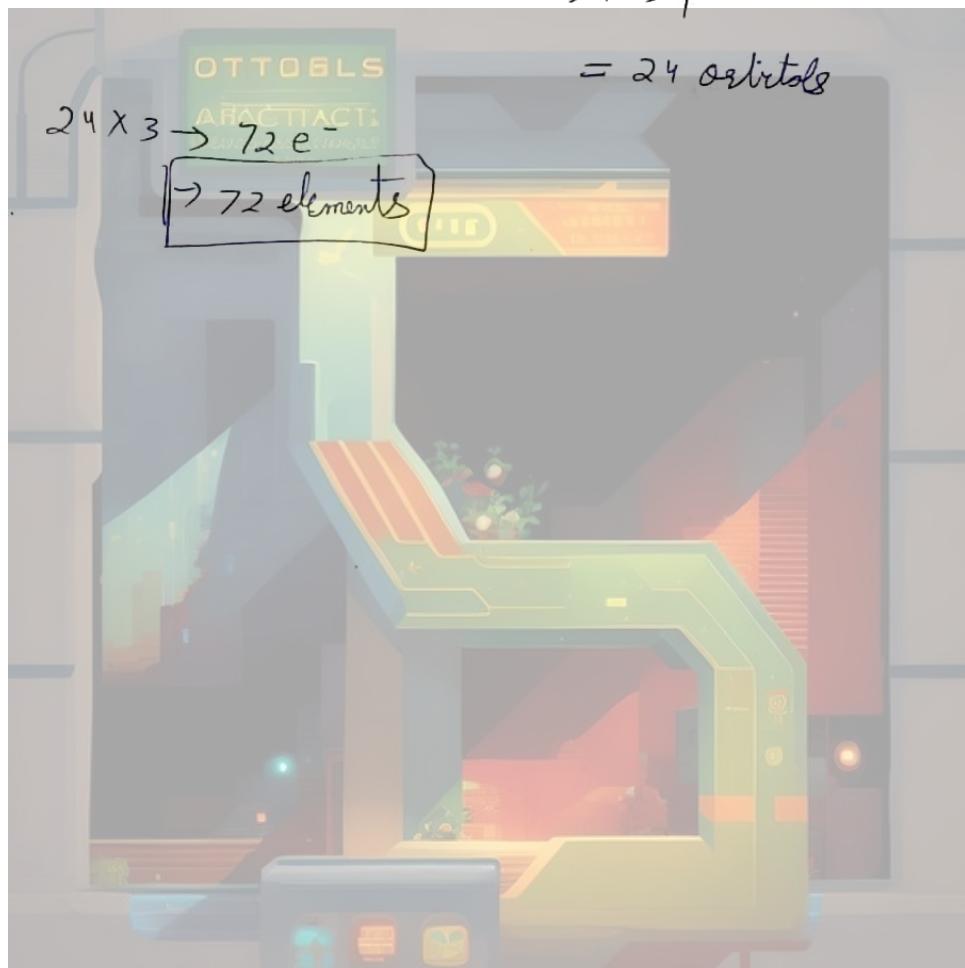
$l = 0(s)$   
 $1(p)$   
 $2(d)$   
 $3(f)$

$m = -1, 0, 1 \rightarrow 3$

$-2, -1, 0, 1, 2 \rightarrow 5$

$-3, -2, -1, 0, 1, 2, 3 \rightarrow 7$

$-4, -3, -2, -1, 0, 1, 2, 3, 4 \rightarrow 9$



## Some Commonly used terms:-

1. Post Lanthanides elements - After lanthanide elements including (after Lu,  $Z=71$ ) or Hafnium ( $Z=72$ )

*not included* onwards elements are known as post lanthanide elements.

2. Trans Uranic elements - After Uranium element, atomic no. 92

*excluded* ( $Z=92$ ) or ( $Np$ ,  $Z=93$ ) are known as Trans  $\uparrow$  Uranic elements.

3. Typical elements - 2nd & 3rd period elements are known as typical elements

Classification of elements according to Block :-

1. S-Block elements - last e- enters in ~~s-block~~

S-Subshell,

General electronic Config  $nS^{10-2}$

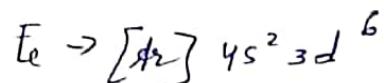
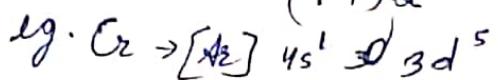
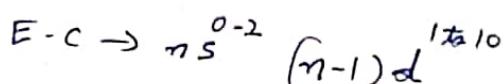
$nS^1$  or  $nS^2$

e.g. Li -  $1S^2 2S^1$

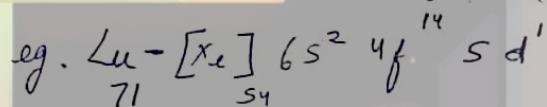
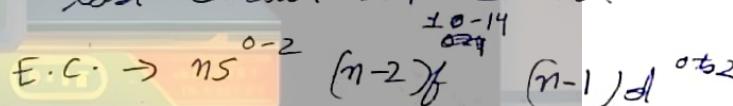
Mg :  $[Ne] 3S^2$

2. P-Block elements - lost electron in P-Subshell  
 $E.C \rightarrow ns^2 \xrightarrow{\text{lose } e^-} n_p^1$   
 eg.  $N \rightarrow [He] 2s^2 2p^3$

3. D-Block elements - lost electron in D-Subshell



4. F-block elements - lost electron in F-Subshell

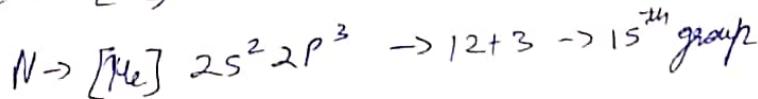
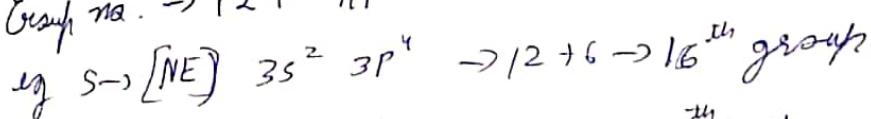


Trick to estimate group number of an electron

- To decide the group of an element, first decide the block of the element.
  - S-Block -  
 (except Helium)       $ns^1 \rightarrow$  1st group H, Li, N, K, Rb, Cs, Fr  
                            $ns^2 \rightarrow$  2nd group Be, Mg, Ca, Sr, Ba, Ra
- no. of electron in valence shell = Group no. (for S-Block)

→ P-Block -

$\text{Group no.} \rightarrow 12 + np e^-$



### ③ Group no. of D-block elements

Group no.  $\rightarrow$  no. of  $nsc^-$  + no. of ~~s<sup>-1</sup>~~  $(n-1)d\ e^-$

e.g. Cr - [Ar]  $4s^1 3d^5$

group  $\rightarrow 1+5 \rightarrow 6^{\text{th}}$  group.  
 $\rightarrow$  D-block.  
 $\rightarrow$  4<sup>th</sup> period.

e.g. 2. Fe  $\rightarrow$  [Ar]  $4s^2 3d^6$

group  $\rightarrow 6+2 \rightarrow 8^{\text{th}}$  group.  
 OTTO  $\rightarrow$  D-block.  
 ARCTIC  $\rightarrow$  4<sup>th</sup> period.

### ④ Group no. of F-block - Group - 3 always

Q1. Atomic no. 32, 56, 27, 63, 2, 83

32  $\rightarrow$  [Ar]  $4s^2 3d^{10} 4p^2$   $\left| 27 \rightarrow [Ar] 4s^2 3d^7 \right.$   
 $\rightarrow$  P-block  
 $\rightarrow$  4<sup>th</sup> period  
 $\rightarrow$  14<sup>th</sup> group

56  $\rightarrow$  [Xe]  $6s^2$   
 $\rightarrow$  S-block  
 $\rightarrow$  6<sup>th</sup> period  
 $\rightarrow$  2<sup>nd</sup> group

63  $\rightarrow$  [Xe]  $6s^2 5d^1 4f^7$   
 $\rightarrow$  F-block  
 $\rightarrow$  6<sup>th</sup> period  
 $\rightarrow$  30<sup>th</sup> group

2  $\rightarrow$   $1s^2$   
 $\rightarrow$  S-block  
 $\rightarrow$  1st period  
 $\rightarrow$  1<sup>st</sup> group

83  $\rightarrow$  [Xe]  $6s^2 4f^{14} 5d^{10} 6p^3$   
 $\rightarrow$  P-block  
 $\rightarrow$  6<sup>th</sup> period  
 $\rightarrow$  15<sup>th</sup> group.

# IUPAC Nomenclature of elements

(atomic num.  $> 10^6$ )

→ All names must end with "ium"

Bi + ium → Biium

Pent + ium → Pentium

Digit	name	Abbreviation
0	Nil	n
1	Un	u
2	Bi	b
3	Tri	t
4	Quad	q
5	Pent	p
6	Hex	h
7	Sept	s
8	Oct	o
9	En	e
+0		

Ex ① -  $Z=118$  (Uuo)  
with Ununoctium

④  $Z=115$  (Uup)  
Ununpentium

②  $-Z=104$  (Uumg)  
Unnilquadium

③  $Z=110$  (Uun)  
Ununnilium

## Diagonal Relationship

→ Properties of elements of 2<sup>nd</sup> Period resembles with the element of 3<sup>rd</sup> Period. These resembles between properties of 2<sup>nd</sup> and 3<sup>rd</sup> period is called diagonal relationship.



Li & Mg show similar properties -

e.g.  $\text{Li}_2\text{CO}_3 \xrightarrow{\Delta} \text{Li}_2\text{O} + \text{CO}_2$

$\text{MgCO}_3 \xrightarrow{\Delta} \text{MgO} + \text{CO}_2$

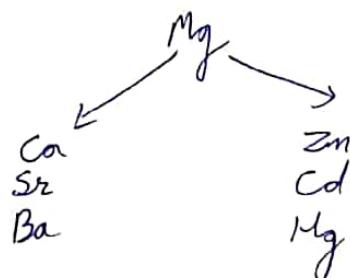
$\text{Na}_2\text{CO}_3 \xrightarrow{\Delta} \text{No reaction}$

BeO > Both are Amphoteric  
 $\text{Al}_2\text{O}_3$

Bridge Element

Mg of 3<sup>rd</sup> period is bridge element

Be



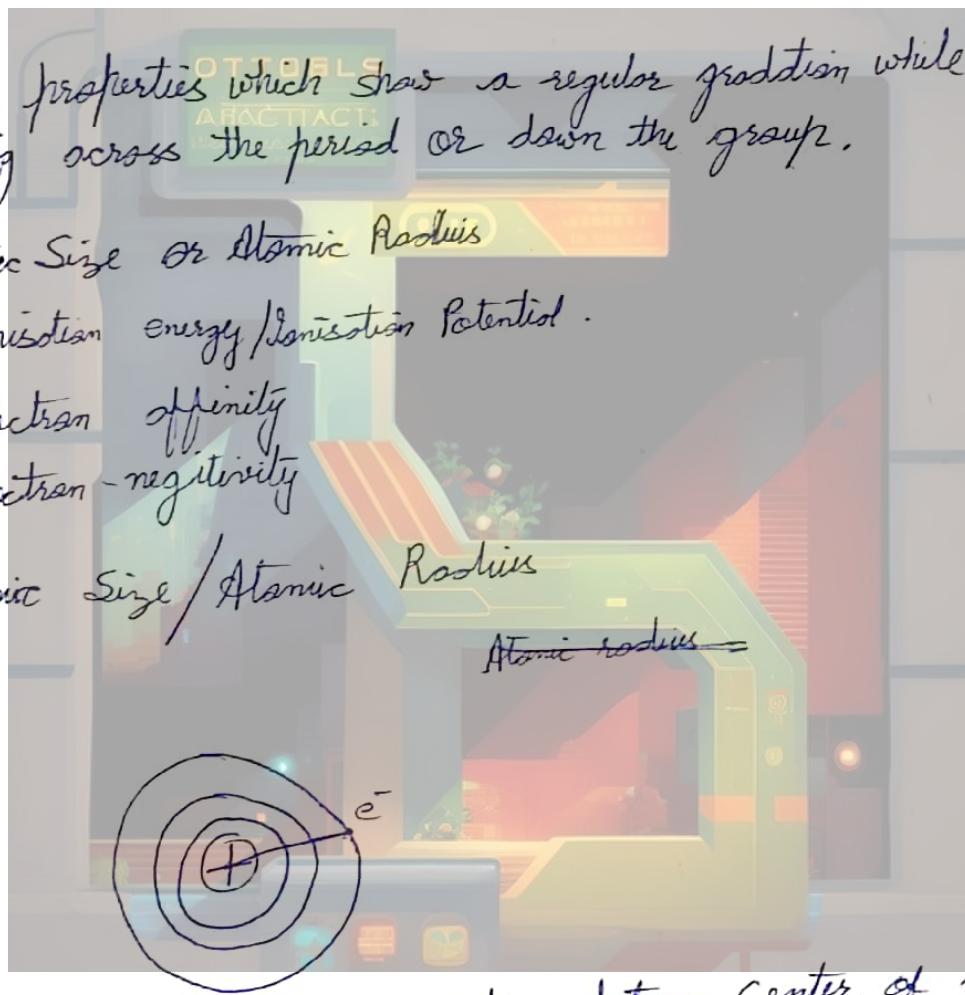
→ The properties of Bridge elements are somewhat mixed of the elements of 2 sub groups as ~~as~~  
magnesium shows similarities with alkaline earth metals on one hand and with zinc metals on other hand.

## Periodic Properties

→ Those properties which show a regular gradation while moving across the period or down the group.

- 1. Atomic Size or Atomic Radius
- 2. Ionisation energy/Ionisation Potential
- 3. Electron affinity
- 4. Electron-negativity

→ Atomic Size / Atomic Radius



Atomic Size - It is the distance between center of nucleus and the outermost shell electron.

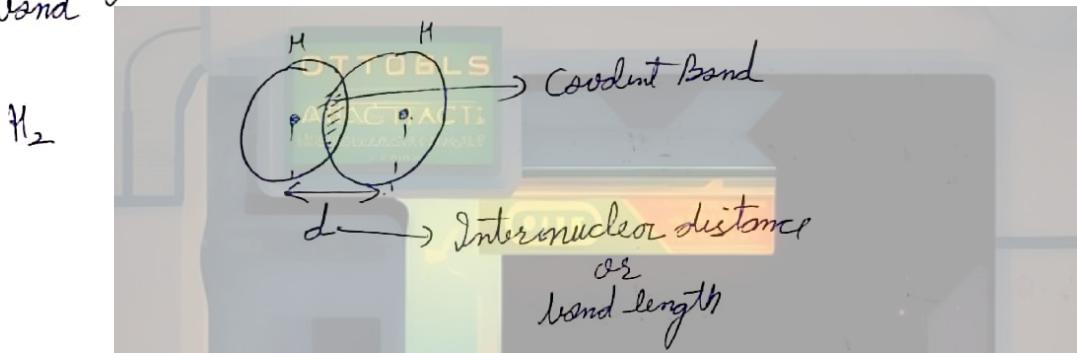
→ It is impossible to calculate exact value of radius or actual value of atomic size

→ Since we are calculating the radius of atoms in different bonded state (covalent bond → covalent radius → for non-metal)  
 Metallic bond → Metallic radius → (for metal)  
 Vanderwaal's bond → Vanderwaal radius  
 Ionic bond → Ionic radius

↓  
 (generally held gases)

### Covalent Radius →

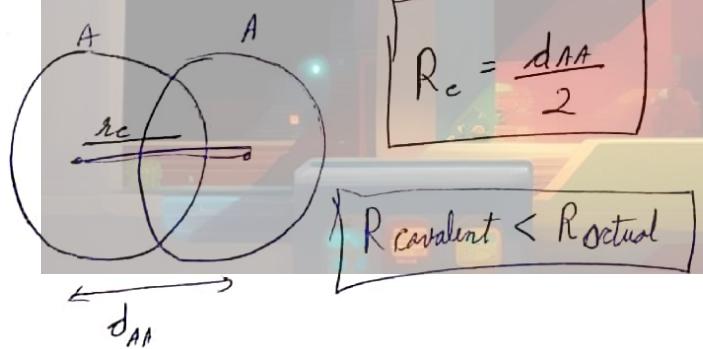
→ It is defined for those elements which are bonded with covalent bond



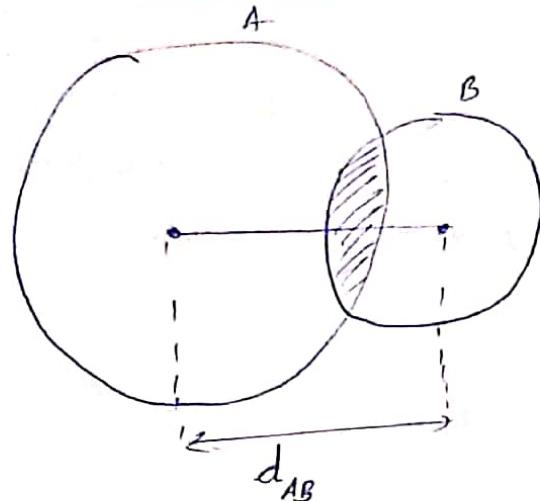
→ Bond length - It is interatomic distance between two atoms in a bonded state.

### Covalent radius

① Homo-diatomic radius ( $H_2$ ,  $Cl_2$ ,  $O_2$  etc.)



② Hetero-diatomic molecule (H-F, H-Cl)



Schoenheimer - Stevensons Equation -

$$d_{AB} = R_A + R_B - 0.09 |EN_A - EN_B|$$

R → Radius

$$d_{AB} = R_A + R_B - 0.09 |EN_A - EN_B|$$

$R_A$  → radius of A

$R_B$  → radius of B

$EN_A$  &  $EN_B$  → Electronegativity of A & B on Pauling scale

$d_{AB}$  → Bond length between A & B

Distance in  $\text{\AA}$

$$1 \text{ \AA} (\text{Angstrom}) = 10^{-10} \text{ m}$$

$$1 \text{ pm} (\text{picometer}) = 10^{-12} \text{ m}$$

$$1 \text{ nm} (\text{nano meter}) = 10^{-9} \text{ m}$$

$$1 \mu\text{m} (\text{micro meter}) = 10^{-6} \text{ m}$$

$$1 \text{ mm} (\text{mille meter}) = 10^{-3} \text{ m}$$

$$d_{AB} = R_A + R_B - 9 |EN_A - EN_B|$$

(In pm)

Q Calculate bond length of HCl molecule, if bond length of  $H_2$  is  $2\text{ \AA}^\circ$  &  $Cl_2$  molecule is  $10\text{ \AA}^\circ$ ; given  $EN_H$  is 2.1 &  $EN_{Cl}$  is 3.

$$d_{HH} = 2\text{ \AA}^\circ$$

$$d_{ClCl} = 10\text{ \AA}^\circ$$

$$d_{HH} = R_H \times 2$$

$$\frac{10}{2} = R_{Cl}$$

$$2\text{ \AA}^\circ = R_H \times 2$$

$$R_{Cl} = 5\text{ \AA}^\circ$$

$$R_H = 1\text{ \AA}^\circ$$

$$d_{HCl} = 1 + 16 - 0.09(2.1 - 3)$$

$$= 7 - 0.09(0.9)$$

$$= 7 - 0.081$$

$$= 6.919$$

$$- 0.081$$

$$56.919\text{ \AA}^\circ$$

Q2. Calculate bond length of AB if  $R_A = 15\text{ pm}$   
 $R_B = 20\text{ pm}$

$$EN_A = 2$$

$$EN_B = 1.5$$

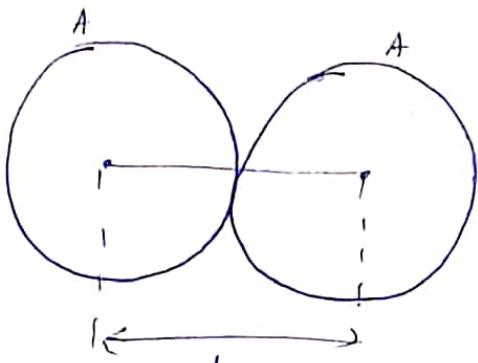
$$d_{AB} = 15 + 20 - 9(2 - 1.5)$$

$$= 35 - 9(0.5)$$

$$= 35 - 4.5$$

$$= 30.5\text{ fm}$$

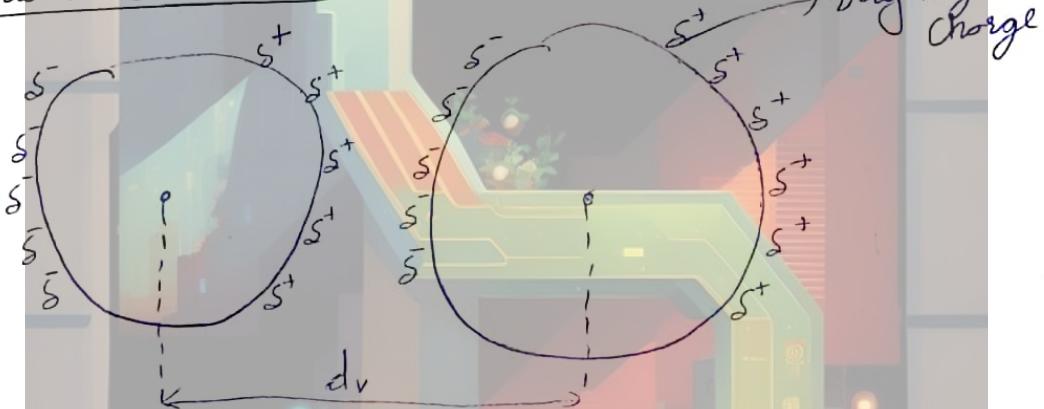
② Metallic Radius/Crystal Radius - It is half the internuclear distance between two identical atoms bonded by a metallic bond.



$$R_{\text{metallic}} = \frac{d}{2}$$

$R_{\text{metallic}} \approx R_{\text{actual}}$

③ Vanderwaal's Radius - due to weak forces



$$R_v = \frac{d_v}{2}$$

$$R_v > R_{\text{actual}}$$

$$R_v > R_m > R_c$$

↓ vanderwaal    ↓ metallic    ↓ covalent

Note - Generally for inert gases or noble gases, Vanderwall radius is calculated.

factors affecting atomic size -

①

$$\text{Size} \propto \frac{1}{Z_{\text{eff}}}$$

$Z_{\text{eff}} \uparrow$  Size  $\downarrow$

②

$$\text{Shell no.} \propto \text{Size}$$

Left Top across the period  
 $Z_{\text{eff}} \uparrow$ , size  $\downarrow$

Bottom  $n \uparrow$   
size  $\uparrow$  (in general)

Right

for S or P block -

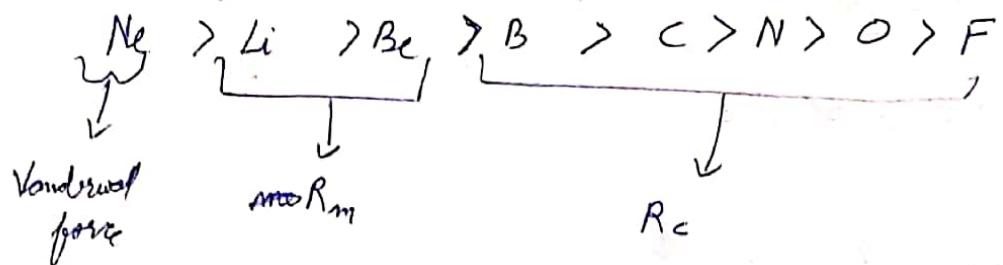
(In Period)

1<sup>st</sup> period - H > He (expected)

He > H (actual)

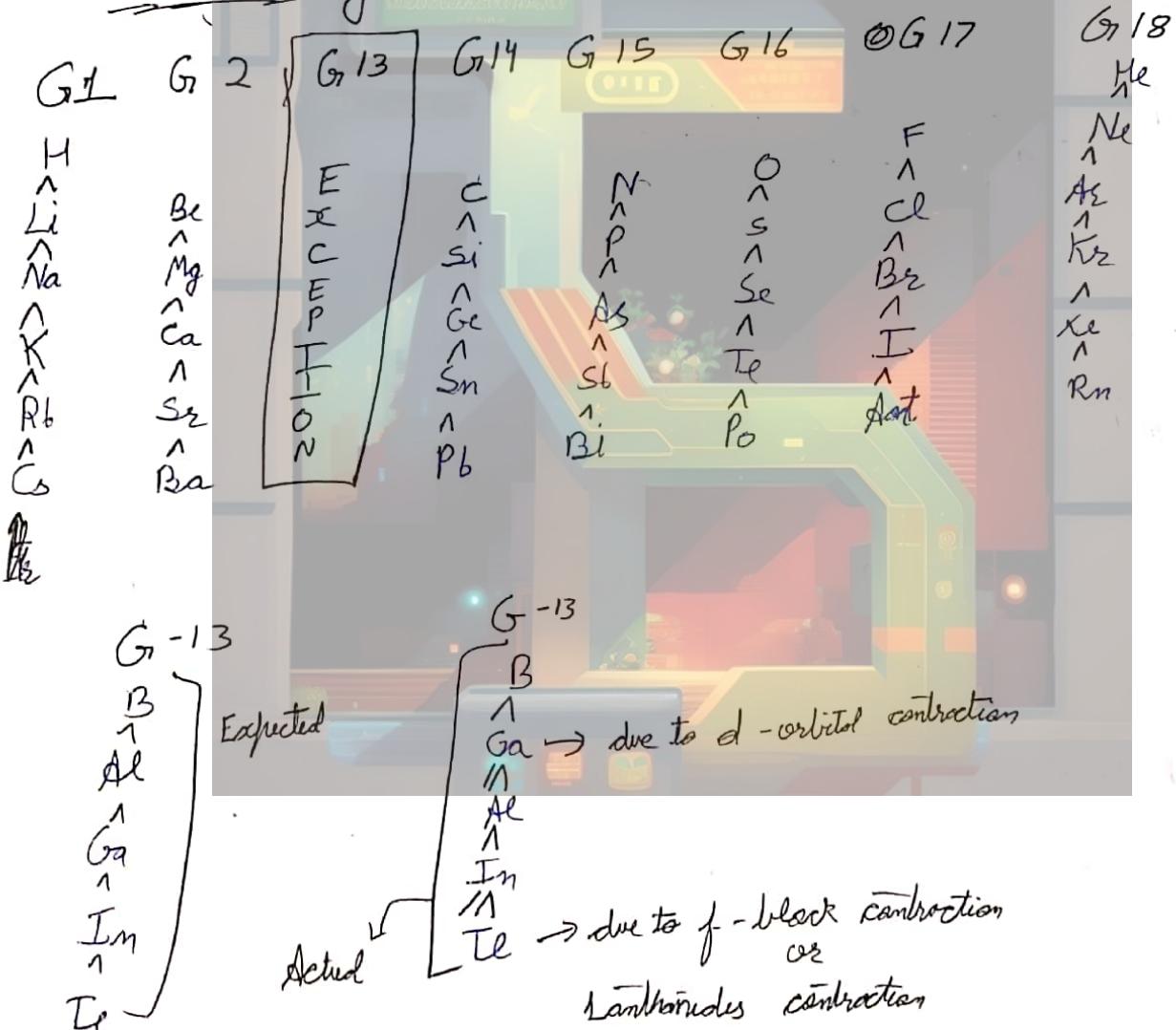
$\downarrow$   
Vanderwall  
radius

2nd Period -  $\text{Ne} > \text{Li} > \text{Be} > \text{B} > \text{C} > \text{N} > \text{O} > \text{F} > \text{Ne}$  *Nodal process*



3rd Period -  $\text{Ar} > \text{Na} > \text{Mg} > \text{Al} > \text{Si} > \text{P} > \text{S} > \text{Cl}$

~~Q2~~ Variation along the group -



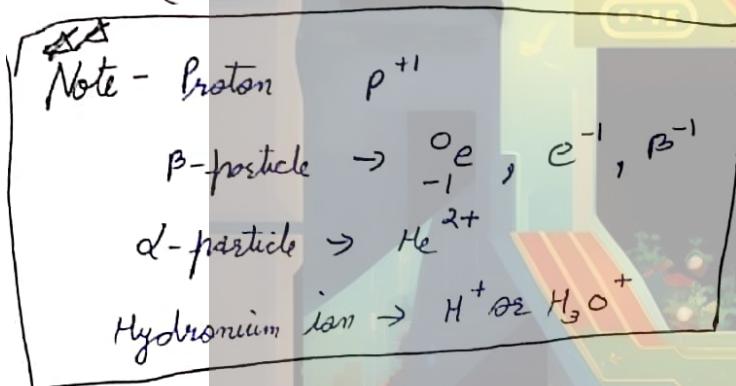
D-Contraction - Due to poor shielding of D-subshell or D-electrons, effective nuclear charge increases and hence size of atom decreases.

Lanthanoid Contraction - Due to poor shielding of F-electrons, effective nuclear charge increases and thus, size of atom decreases.

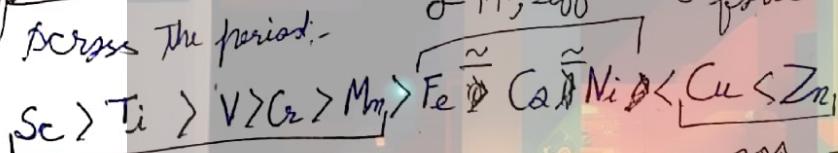
H.W. 21/04/2025

Topic 1-4

$$\left. \begin{array}{l} \text{Size of atom} = 10^{-10} \text{ m} \\ \text{nucleus} = 10^{-14} \text{ m} \\ p/\pi/e^{-1} = 10^{-15} \text{ m} \end{array} \right\} \text{approx}$$



for D-block -  
across the period -  $\sigma \uparrow, Z_{eff} \uparrow$  (both attraction force dominant, force of repulsion)

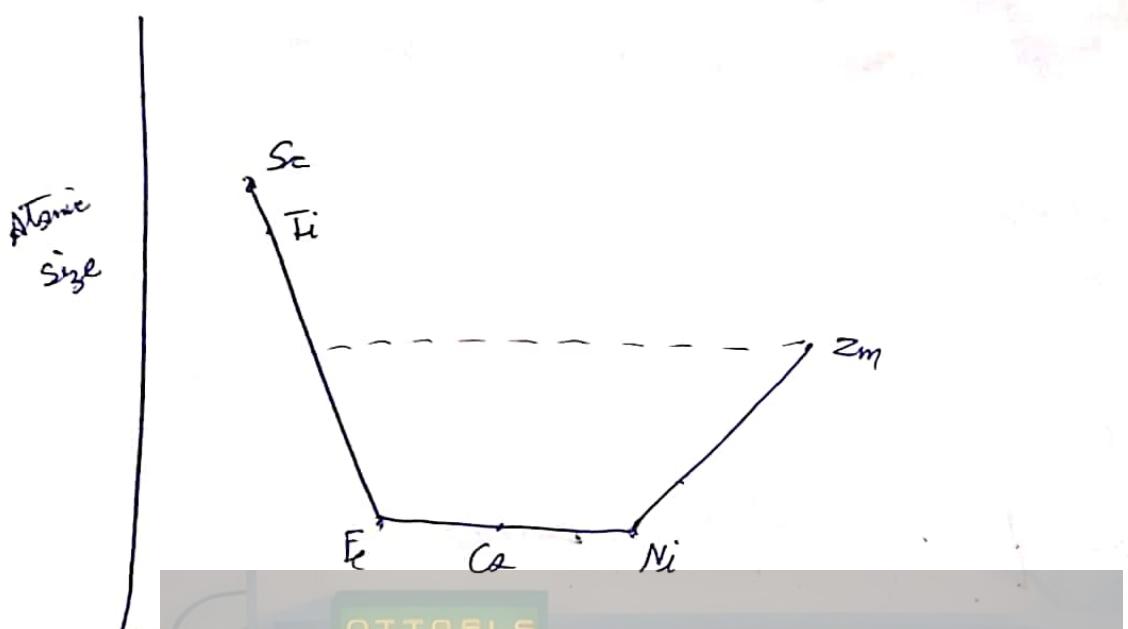


$\sigma \uparrow, Z_{eff} \uparrow$

Size  $\downarrow$

(attraction force dominant)

$\sigma \uparrow, Z_{eff} \uparrow$   
(repulsion force dominant)



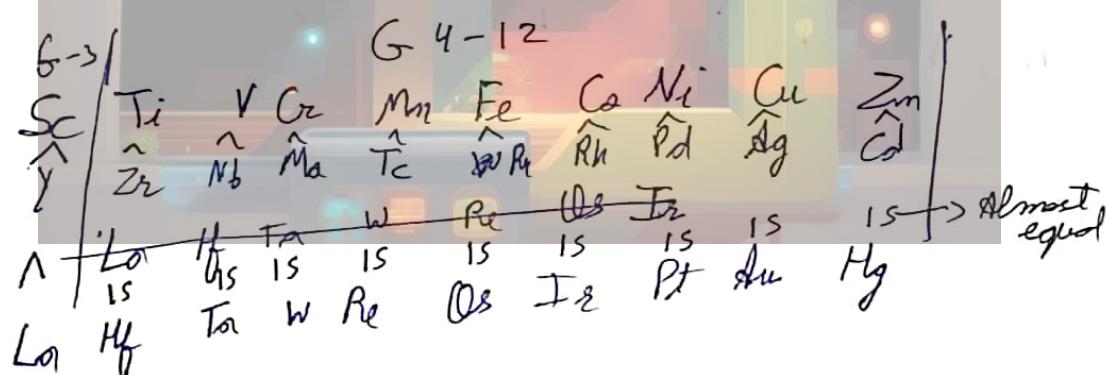
(~~more~~)

variation along the groups

Group - 3 -  $3d < 4d < 5d$

$Sc < Y < La$

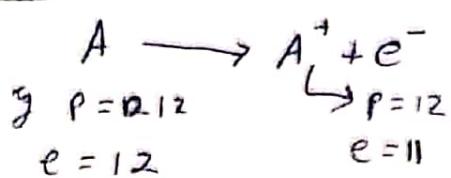
Group - 4 to  $^{12}$  - ( $3d < 4d \approx 5d$ )



2 3

# Ionic Radius (Cations or Anions)

## Cation -



Attraction  $\uparrow$ , Size  $\downarrow$

  $\boxed{\text{Size of atom} > \text{Size of cation}}$

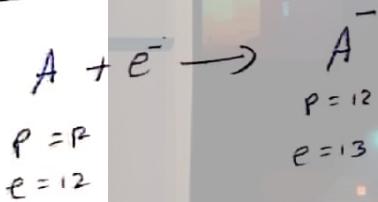
Radius order:-

$$\left[ A > A^+ > A^{2+} > A^{3+} \right]$$

Eg

$$\begin{aligned} Na &> Na^+ \\ Mg &> Mg^{2+} \\ Al &> Al^{3+} \end{aligned}$$

## Anion -



Attraction  $\downarrow$ , Size  $\uparrow$

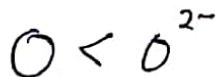
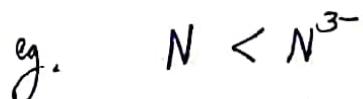
  $\boxed{\text{Size of atom} \leftarrow \text{Size of anion}}$

Radius order

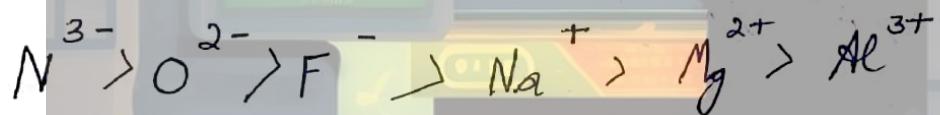
$$\left[ A < A^- < A^{2-} < A^{3-} \right]$$

Note :- Size

$$A^{3+} < A^{2+} < A^+ < A < A^- < A^{2-} < A^{3-}$$



Size or Radius comparison between iso-electronic species.

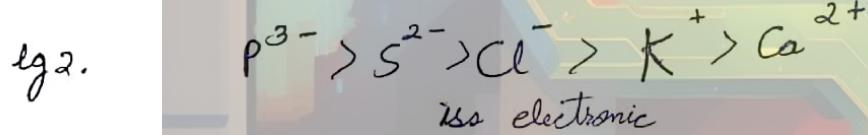


$Z \uparrow$

iso-electronic

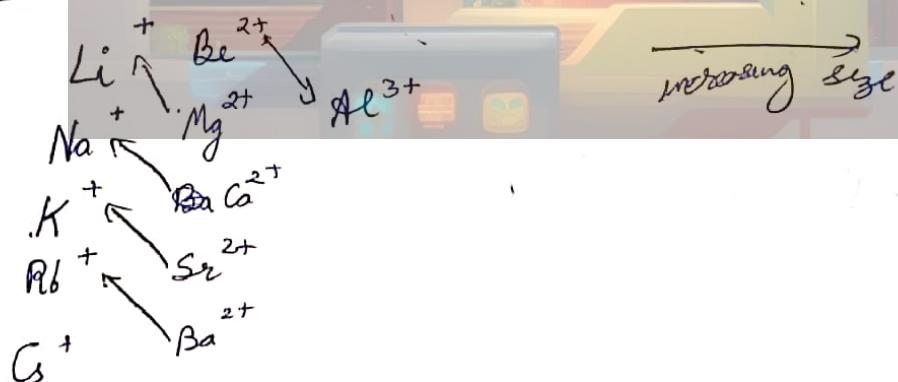
$O = \text{some}$

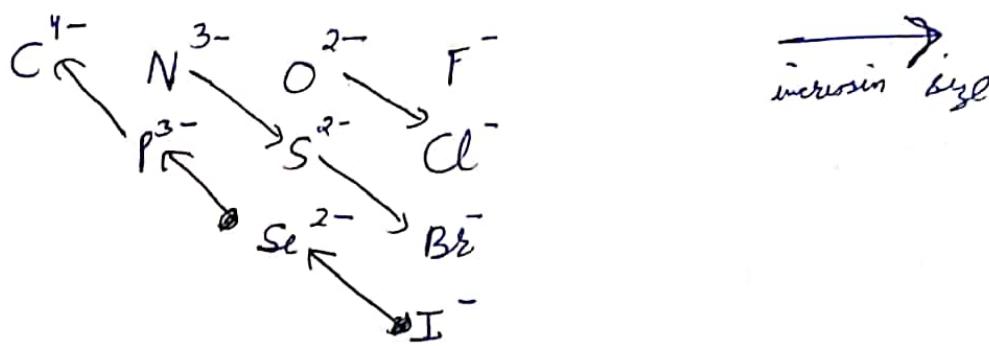
$Z \uparrow \rightarrow r \downarrow$ , Size  $\downarrow$



iso electronic

Some Mixed Order.





① Radius Order?

① K, Rb, Cs

~~K < Rb < Cs~~ ✓

② Be, F, O, N, Ne

~~Ne > Be > O > N > F~~ ✓

③ Mg, Na, K, Rb

Mg < Na < K < Rb ✓

④ Sb, P, As, S

S < P < As < Sb ✓

⑤ P, As, Cl, S

Cl < S < P < As ✓

⑥ Sc, V, Mn

Sc > V > Mn ✓

⑦ Fe, Co, Ni

Fe ≈ Co ≈ Ni ✓

⑧ Cu, Zn

Cu < Zn ✓

⑨ Fe,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$

$\text{Fe} > \text{Fe}^{2+} > \text{Fe}^{3+} \checkmark$

⑩ O,  $\text{O}^{-1}$ ,  $\text{O}^{-2}$

~~$\text{O}^{-1} > \text{O} > \text{O}^{2+}$~~   $\text{O}^{2-} > \text{O}^{-1} > \text{O}$

⑪ Pd, Ni, Pt

Ni < Pd  $\approx$  Pt ✓

⑫ V, Ta, Nb

V < Nb  $\approx$  Ta ✓

⑬ Sb, S, Se, Te

S < Se  $\approx$  Te < Sb ✓

⑭ Xe, Rn, Kr

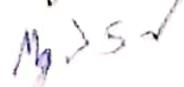
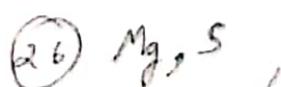
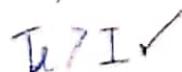
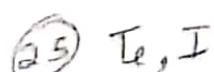
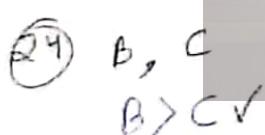
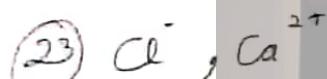
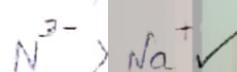
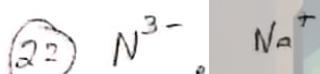
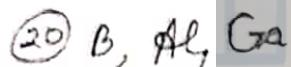
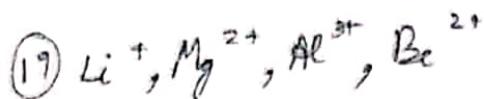
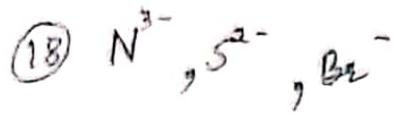
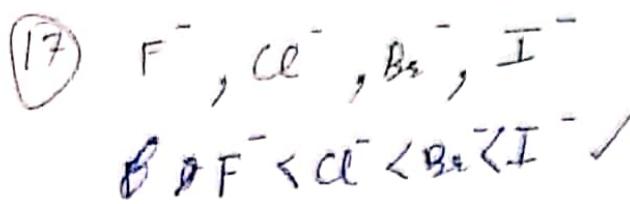
Kr < Xe < Rn ✓

⑮  $\text{A}^+, \text{A}^{2+}, \text{A}^{2-}, \text{A}^-, \text{A}^0$

$\text{A}^{2-} > \text{A}^- > \text{A}^0 > \text{A}^+ > \text{A}^{2+} \checkmark$

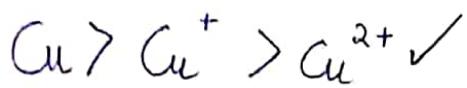
⑯  $\mu^-$ ,  $\text{Li}^{\oplus +}$

$\mu^- > \text{Li}^+ \checkmark$

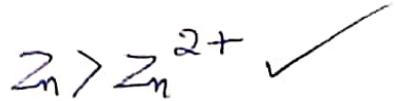


97

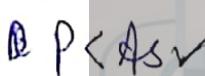
(27)  $\text{Cu}, \text{Cu}^+, \text{Cu}^{2+}$



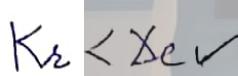
(28)  $\text{Zn}, \text{Zn}^{2+}$



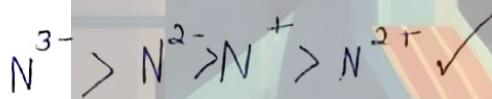
(29)  $\text{P}, \text{As}$



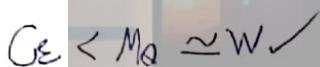
(30)  $\text{Ar}, \text{Kr}$



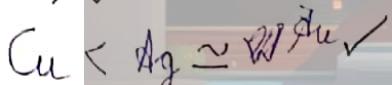
(31)  $\text{N}^{3-}, \text{N}^{2-}, \text{N}^+, \text{N}^{2+}$



(32)  $\text{Ge}, \text{Mg}, \text{W}$



(33)  $\text{Cu}, \text{Ag}, \text{Au}$



(34)  $\text{Ni}, \text{Zn}, \text{Cu}$

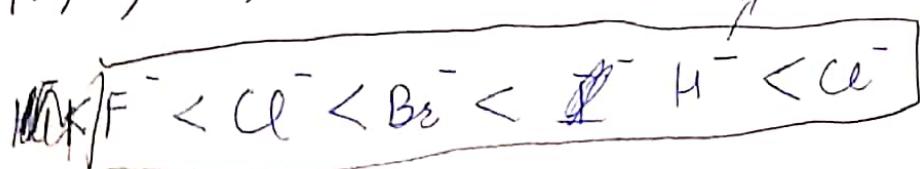


(35)  $\text{Cl}, \text{Cl}^+, \text{Cl}^-$



\* high repulsion  
bcs of extra e-

(36)  $\text{H}^-, \text{F}^-, \text{Cl}^-, \text{Br}^-, \text{I}^-$



(38)

H.W. 29-04-2024

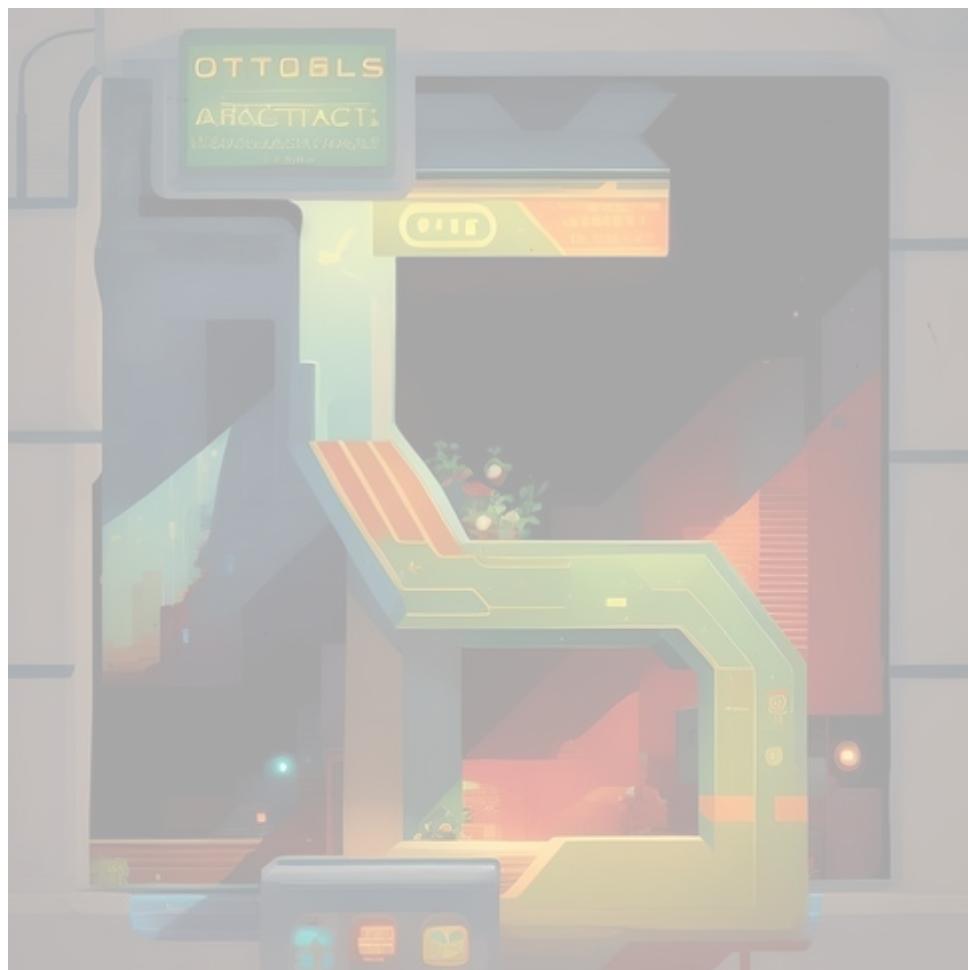
~~O~~. O-1 (Q1-Q14)

O-2 (Q1,2)

S-1 (Q13)

J M (3, 6, 7, 13, 15, 18, 21, 25, 27, 32, 35)

J A (2,6)



Note - Largest Cation -  $\text{Cs}^+$

Smallest cation -  $\text{H}^+$

Largest mono negative anion =  $\text{I}^-$

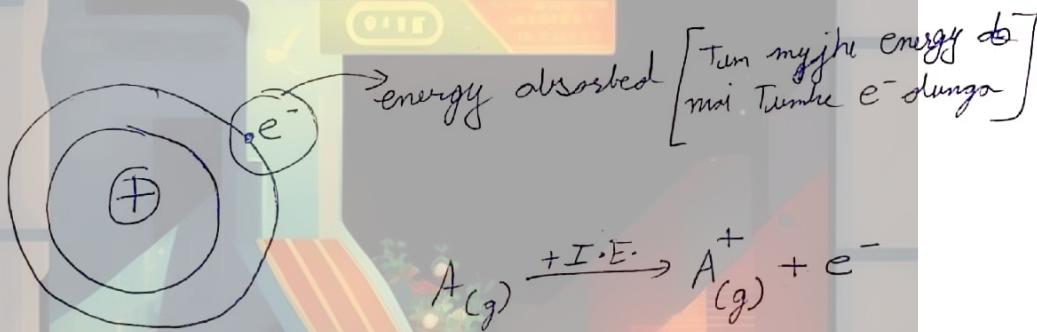
Second - largest mono negative anion =  $\text{H}^-$

Smallest mono - negative anion =  $\text{F}^-$

## \* Ionisation Energy / Ionisation Potential (I.P.)

at Constant temp & pressure

→ It is the minimum amount of energy required to remove the outermost electron from isolated gaseous atom or ion.



→ Unit of I.E. :-  $\text{kJ/mol}$   $\Rightarrow \text{e.v/mol}$ ,  $\text{Kcal/mol}$ ,  $\text{J/mol}$ ,  $\text{Col/mol}$

↓  
per electron  
volt

Enthalpy - It is the heat content of system.



$$\Delta H (\text{change in heat/enthalpy}) = E_P - E_R$$

$\Delta H = \text{① } \text{Ve} \rightarrow$  Endothermic reaction  $\rightarrow$  Energy absorbed

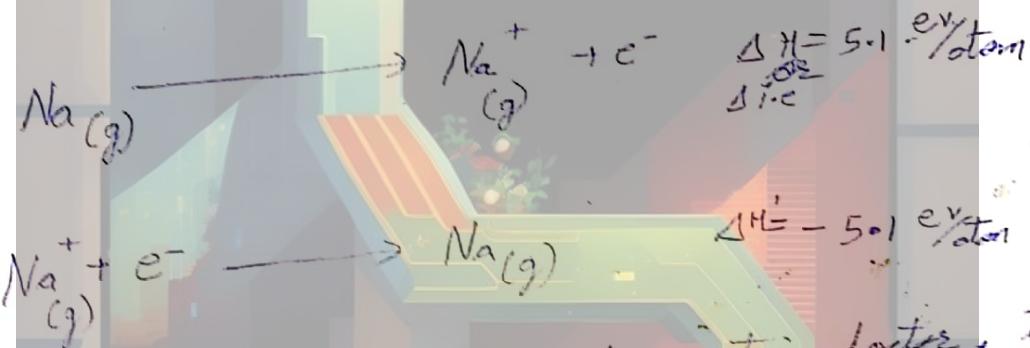
$\Delta H = \text{② } \text{Ve} \rightarrow$  Exothermic Reaction  $\rightarrow$  Energy released.

$\Delta H_{I.E}$  (Ionization Enthalpy) :- It is the change in enthalpy when 1 mole of outermost electrons are removed from 1 mole of isolated gaseous atoms/ions.

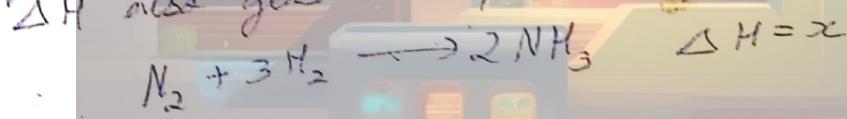
### Properties of Enthalpy of reactions :-

#### Properties of Enthalpy of reactions :-

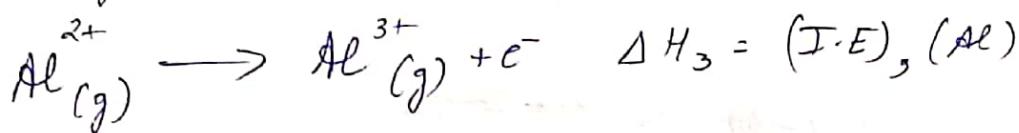
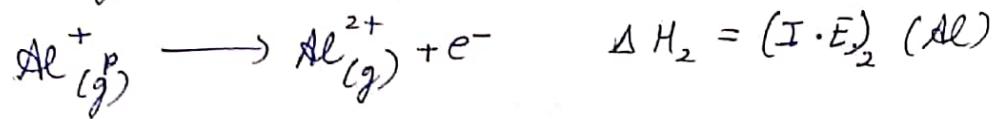
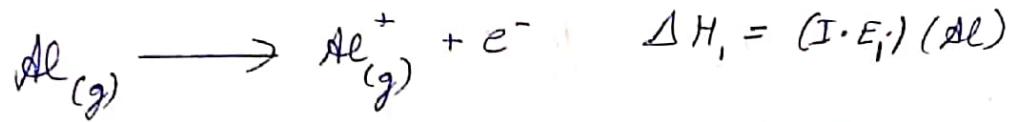
- ① If the reaction is reversed, the sign of  $\Delta H$  is also reversed.



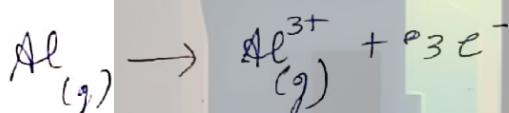
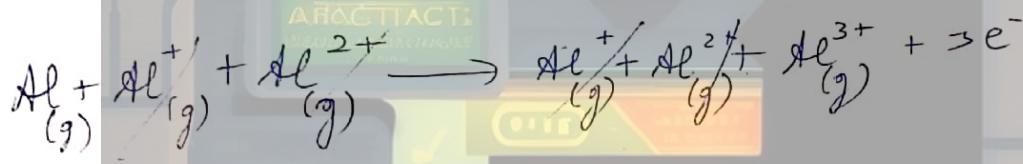
- ② If the reaction is multiplied by certain factor, then  $\Delta H$  also gets multiplied by that factor.



③ If two or more than two reactions are added, their  $\Delta H$  are also added

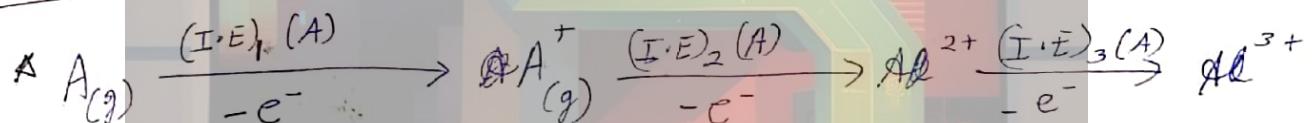


Adding the three



$$\boxed{\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3}$$

Successive Ionisation Energy =

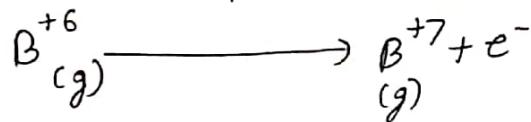


$$(I \cdot E)_1(A) = (I \cdot E)_2(A^+)$$

$$(I \cdot E)_3(A) = (I \cdot E)_2(A^+) = (I \cdot E)_3(A^{2+})$$

Note:-  $\boxed{(I \cdot E)_1 < (I \cdot E)_2 < (I \cdot E)_3}$

Q which of the following I.E's correspond to the process



- A) I.E<sub>1</sub>(B)  
✓ B) I.E<sub>6</sub>(B)  
✓ C) I.E<sub>7</sub>(B)  
✓ D) I.E<sub>5</sub>(B<sup>2+</sup>) ✓

- ✓ E) I.E<sub>4</sub>(B<sup>3+</sup>) ✓  
✓ F) I.E<sub>3</sub>(B<sup>4+</sup>) ✓  
✓ G) I.E<sub>1</sub>(B<sup>5+</sup>) ✓  
✓ H) I.E<sub>2</sub>(B<sup>6+</sup>) ✓  
✓ I) I.E<sub>6</sub>(B<sup>+1</sup>) ✓

Q

Valence e<sup>-</sup> calculation

~~(I.E)~~<sub>1</sub>(x)

Q. An element X, find valence shell e<sup>-</sup>

$$(I.E)_1(x) = 5 \text{ ev/atom}$$

$$(I.E)_2(x) = 13 \text{ ev/atom}$$

$$(I.E)_3(x) = 80 \text{ ev/atom}$$

$$(I.E)_4(x) = 100 \text{ ev/atom}$$

valence shell has 2e<sup>-</sup>

Q. Identify X

$$(I.E)_1(x) = 8 \text{ ev/atom}$$

A) Be

$$(I.E)_2(x) = 14 \text{ ev/atom}$$

B) Na

$$(I.E)_3(x) = 25 \text{ ev/atom}$$

C) Al

$$(I.E)_4(x) = 140 \text{ ev/atom}$$

D) B

$$(I.E)_5(x) = 172 \text{ ev/atom}$$

$$(I.E)_6(x) = 210 \text{ ev/atom}$$

Q3. find the no. of valence shell  $e^-$  in element A.

$$I.E_1 = 28 \text{ eV/atom}$$

$$I.E_2 = 39 \text{ eV/atom}$$

$$I.E_3 = 64 \text{ eV/atom}$$

$$I.E_4 = 102 \text{ eV/atom}$$

$$I.E.5 = 775 \text{ eV/atom}$$

$$I.E.6 = 1020 \text{ eV/atom}$$

$$\text{Valence Shell } e^- = 3$$

factors affecting I.E. →

① Effective Nuclear Charge ( $Z_{eff}$ ) :- Ionisation energy is directly proportional to  $Z_{eff}$ .

$$Z_{eff} \uparrow \wedge I.E. \uparrow$$

Size ↓

$$Z_{eff} \propto \frac{1}{\text{size}} \propto I.E.$$

② value of  $n$ :

$$n \uparrow; \text{size} \uparrow; I.E. \downarrow$$

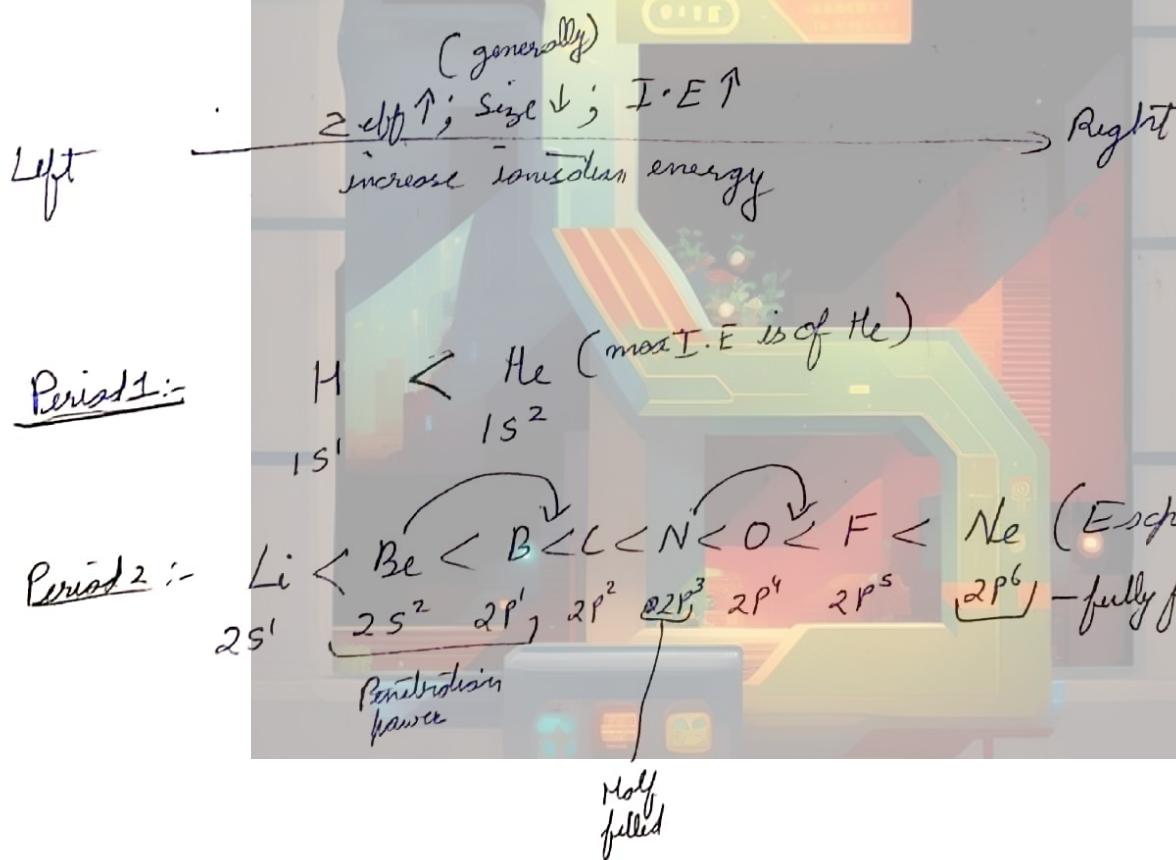
$$I.E. \propto \frac{1}{\text{size}} \propto \frac{1}{n}$$

③ Type of subshell -

$$ns > np > nd > nf$$

④ Half & fully filled e<sup>-</sup> config:- Half & fully filled e<sup>-</sup> config are more stable hence process of e<sup>-</sup> removal will be difficult for such configuration -

Variation along period - Variation of ionisation energy across period.



Li  $<$  B  $<$  Be  $<$  C  $<$  O  $<$  N  $<$  F  $<$  Ne (Actual)

Reason :- ① Due to high penetration of  $2s$  subshell compared to  $2p$  subshell, the removal of  $e^-$  from  $2s$  of Be requires more energy as compared to energy required for removal of  $e^-$  from  $2p$  of boron.

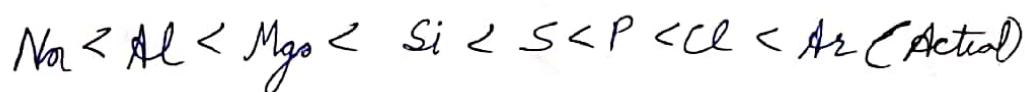
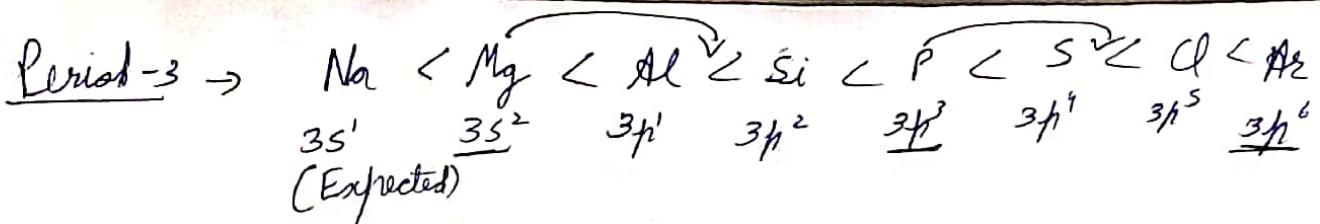
The configuration of Be is  $1s^2 2s^2$  which is more stable configuration therefore to remove an  $e^-$  from Be its stability should be broken first which requires energy. Also now  $e^-$  will be removed from  $2s$  which is closer to nucleus thereby requiring more energy.

Hence Overall energy requirement is high.

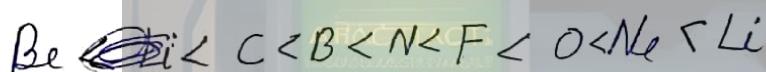
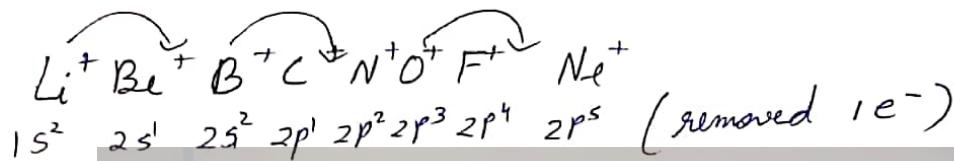
② In case of Nitrogen and oxygen, Nitrogen has half filled stability therefore to remove an electron more energy is required.

$$I.E.(N) > I.E(O)$$

③ Neon has highest ionisation energy in 2nd period due to fully filled electronic configuration and very high  $Z_{eff}$ .



Q1. ( $I.E_3$ ) order



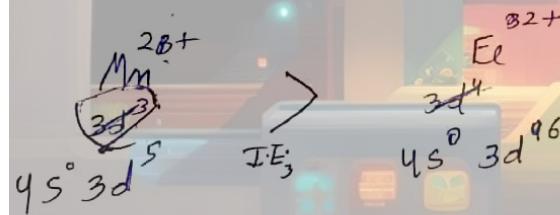
Note - In a periodic table He has highest Ionisation Energy.

② In periodic Table Cesium ~~has~~ has has highest ionisation energy. Cs/Fr

③ In D-block from left to right no regular order was observed hence need not to study

Q2.

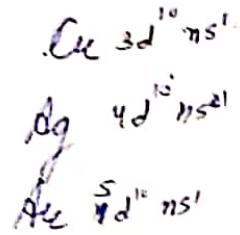
$I.E_3 \text{ Mn}$        $I.E_3 \text{ Fe}$



↓  
Half filled

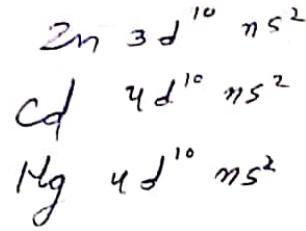
Q3. I.E.

Group 11



$<$   
 $<$   
 $<$

Group 12



Variation of I.E. down the group:-

Top



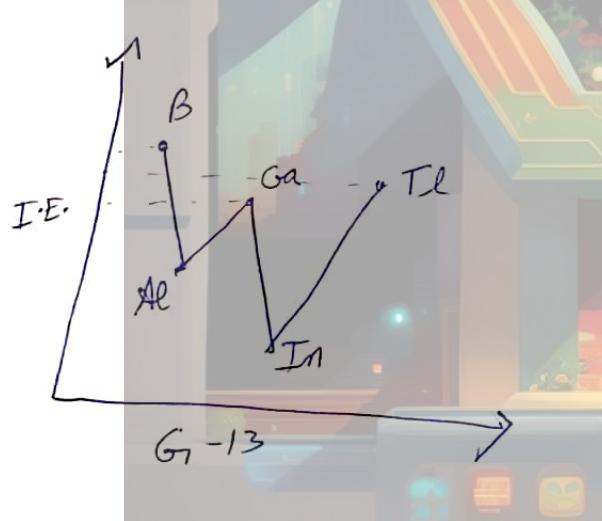
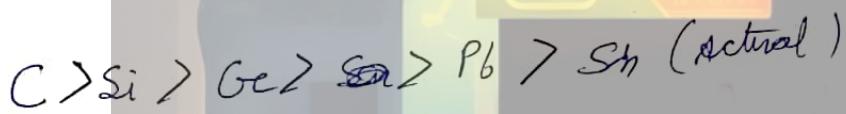
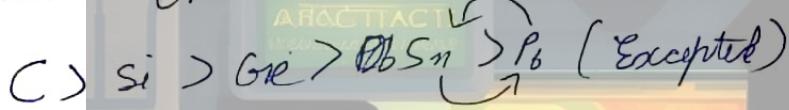
	G 1	G 2	G 13	G 14	G 15	G 16	G 17	G 18
Li	Be	E	C	N	O	F	Ne	
✓	✓	X	✓	✓	✓	✓	✓	
Na	Mg		Si	P	S	Cl	Az	
✓	✓		✓	✓	✓	✓	✓	
K	Ca	E	Ge	As	Se	Br	Kz	
✓	✓	C	✓	✓	✓	✓	✓	
Rb	Si	T	Se	Sb	Te	I	Xe	
✓	✓	T	✓	✓	✓	✓	✓	
Cs	Ba	I	Pb	Bi	P	At	Rn	
		R	V					
			Sn					

# Exception 1 - G<sub>7</sub>-13



	Actual
B	1
Al	5
Ga	3
In	2
Tl	4

# Exception 2 - G<sub>7</sub>-14



Explanation (Exception 1) — In Boron family, Due to lanthanides and D-~~state~~ contraction in Tl, its Z<sub>eff</sub> increases sharply due to which Ionisation Energy also increases and becomes next to boron.

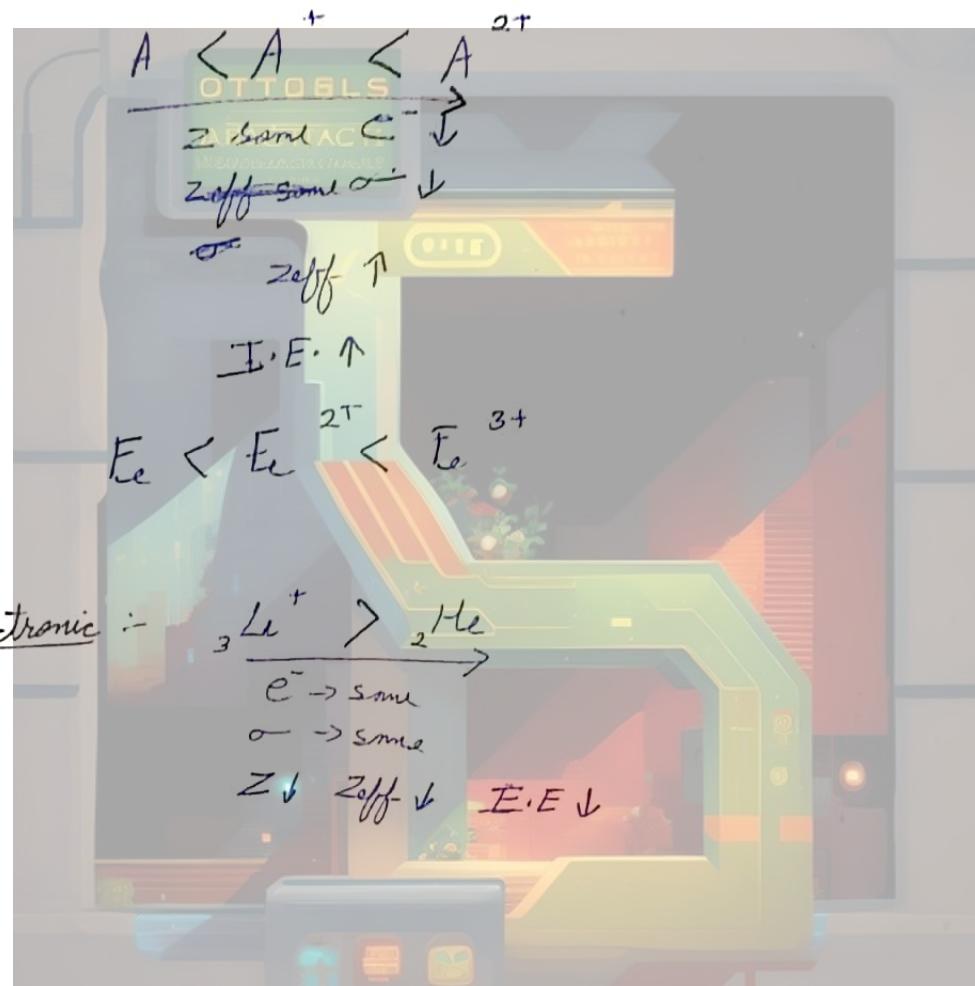
Similar effect is observed with respect to third Lead (Sn, Pb) but ionisation energy of lead does not increase too much like thallium.

## D-Block

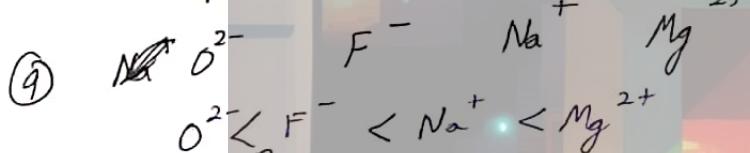
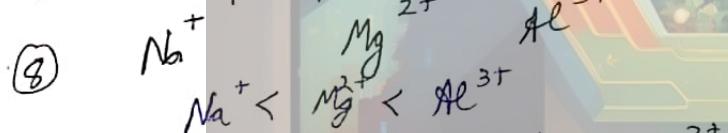
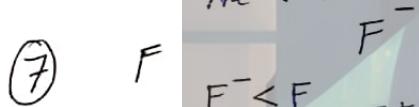
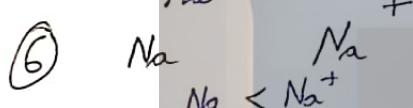
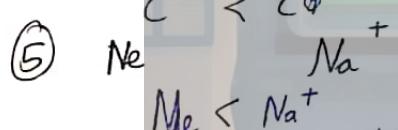
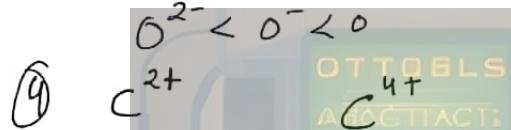
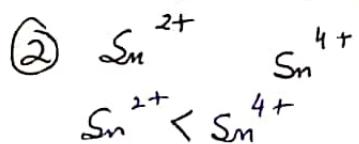
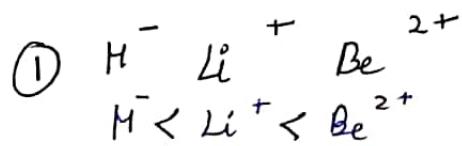
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
✓	ss								
Y	Zr	Nb	Mo	Tc	Ru	Rh	Pt	Ag	Cd
✓	VA	VA	VA	X	X	X	X	X	X
La	Hf	Ta	W	Re	Os	Ta	Pt	Ag	Pt

I<sub>so</sub> - Protonic :-

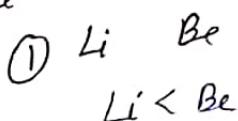
e.g. 1.



Q① I.E order



Q②:



(11)

③ B C N  
 $B < C < N$

④ O N F  
 $O < N < F$

⑤ N O  
 $O < N$

⑥ Na Al Mg Si  
 $Na < Al < Mg < Si$

⑦ Cl Br I  
~~Cl > B~~  $I < Br < Cl$

⑧ S O F  
 $S < O < F$

⑨ He Kr Xe  
 $Xe < Kr < He$

⑩ K Na Mg  
 $K < Na < Mg$

⑪ P As Sb  
 $Sb < As < P$

⑫ B Ga Al  
 $B, Al < Ga < B$

⑬ C Si Sn  
 $Sn < Si < C$

(14) Ge Mn

$$\text{Ge} < \text{Mn} \checkmark$$

(15) V Nb Ta

$$\text{V} \text{Ta} > \text{Nb} \simeq \text{V} \checkmark$$

(16) Sc Y La

$$\text{Sc} > \text{Y} > \text{La} \checkmark$$

(17) H<sup>-</sup> Li<sup>+</sup> Be<sup>2+</sup>

$$\text{H}^- < \text{Li}^+ < \text{Be}^{2+} \checkmark$$

### Application of I.E -

① As ionisation energy

I.E.↑, M.C.↓

increases, metallic character decreases

Ex :- Li > Na > K > Rb > Cs [I.E. order]

Metallic character order

$$\text{Li} < \text{Na} < \text{K} < \text{Rb} < \text{Cs}$$

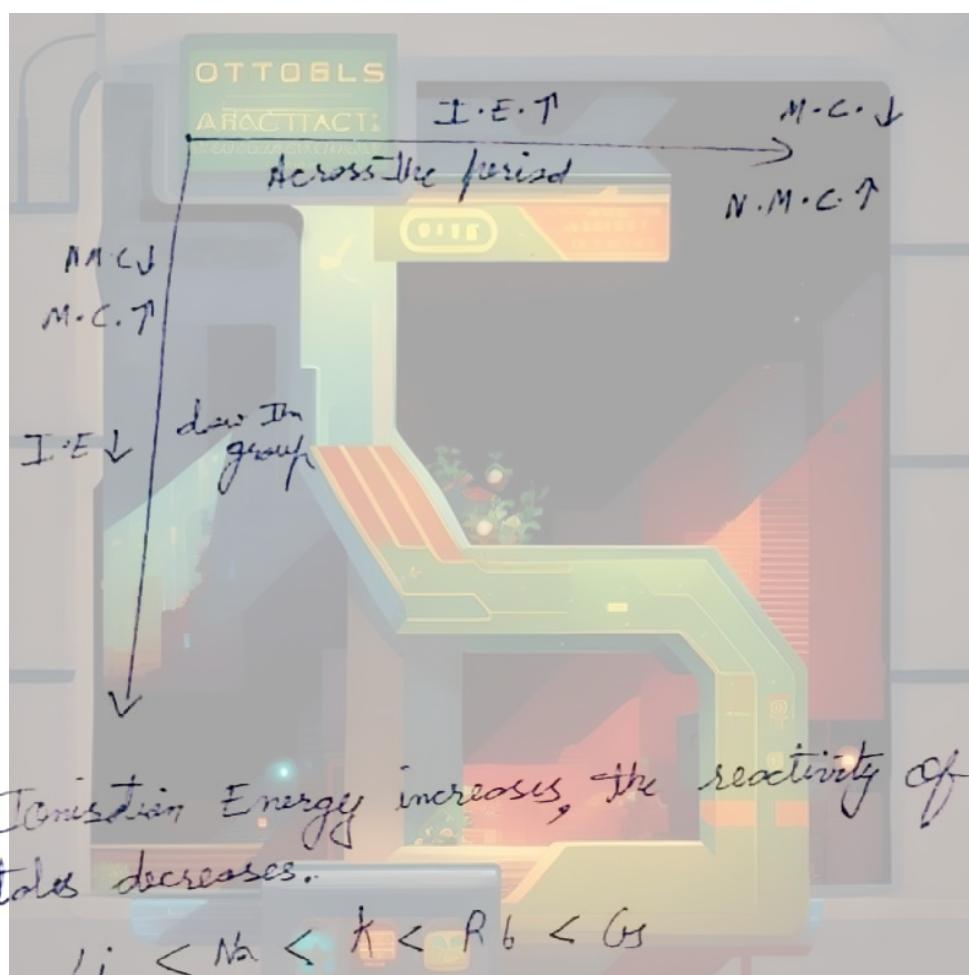
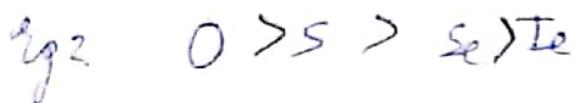
I.E.↑, M.C.↑

Eg 2.  $\frac{\text{Be}}{2s} < \frac{\text{B}}{2p}$

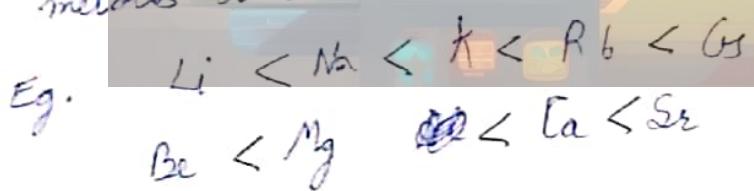
Eg 3.  $\text{Be} < \text{Mg}$

② As the ionisation energy increases, non-metallic character increases.

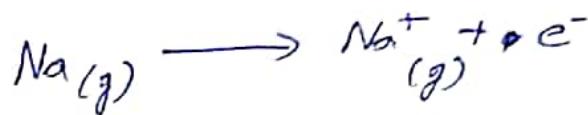
$$I.E \uparrow \quad N.M.C \uparrow$$



③ As Ionisation Energy increases, the reactivity of metals decreases.



④ Oxidation  $\rightarrow$  It means removal of  $e^-$ .



Reduction  $\rightarrow$  Addition of  $e^-$ .



Oxidising Power  $\rightarrow$

Oxidising Power  $\rightarrow$  It means the tendency of an element to oxidise other elements by reducing itself.

Reducing Power  $\rightarrow$  Tendency of an element to reduce other elements by oxidising itself. (Oxidise easily  $\Rightarrow$  loses electrons)

$$I.E. \propto \frac{1}{\text{Reducing Power}}$$

$$\underline{I.E. \downarrow \quad \text{Reducing Power} \uparrow}$$

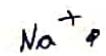
⑤ ② If

$$(I.E.)_{n+1} - (I.E.)_n > 16 \text{ eV/atom}$$

Then lower oxidation state ( $n$ ) will be more stable.

Na

eV/atom



IE<sub>1</sub>

05.1



IE<sub>2</sub>

41.2

36.1 Na<sup>+</sup> more stable

IE<sub>3</sub>

71.62

b)  $(I \cdot E)_{n+1} - (I \cdot E)_n < 11 \text{ eV/atom}$

then higher oxidation will be more stable

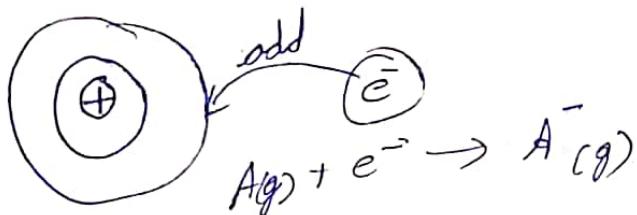
Eg2.  $(I \cdot E)_2 - (I \cdot E)_1 = 7.4 \text{ eV/atom} < 11 \text{ eV/atom}$

(Mg)

Mg<sup>2+</sup> is more stable than Mg<sup>+</sup>

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Electron Affinity (E.A.) - amount of energy released when an electron is added to the valence shell of an isolated gaseous atom or ion.



let energy released = 100 kJ/mol

$$E.A = 100 \text{ kJ/mol}$$

$$\Delta H_{E.g} (\text{electron gain enthalpy}) = -100 \text{ kJ/mol} \quad (\text{Exothermic reaction})$$

Electron Gain Enthalpy ( $\Delta H_{E.G.}$ ) - Change in enthalpy when ~~1 mol~~ mole of electrons are added to the outermost shell of 1 mole isolated gaseous atoms.



energy released = 0 (atom ka e⁻ ke liye koi affection nahi)

energy supplied = 100 kJ/mol

$$\Delta H_{E.g} = +100 \text{ kJ/mol}$$

endothermic

(e⁻ zabolardosti olaya)

at 0K (0 Kelvin)

$$\Delta H_{E.G.} = -E.A$$

Note:- ①  $\Delta H_{Eg} = -\text{ve}$ ;  $E.A = +\text{ve} \Rightarrow$  energy released

②  $\Delta H_{Eg} = +\text{ve}$ ;  $E.A = -\text{ve}$  or zero  $\Rightarrow$  energy absorbed

Note:-

① In case of inert gas or some stable configuration energy is ~~does~~ not released, instead of ~~this~~, we have to supply energy.

Ex Be, Mg, N and all inert gases (He, Ne, Ar, Kr, Xe, Rn) follow this and absorb energy on addition of electron.

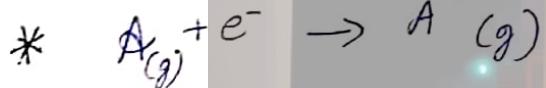
$$\Delta H_{Eg_1} = +\text{ve}$$

$$E.A_1 = -\text{ve}$$

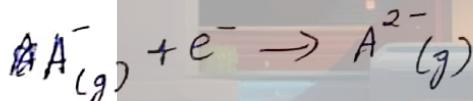
Rest all atoms except Be, Mg, N and inert gases

$$\Delta H_{Eg_1} = -\text{ve}$$

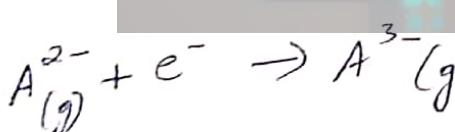
$$E.A_1 = +\text{ve}$$



$$\Delta H_{Eg_1} \text{ or } E.A_1$$



$$\Delta H_{Eg_2} \text{ or } E.A_2$$



$$\Delta H_{Eg_3} \text{ or } E.A_3$$

For Any Atom  $\rightarrow \boxed{\Delta H_{Eg_1} = +\text{ve} (\text{always})}$

Reason:- Since Anion is always negatively charged so, incoming electron faces repulsion from the Anion and its repulsion is dominating.

$$\Delta H \Rightarrow \text{supplied}$$

$$\left[ \Delta H_{E.G.E_3} > \Delta H_{E.G.E_2} > \Delta H_{E.G.E_1} \right]$$

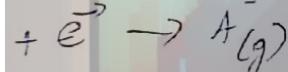
$\oplus$  ve

$\ominus$  ve or  $\oplus$  ve

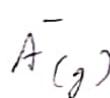
Note-  $E_{A_1^-}$  can be positive or negative

( $\text{Be}, \text{Mg}, \text{N}$ , All inert gases)

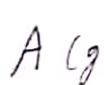
$\ominus \Delta H_{E.G.E_1}$  can be  $\ominus$  ve or  $\oplus$  ve



$\Delta H_{E.G.E_1} \Rightarrow \oplus \text{ve} / \ominus \text{ve}$



$\Delta H_{E.G.E_2} \Rightarrow \oplus \text{ve always}$

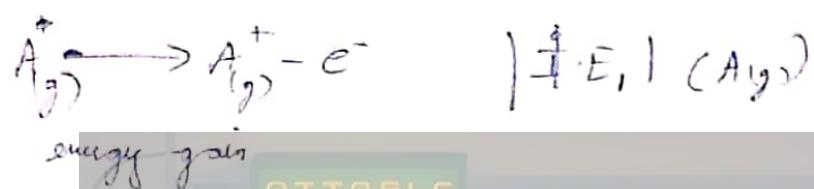
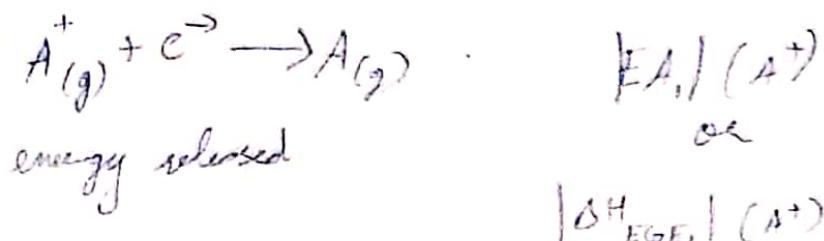


$\Delta H_{E.G.E_{\text{Total}}} = \Delta H_{E.G.E_1} + \Delta H_{E.G.E_2}$

$\ominus \text{ve} / \oplus \text{ve} + \oplus \text{ve}$

$\oplus \text{ve always}$

For Cations :-



$$| \Delta H_{E.G.E.1}(A^+) = | I.E.1(A)$$

$$| EA_1(A^+) = | I.E.1(A)$$

For Anion :-



$$| \Delta H_{E.G.E.1}(A_{(g)}) = | I.E.1(A_{(g)})$$

~~Trends in E.G.~~

## Trends in E.G.

①  $Z_{\text{eff}} \uparrow$  Attract  $\uparrow$  E.A.  $\uparrow$

② value of  $n$ :  $n \uparrow$ ; size  $\uparrow$ ;  $Z_{\text{eff}} \downarrow$ ; E.A.  $\downarrow$

③ Type of Subshell in which  $e^-$  is added - (Penetration power)

EA:  $ns > np > nd > nf$   
के निकट से प्रवाह करते हैं इनस की अवधि ज्यादा होती है।

④ Half filled & fully filled - for such atoms E.A. is very less or zero in magnitude.

## In Periodic Table

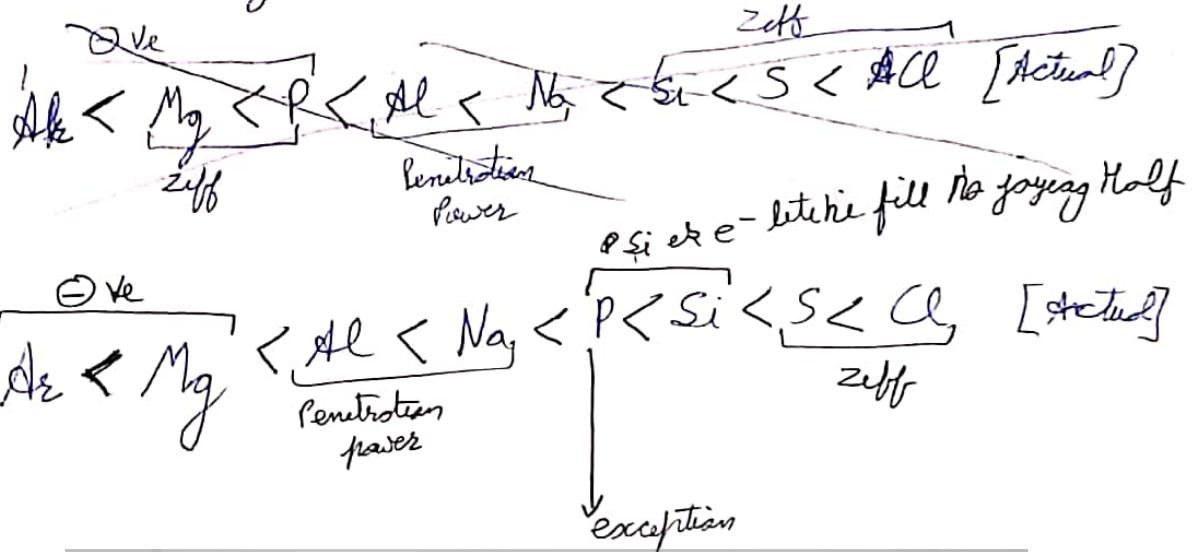
$Z_{\text{eff}} \uparrow$ ; E.A.  $\uparrow$  (in general)

Period - 2  $Li < Be < B < C < N < O < F < Ne$  (Expected)

$Ne < Be < N < B < Li < C < O < F$  (Expected)  
 $Z_{\text{eff}}$  Penetration power

Period - 1  $H > He$

Period-3  $\text{Na} < \text{Mg} < \text{Al} < \text{Si} < \text{P} < \text{S} < \text{Cl} < \text{Ar}$  [Expected]

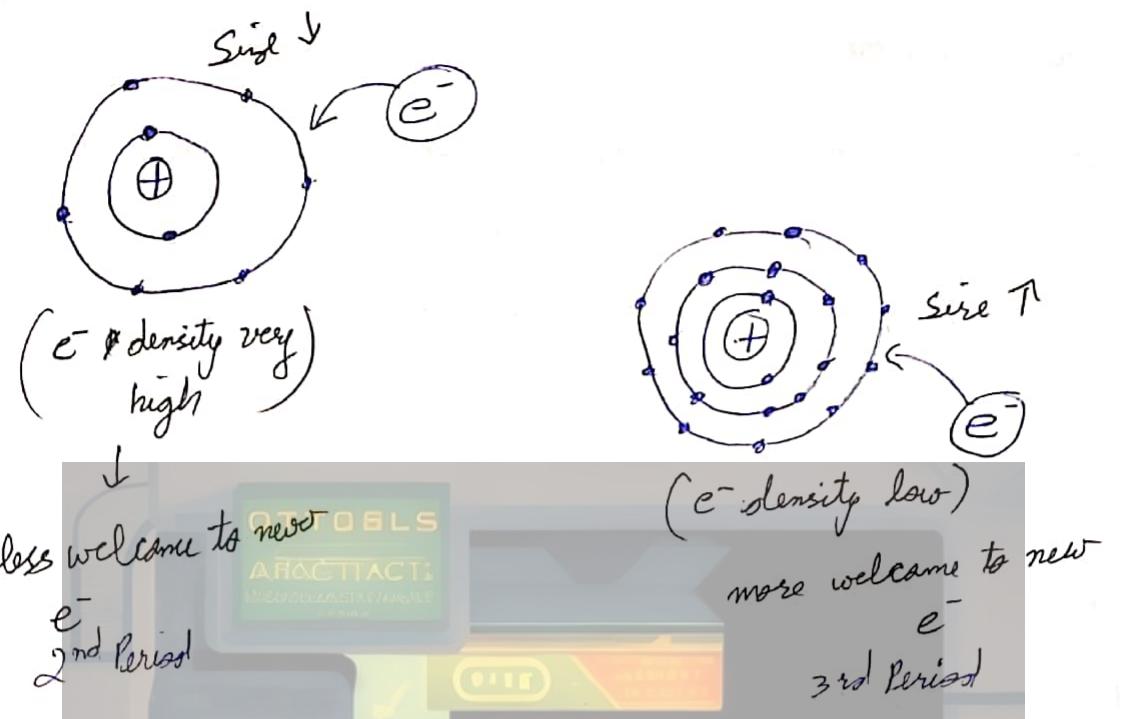


Top



2-nd Period :- B C N O F  
3-nd Period :- Al Si P S Cl

Reason:-



Due to small size of 2nd Period, P-Block elements, ~~other~~ other  $e^-$  which upcoming  $e^-$  feels more repulsion cause of other  $e^-$  which are already present in the atom.

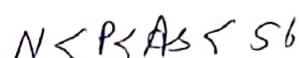
Halogen Family :-



Oxygen Family :-



Nitrogen :-



} experimental based on E.A. Data  
(No reason)

Note:-

- ① Oxygen and Nitrogen shows least e<sup>-</sup> affinity in their respective groups.
  - ② Chlorine has highest e<sup>-</sup> affinity in periodic table and fluorine comes to 2nd position.
  - ③ As E.A. ↑ ; Non metallic character ↑
- Q1. - E A. order?

① Cl, Br, I

$$I < Br < Cl \checkmark$$

② Na, Al, Mg, Si

$$Mg < Al < Na < Si \checkmark$$

③ F, Cl

$$F < Cl \checkmark$$

④ O, S

$$O < S \checkmark$$

⑤ C, N

$$N < C \checkmark$$

⑥ Se, S

$$Se < S \checkmark$$

⑦ P, As, Sb

$$P < As < Sb \checkmark$$

⑧ Li, Be, B

$$Be < B < Li \checkmark$$

⑨ O, F,  
 $O < F \checkmark$

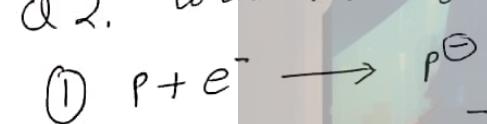
⑩ O, F, Cl  
 $O < F < Cl \checkmark$

⑪ N, O, F  
 $N < \cancel{O} \quad O < F \checkmark$

⑫ C, O  
 $C \cancel{O} < O \checkmark$

⑬ O, N  
 $N < O \checkmark$

Q2. Write the sign of  $\Delta H$  in the following.



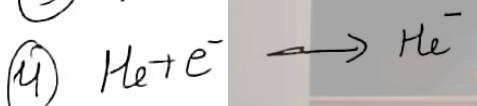
$$\Delta H = \Theta Ve \checkmark$$



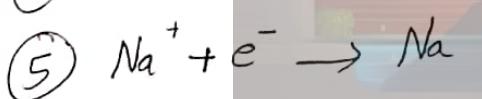
$$\Delta H = \cancel{\Theta} \quad \cancel{\Theta} \quad \Theta Ve \checkmark$$



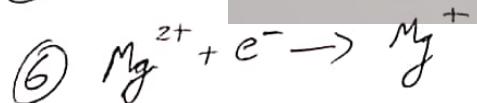
$$\Delta H = \oplus Ve \checkmark$$



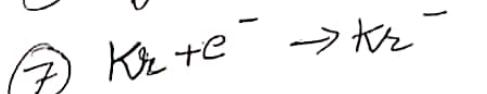
$$\Delta H = \oplus Ve \checkmark$$



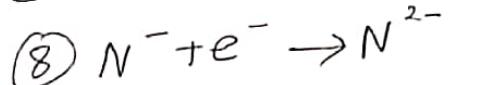
$$\Delta H = \Theta Ve \checkmark$$



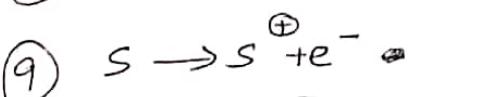
$$\Delta H = \Theta Ve \checkmark$$



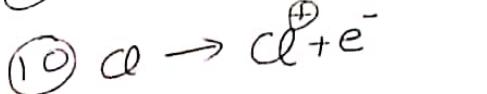
$$\Delta H = \cancel{\Theta} \quad \oplus Ve \checkmark$$



$$\Delta H = \oplus Ve \checkmark$$



$$\Delta H = \Theta Ve \checkmark$$



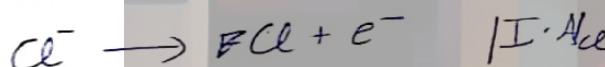
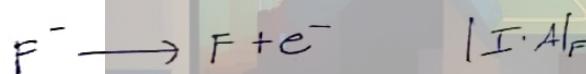
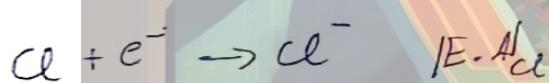
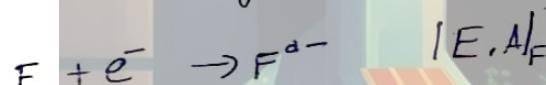
$$\Delta H = \Theta Ve \checkmark$$

## Application of E.A.

E.A means  $\rightarrow$  Gain of  $e^-$  easily  $\rightarrow$  Reduce easily  
 $\downarrow$   
Oxidise rapidly  
 $\downarrow$   
Oxidising Power  $\uparrow$

$\rightarrow$  As The value of E.A. increases, the oxidising Power of the element increases

Q) Compare I.E. of  $F^G$  and  $Cl^-$

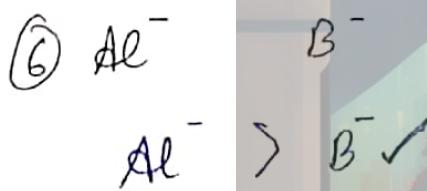
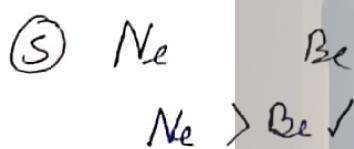
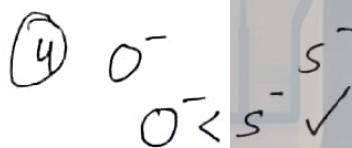
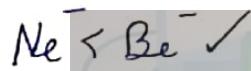
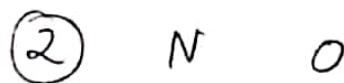
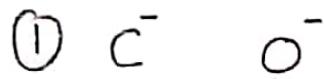


$$E.A = I.A$$

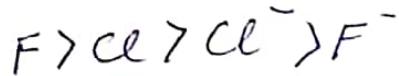
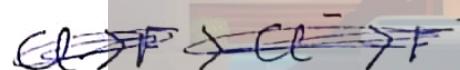
$$E.A_{Cl^-} > E.A_{F^-}$$

$$I.E_{F^-} < I.E_{Cl^-}$$

Q2. Compare I.E. order in following.



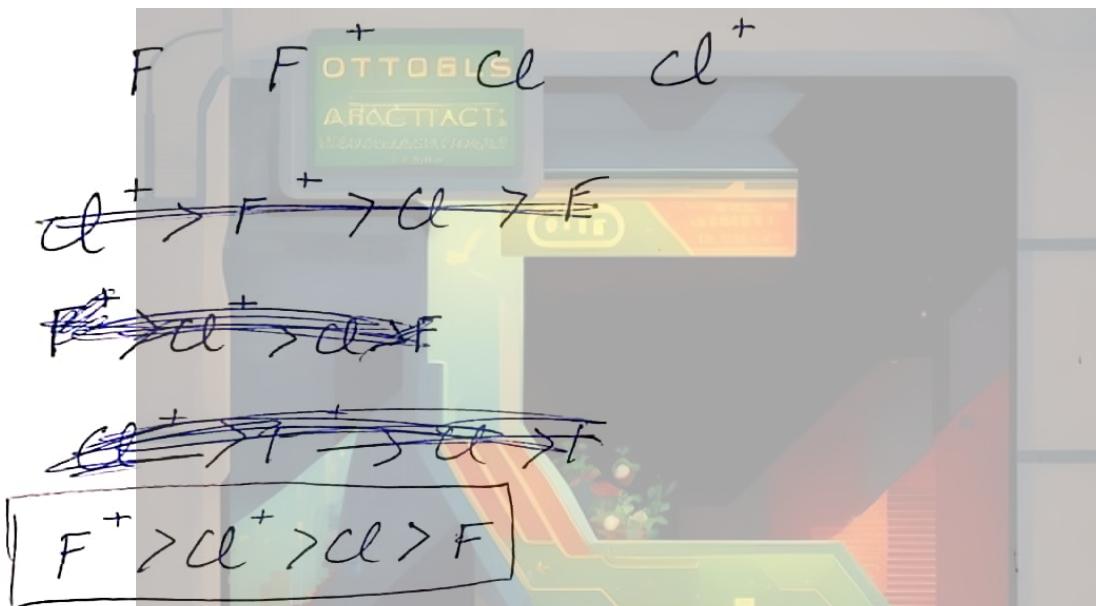
Q3. Compare I.E.



Q34. I.E.



(1) S.E. - A. order. ?



$Q \quad O \quad O^+ \quad S \quad S^+$



H.W. 06 - 05 - 2024

O-1 (Q 15-27)

O-2 (Q 3, 4, 5, 6)

~~O-3~~ S-1 (1, 3, 4, 5, 6, 9, 10, 11)

(~~6, 7~~) (~~10, 5~~)

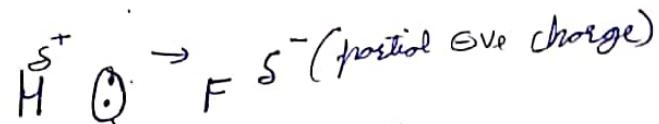
J-A A (Q 3, 1, 4, 5, 8)

J-M (Q 1, 4, 5, 8, 10, 11, 14, 1@.9, 21, 26, 28, 29, -33, 36, 38)

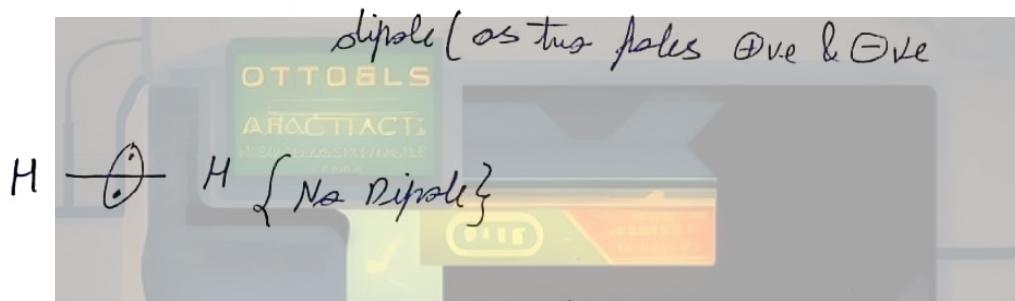


## Electron Negativity (E.N) (x)

→ It is the tendency to attract shared pair of electrons by an element in a covalent bonded molecule.



↓ shared pair of  $e^-$  moves slightly to F as it is powerful.



→ Electron Negativity has no unit.

→ Three Scales to measure → Pauling Scale, Mulliken Scale, Alfred Rochow Scale.

### ① Pauling Scale of E.N. :-

→ It is a relative scale of Electron Negativity (Reference element - Fluorine (F)).

→ Used Bond energy data to find Electron Negativity -  
for two atoms A & B

$$\Delta E_N = \frac{E_B - E_A}{E_{A-B}} = 0.208 \sqrt{E_{A-B}^{-1} \cdot E_{A-A} \times E_{B-B}}$$

$EN_A \Rightarrow$  Electron Negativity of A

$EN_B \Rightarrow$  Electron Negativity of B

$E_{A-B} \Rightarrow$  Bond energy of A-B bond (~~kJ~~ Kcal/mol)

$E_{A-A} \Rightarrow$  Bond energy of A-A bond (Kcal/mol)

$E_{B-B} \Rightarrow$  Bond energy of B-B bond (Kcal/mol)

$$\Delta EN = |EN_B - EN_A| = 0.102 \sqrt{E_{A+B}} \sqrt{E_{A-A} \times E_{B-B}}$$

~~for kJ/mol~~ for Kilo J/mol

Q1. If  $EN_A = 2$

$EN_B > EN_A$

$$E_{A-B} = 76 \text{ Kcal/mol}$$

$$E_{A-A} = 81 \text{ Kcal/mol}$$

$$E_{B-B} = 64 \text{ Kcal/mol}$$

$$EN_B = ?$$

$$EN_B = \cancel{0.2} + 0.208 \sqrt{76 - \sqrt{81 \times 64}}$$
$$= 2 + 0.208 \sqrt{76 - 72}$$
$$= 2 + 0.208 \times 2$$
$$= 2 + 0.416$$

$$EN_B = 2.416$$

Q2. Calculate  $EN_A$  if

$$EN_B = 3$$

$$E_{AB} = 65 \text{ kcal/mol}$$

$$E_{A-A} = 49 \text{ kcal/mol}$$

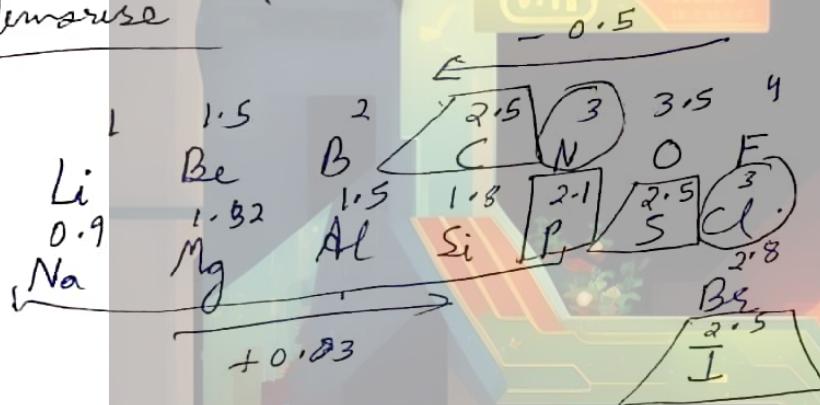
$$E_{B-B} = 64 \text{ kcal/mol}$$

$$EN_A = 3 + 0.208 \times 3$$

$$= 3 + 0.624$$

$$\boxed{= 3.624}$$

Memorise



$$\boxed{H \rightarrow 2.1}$$

Note -

$$C \approx I \approx S = 2.5$$

$$H \approx P = 2.1$$

$$N \approx Cl = 3$$

$$F = 4 \text{ (Max)}$$

## ② Mulliken Scale

$$E.N(x) = \frac{|I.E.(x)| + |E.A.(x)|}{2}$$

I.E, E.N in eV/atom

$$(E.N)_p = \frac{(E.N)_m}{2.8}$$

Q Calculate E.N. (Cl) in Paulin Scale

$$I.E(Cl^-) = 4 \text{ ev/atom} = [E.A]_{Cl}$$

$$E.A(Cl^+) = 13 \text{ ev/atom} = [E.I]_{Cl}$$

$$EN.(m) = \frac{13 + 4}{2}$$

$$= \frac{17}{2}$$

$$(E.N.)_p = \frac{17}{2} \times \frac{1}{2.8}$$

$$= \frac{17}{5.6} = 3.03$$

③ Alfred Roschow Scale :-

$$E.N._{(AR)}(x) = \frac{0.359 Z_{\text{eff}}}{r^2}$$

$Z_{\text{eff}}$  → effective nuclear charge

$r$  → covalent radius in  $\text{\AA}^\circ$

$$1 \text{ \AA}^\circ = 10^{-10} \text{ m}$$

$$1 \text{ pm} = 10^{-12} \text{ m}$$

$$E.N._P(x) = E.N._{AR} + 0.744$$

$Z_{\text{eff}} \uparrow$ ;  $E.N. \uparrow$

Factors Affecting Electron Negativity

①  $Z_{\text{eff}}$  :-

$Z_{\text{eff}} \uparrow$

$E.N. \uparrow$

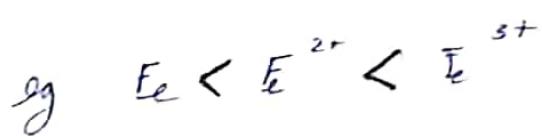
② Value of  $n$  :-

$n \uparrow$

$E.N. \downarrow$

③ charge :- (+ve)

$E.N \propto$  oxidation state of element.

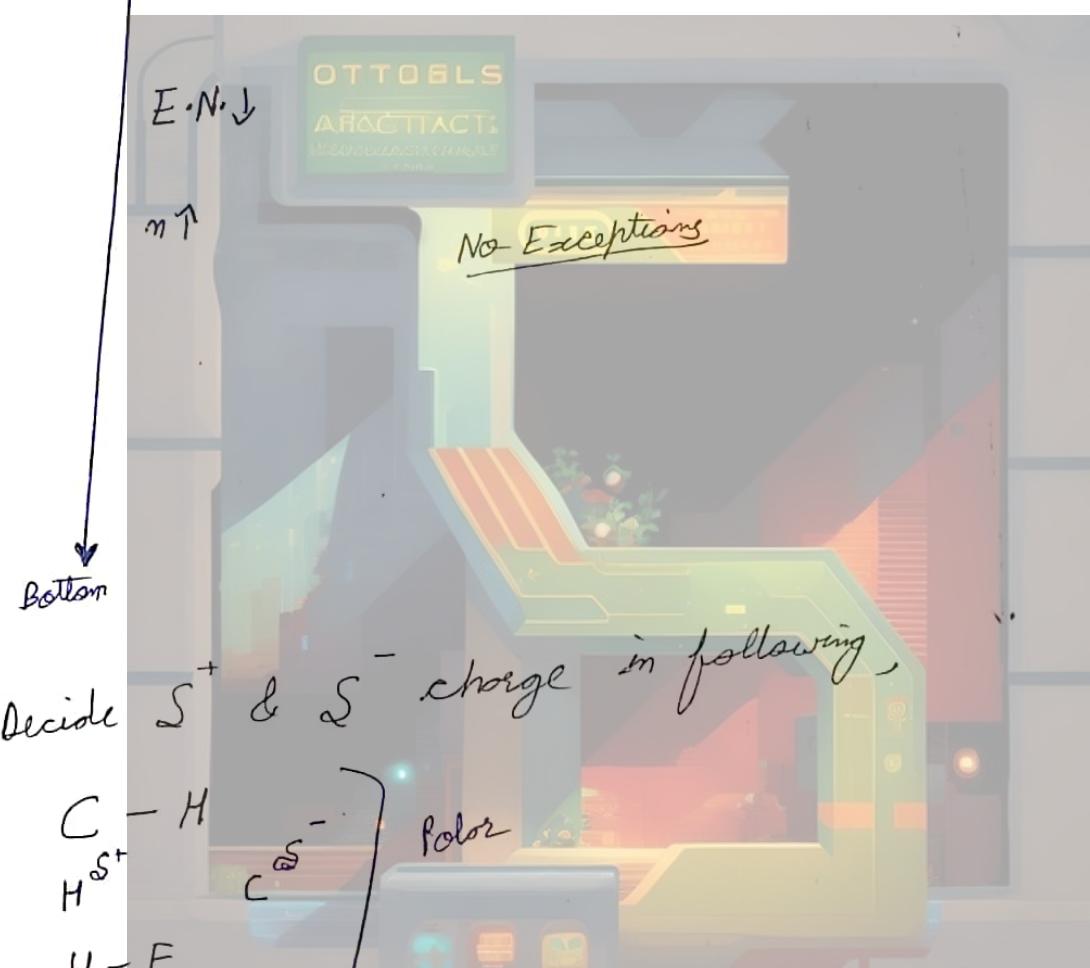


~~Note~~

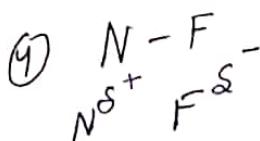
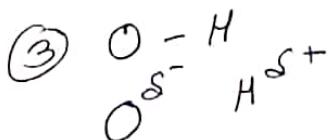
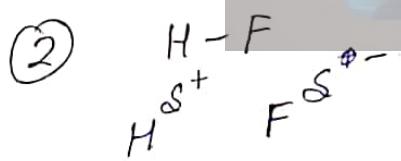
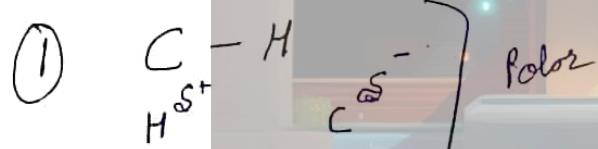
Note - ① No Effect of half filled or fully filled e<sup>-</sup> config.

Variation across Periodic Table

Left Top  $Z_{eff} \uparrow$  E.N.T Right



Q: Decide  $S^+$  &  $S^-$  charge in following,



(2)

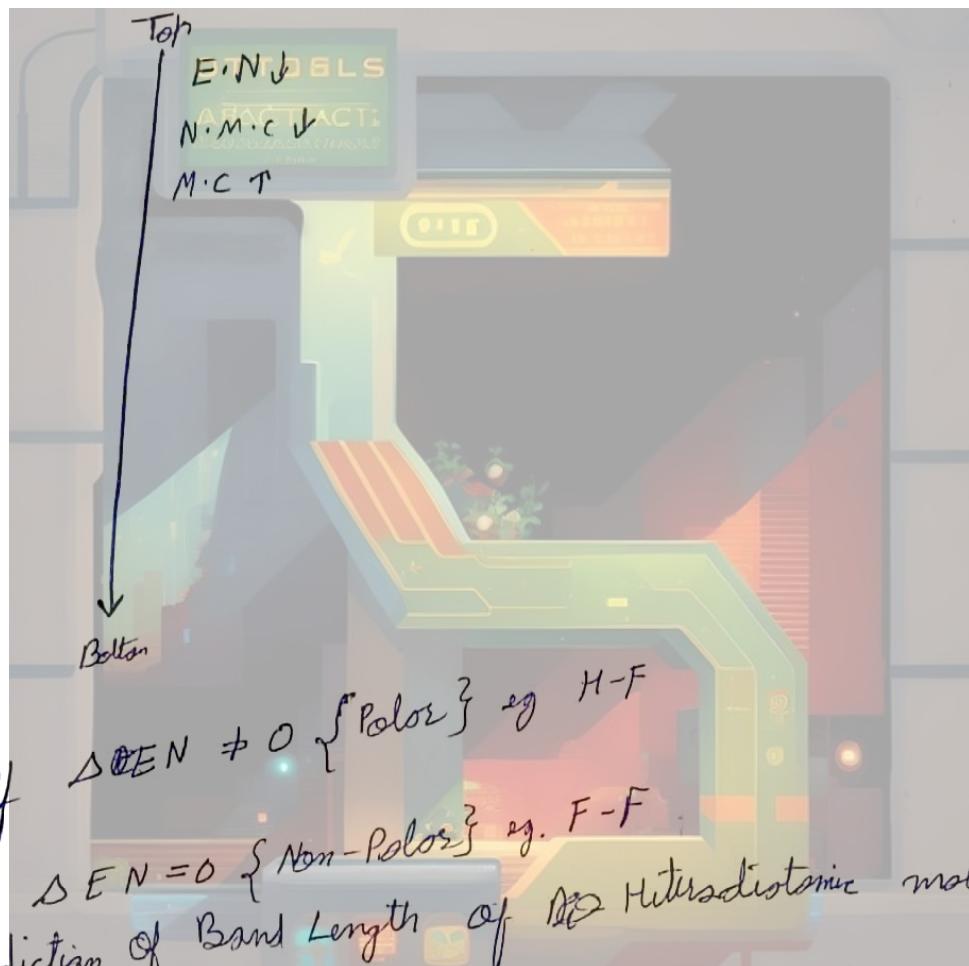
F - F

(5) Non-Polar

## Applications of Electron Negativity

→ ①

$$\xrightarrow{\substack{L \text{ size} \downarrow; Z_{\text{eff}} \uparrow; EN \uparrow; I.E \uparrow; E.A \uparrow \\ M.C. \downarrow; N.M.C. \uparrow}}$$



- ② If  $\Delta EN \neq 0$  {Polar} e.g. H-F  
 $\Delta EN = 0$  {Non-Polar} e.g. F-F
- ③ Prediction of Bond Length of Heteroditomic molecule.

$$d_{AB} = r_A + r_B + 0.09 |EN_A - EN_B| \text{ (in } \text{\AA})$$

(4) Predicting of % of ionic character in covalent bond.

$$\boxed{\% \text{ Ionic character} = 1.68 / (\Delta EN) + 3.5 (\Delta EN)^2}$$

$\Delta EN$  in Pauling Scale

$EN \uparrow ; \% \text{ I.C.} \uparrow ; \% \text{ covalent character} \downarrow$

$$\% \text{ I.C.} + \% \text{ covalent character} = 100$$

Q1. calculate % Ionic character order:

H-F	H-Cl	H-Br	H-I
1.9	0.9	0.7	0.4

$$H-F > H-Cl > H-Br > H-I$$

Q2. Calculate Covalent Character (CC) order in Cl-F bond.

$$EN_{\alpha} = 3$$

$$EN_{N.F} = 4$$

$$\Delta EN = 4 - 3 = 1$$

$$IAC = 16 + 3.5$$

$$\boxed{IAC = 19.5}$$

$$CC = 100 - IAC$$

$$\boxed{CC = 80.5}$$

Q3. I.C% in HCl

$$\Delta EN = 2.1 - 3 \\ = 0.9$$

$$I \cdot C = 16(0.9) + (0.9)^2 \\ = 14.4 + 0.81$$

$$\boxed{= 22.5} \quad = 14.4 + 2.8 \\ = 17.2$$

$$\begin{array}{r} 9 \\ 350 \\ 81 \\ \hline 350 \\ 28000 \\ \hline 28350 \end{array}$$

Q4.  $\Delta EN$  for  $I \cdot C = 50$

$$\Delta EN = x$$

OTTOBLS  
ARACTACTIC

$$50 = 16x + \frac{0.81(x^2)}{3.5}$$
$$7x^2 + 10x - 100$$
$$x = -14 \pm \sqrt{196 + 2800}$$
$$= -14 \pm \sqrt{2996}$$
$$= -14 \pm 54$$
$$x = -32 \pm \sqrt{1024 + 2800}$$
$$= -32 \pm \sqrt{3824}$$
$$= -32 \pm 61$$
$$= \frac{-16 \pm 30.5}{7}$$
$$= \frac{14.5}{7}$$
$$\boxed{= 2.1}$$

496  
416  
104  
224  
122

Note:- In Real, no bond is 100% ionic or 100% covalent.

$$\Delta EN = 2.1$$

$$\% \text{ I.C} = 50\%$$

$$\% \text{ C.C} = 50\%$$

Predominantly ionic compound

Nature of Compound  $\rightarrow$  Ionic

$$\Delta EN < 2.1$$

$$\% \text{ I.C} < 50\%, \% \text{ C.C} > 50\%$$

Covalent compound

$$\Delta EN > 2.1$$

$$\% \text{ I.C} > 50\%, \% \text{ C.C} < 50\%$$

Ionic compound

Q1. If the value of  $\sqrt{E_{A-B} - \frac{1}{2}(E_{AA} + E_{BB})}$  is termed as  $\Delta$ , if  $\Delta$  is given as 14.4 for elements A and B, and bond length of A-A bond is  $1.4 \text{ \AA}$  and bond length of B-B bond is  $1.2 \text{ \AA}$ . Calculate -

- Calculate I.C of A-B bond.
- Covalent bond length of A-B bond.

$$\Delta EN = 0.102 \times 14.4$$

$$= 1.4688$$

$$\begin{array}{r} 144 \\ 102 \\ \hline 288 \end{array}$$

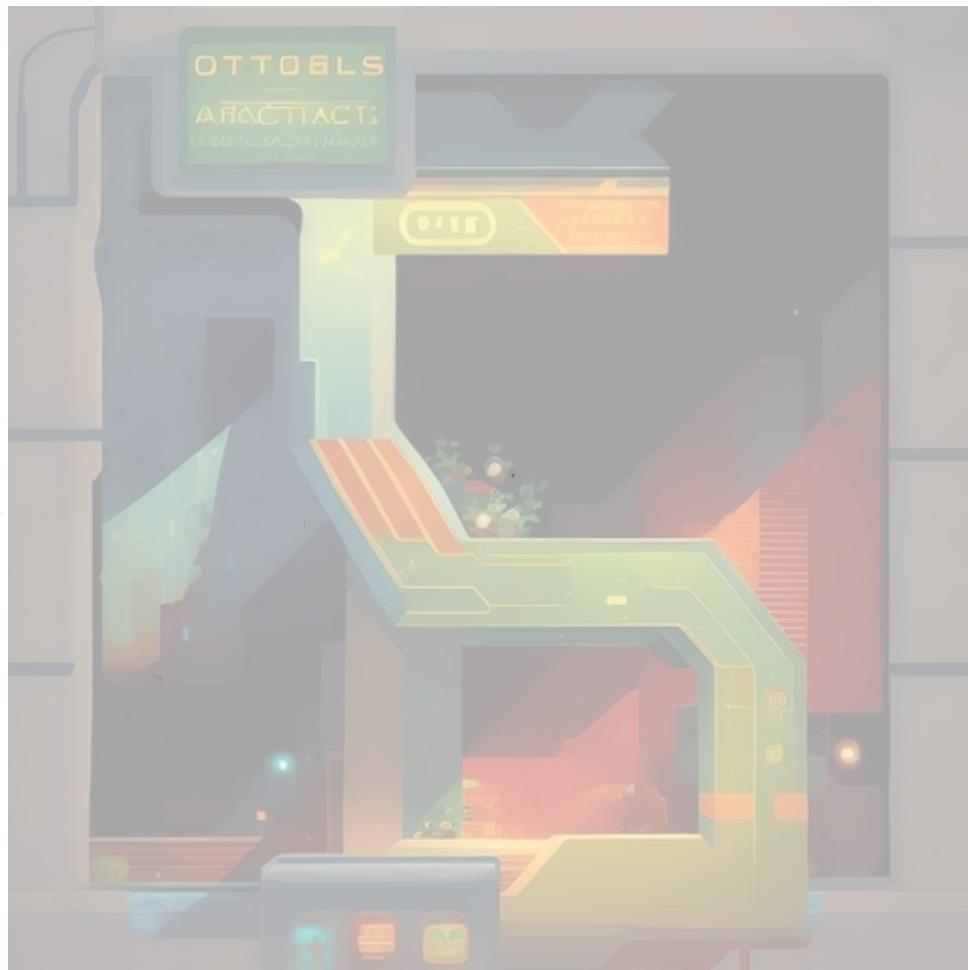
$$\therefore \text{I.C} = 16(1.4688) + 0.35(1.4688)^2$$

$$\begin{array}{r} 14400 \\ 14688 \\ \hline 512 \end{array}$$

$$\therefore \text{I.C} = 23.5008 + 0.7556$$

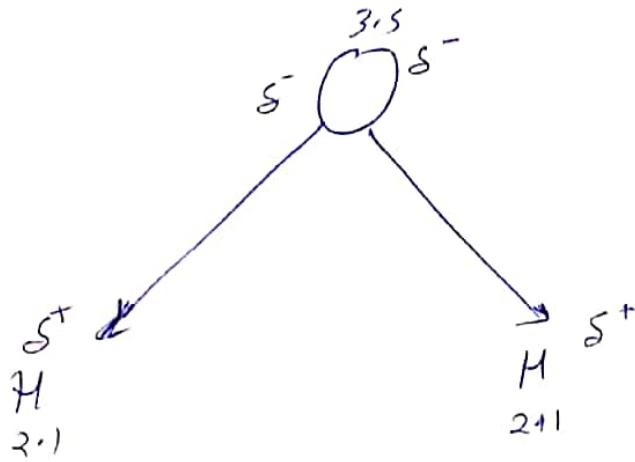
$$= 24.25\%$$

$$\text{Bond length} = D_{A,B} = 0.5 + 0.6 - 0.09(1.4688)$$
$$= 0.5 + 0.6 - 0.132 \cancel{1.4688}$$
$$= 0.968 \text{ \AA}^{\circ}$$



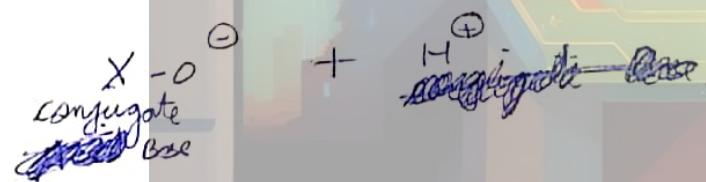
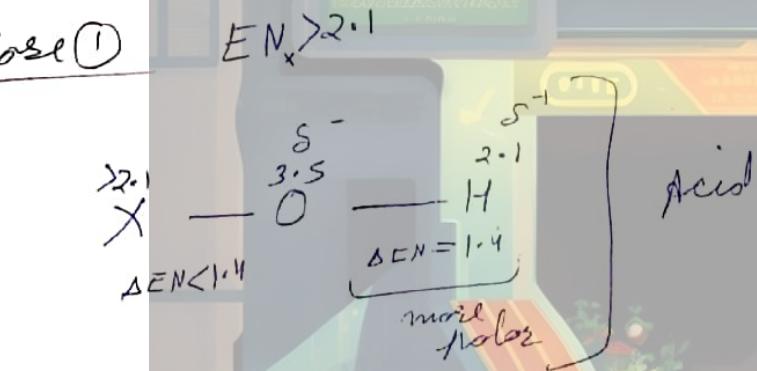
# Nature of Hydroxide

→

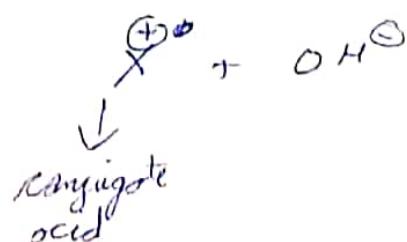
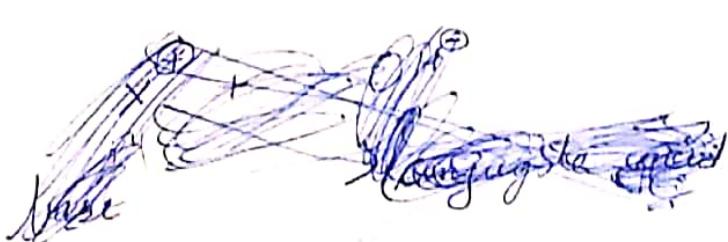
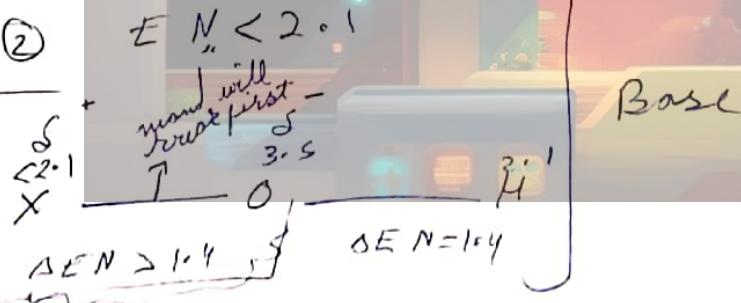


more polar bond will break in aqueous solution.

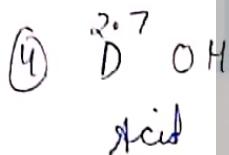
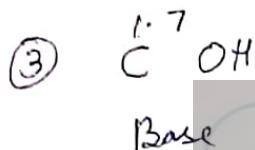
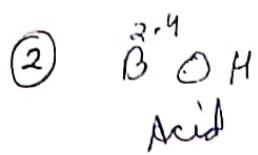
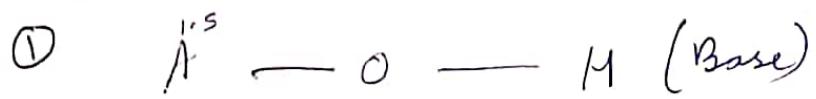
Case ①



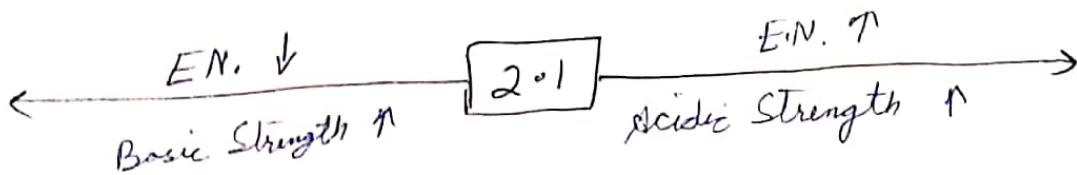
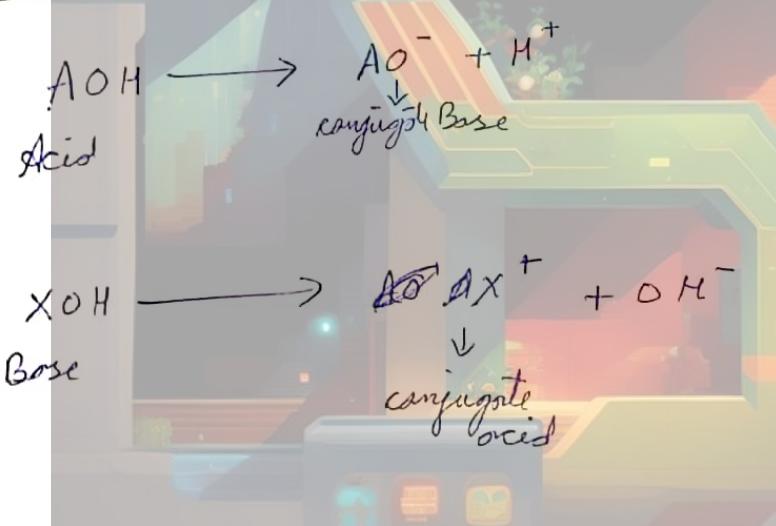
Case ②



Q find Acid & Base.

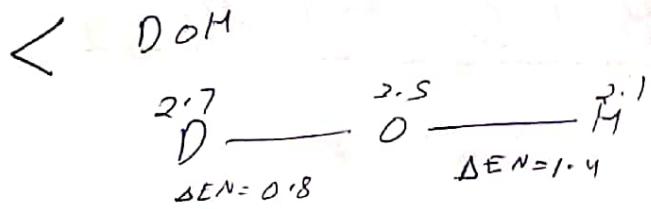
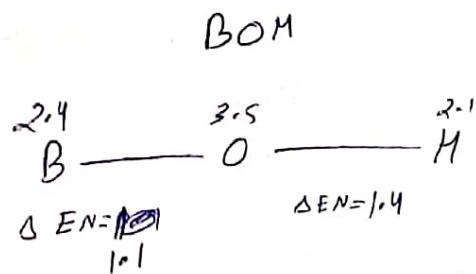


Acidic And Basic Strength of Hydroxides.



Ex.:

### Acidic Strength

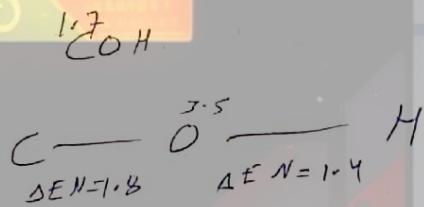
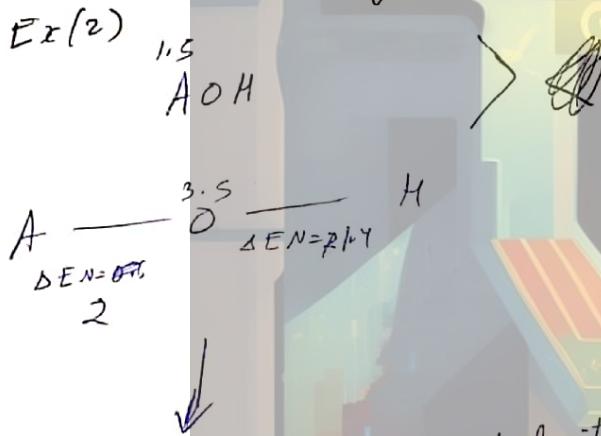


less ~~SEN~~, less strength in ~~bond~~  
break easily

conjugate Base more ~~stable~~ stable

Thus, Acid strength ↑

### Basic strength



Break easily (because of high polarity)

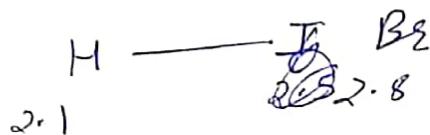
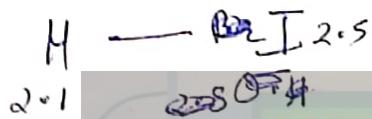
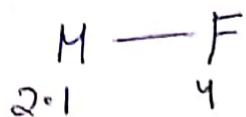
More Basic strength ↑

More stable Conjugate Acid.

## ~~XX~~ Bond Strength/Bond Energy

Bond Strength  $\propto \Delta E_{\text{EN}}$

Ex:-



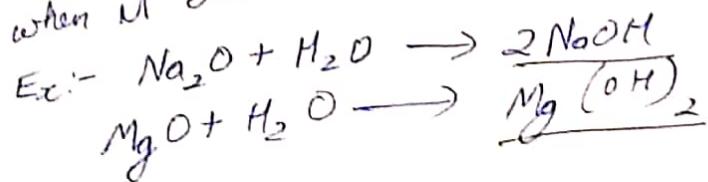
$\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$  (Bond strength)  
 $\Delta E_{\text{EN}} \uparrow$ , bond strength  $\uparrow$

$\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$  (Acidic strength)  
 $\Delta E_{\text{EN}} \downarrow$ , acidic strength  $\downarrow$

## ~~XX~~ Types of Oxides

① Basic oxides -  $(M^{\uparrow \text{ metal}} \rightarrow \text{Basic})$   
 $\rightarrow$  usually metals form basic oxides which reacts with acid.

$\rightarrow$  when it dissolve in water ( $\text{H}_2\text{O}$ ) form base.

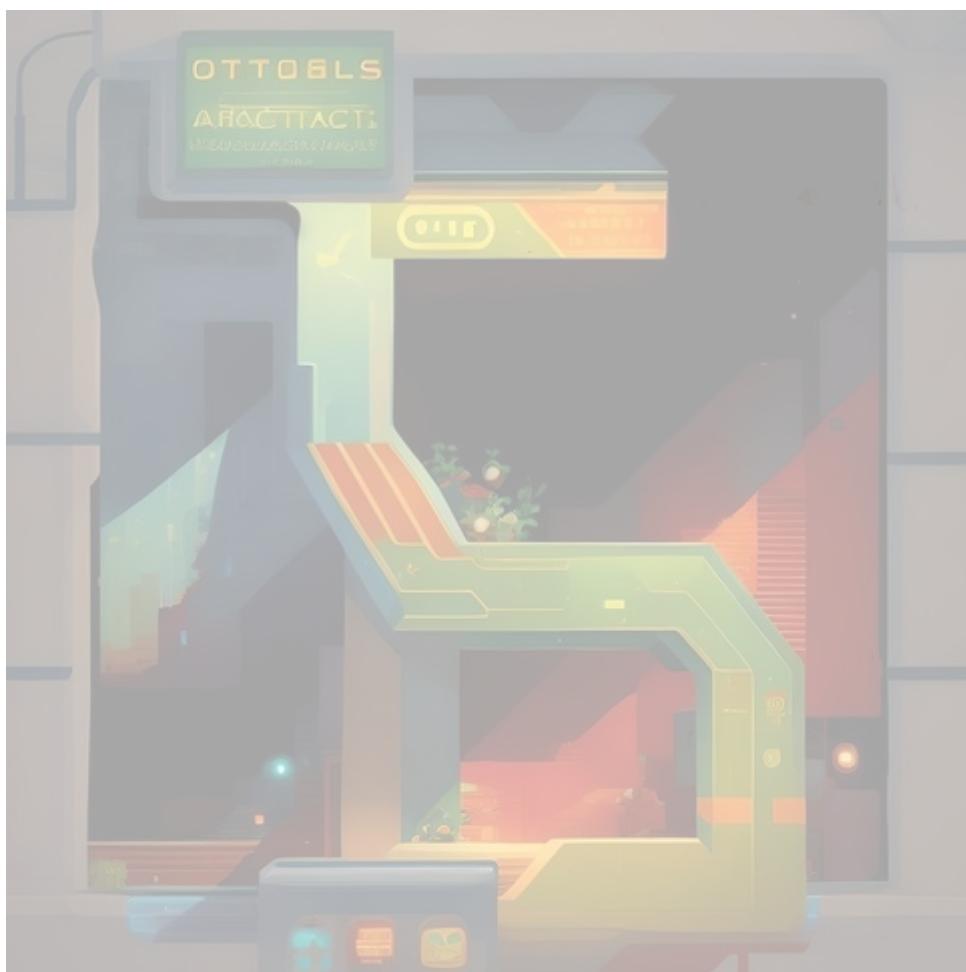


M.W.

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~~2024~~

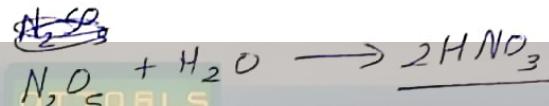
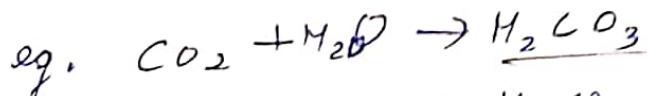
O-1, S-1 (complete)



## ② - Acidic Oxides ( $\overset{\text{non metals}}{\underset{\text{N/M/A}}{\text{NM}}} \rightarrow \text{Acidic}$ )

→ usually Non-metals forms Acidic oxides which reacts with base.

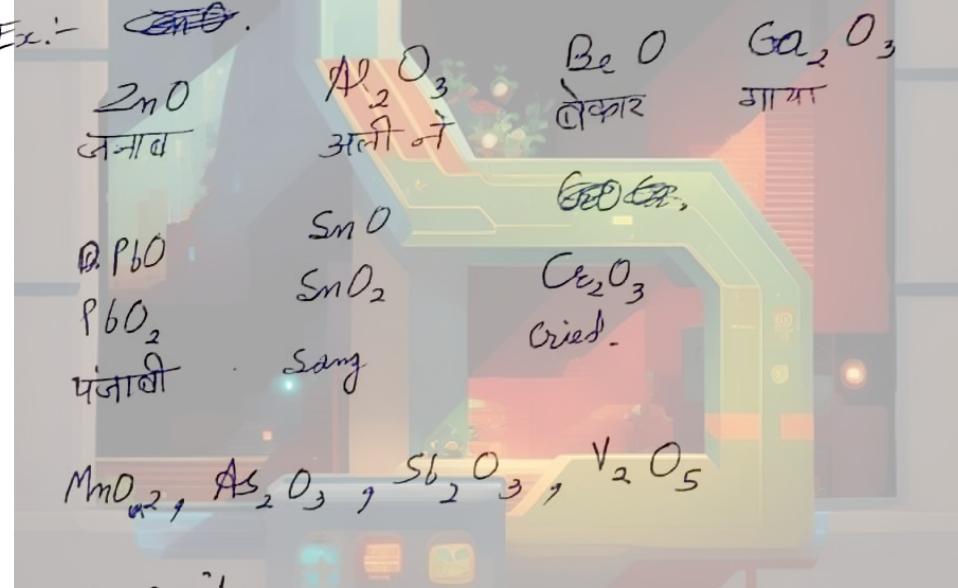
→ when it dissolves in water forms acids.



## ③ - Amphoteric Oxides -

→ They react with both acids and bases.

Ex. -  ~~$\text{Al}_2\text{O}_3$~~ .



## ④ - Neutral Oxides

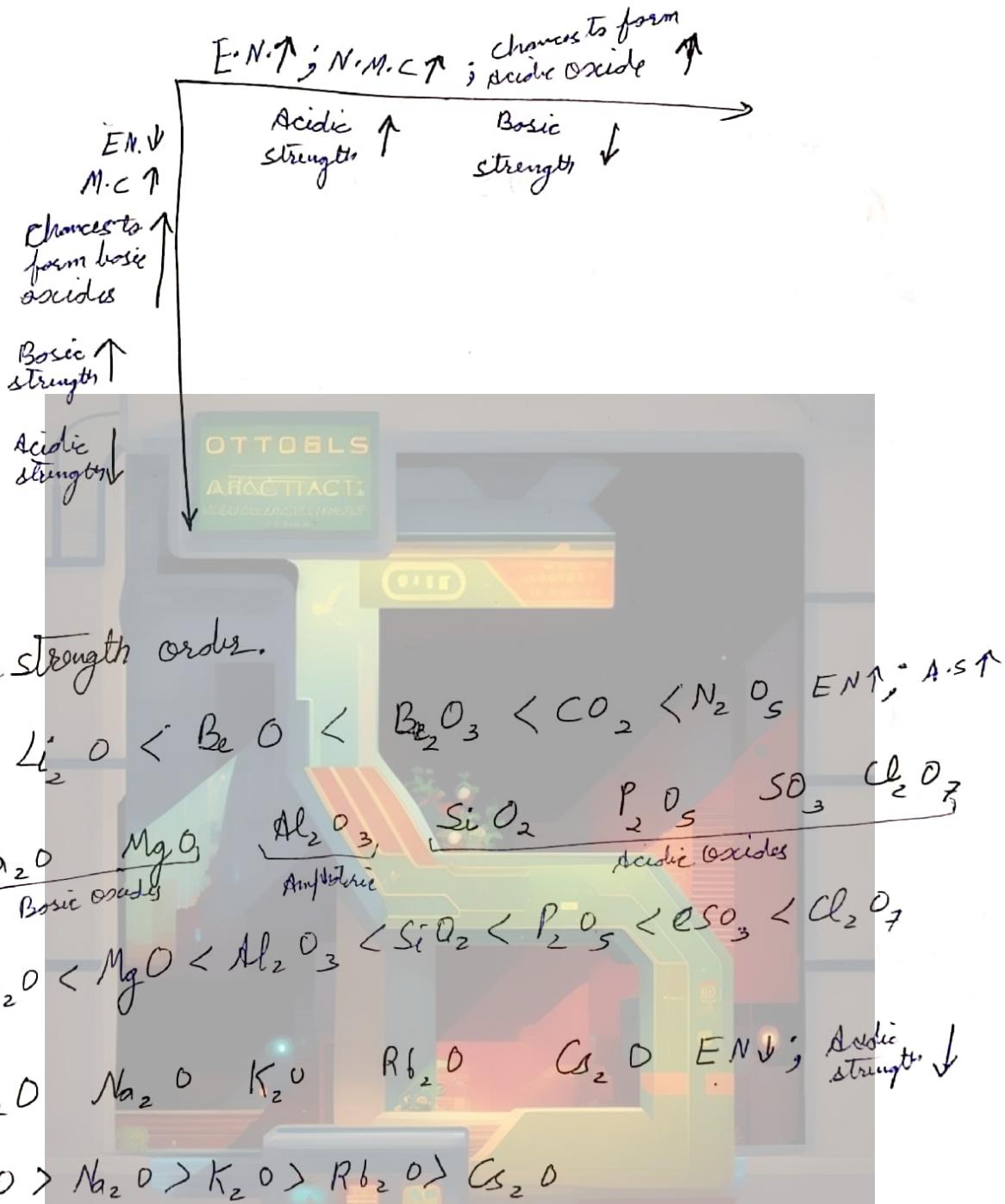
→  $\text{N}_2\text{O}, \text{NO}$

→ oxides which do not react with acid as well as base.

→ Ex.  $\text{N}_2\text{O}, \text{NO}, \text{CO}, \text{H}_2\text{O} \rightarrow$  (If treated as solvent, then considered neutral)

(If not used as a solvent, considered Amphoteric)

## Periodicity of oxides



## # Oxidation Number

→ It is a hypothetical charge on element if every bond is considered to be ionic

Some general oxidation state -

① Alkali Metal ⇒ +1 {Li, N, K, Rb, Cs, Fr}

In Bonded state

② Alkali Earth Metals ⇒ +2 {Be, Mg, Ca, Sr, Ba}

② Hydrogen ⇒ Hydride with metal ⇒ -1 {LiH, NaH, KH...}

Hydrides with non metals / other elements ⇒ +1, {NH<sub>3</sub>, PH<sub>3</sub>, CH<sub>4</sub>}

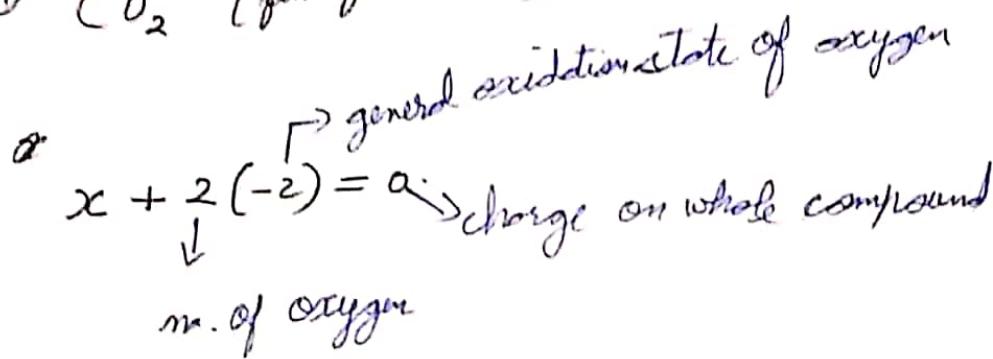
③ Oxygen general oxidation state ⇒ -2

④ Fluorine ⇒ -1 (Always)

Acidic Strength & oxidation state

H<sub>2</sub>O<sub>2</sub> ⇒ -1  
KO<sub>2</sub> ⇒ -½  
KO<sub>3</sub> ⇒ -⅓  
OF<sub>2</sub> ⇒ +2  
O<sub>2</sub>F<sub>2</sub> ⇒ +1

Q. ①  $\text{CO}_2$  (find for carbon)



$$x - 4 = 0$$

$$\boxed{x = 4}$$

②  $\text{SO}_2$

$$x + 2(-2) = 0$$

$$x - 4 = 0$$

$$\boxed{x = 4}$$

③  $\text{SO}_4^{2-}$

$$x + 4(-2) = -2$$

$$x - 8 = -2$$

$$\frac{x - 8}{x} = -2$$

$\boxed{x = 6}$  non metal

④  $\text{NH}_3$

$$x + 3(+1) = 0$$

$$x + 3 = 0$$

$$\boxed{x = -3}$$

⑤  $\text{H}_2\text{NO}_2$

$$1 + 2 + 3(-2) = 0$$

$$2x + 1 - 6 = 0$$

$$\begin{cases} 2x = 6 - 1 \\ \boxed{x = 5} \end{cases} \checkmark$$

⑥  $\text{Na}_2\text{O}_5$

$$2x + 5(-2) = 0$$

$$2x - 10 = 0$$

$$2x = 10$$

$$x = \frac{10}{2}$$

$$\boxed{x = 5} \checkmark$$

⑦  $\text{FeO}_4$

$$x + 4(-2) = -3$$

$$x - 8 = -3$$

$$\begin{cases} x = 8 - 3 \\ \boxed{x = 5} \end{cases}$$

⑧  $\text{NH}_4^+$

$$x + 4(+1) = 1$$

$$x + 4 = 1$$

$$x = 1 - 4$$

$$\boxed{x = -3} \checkmark$$

(160)



$$x + 4(-2) = -1$$

$$x - 8 = -1$$

$$x = -1 + 8$$

$$\begin{cases} x = 8 - 1 \\ x = 7 \end{cases} \checkmark$$

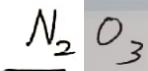
⑩



$$x + 4(+1) = 0$$

$$\begin{cases} x = -4 \\ \text{OTOBLS} \\ \text{ARCTACT} \end{cases} \checkmark$$

⑪



$$2x + 3(-2) = 0$$

$$2x - 6 = 0$$

$$2x = 6$$

$$\begin{cases} x = 3 \\ \text{OTOBLS} \end{cases} \checkmark$$

⑫

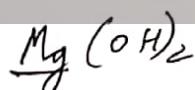


$$x + 3(+1) + 2(-2) = 0$$

$$x + 3 - 4 = 0$$

$$\begin{cases} x = 4 - 3 \\ x = 1 \end{cases} \checkmark$$

⑬



$$x + 2(-1) = 0$$

$$\begin{cases} x - 2 = 0 \\ x = 2 \end{cases} \checkmark$$

⑯

(14)  $\text{Na}$ 

$$\boxed{x=0} \checkmark \text{ (Elemental State) (Non-Bonded)}$$

(15)  $\text{O}_2$ 

$$2x \neq 0$$

$$2(-2) = -4$$

$$\boxed{\begin{array}{l} 2x=0 \\ x=0 \end{array}} \checkmark$$

(16)  $\text{H}_2\text{O}_2$ 

$$2x + 2(+1) = 0$$

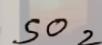
$$2x + 2 = 0$$

$$x = \frac{-2}{2}$$

$$\boxed{x=-1} \checkmark$$

Q Compare Acidic Strength

Ex ①



$$x + 2(-2) = 0$$

$$x = +4$$



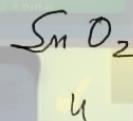
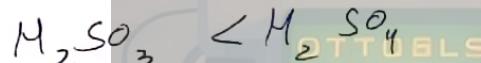
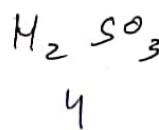
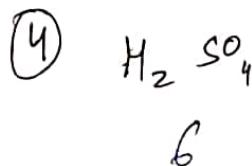
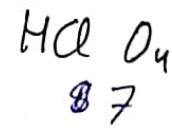
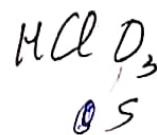
$$x = 6$$

$$\boxed{\text{SO}_2 < \text{SO}_3} \checkmark$$

(2)  $\text{N}_2\text{O}$        $\text{NO}$        $\text{N}_2\text{O}_3$        $\text{NO}_2$        $\text{N}_2\text{O}_5$

$$\boxed{\text{N}_2\text{O} < \text{NO} < \text{N}_2\text{O}_3 < \text{NO}_2 < \text{N}_2\text{O}_5} \checkmark$$

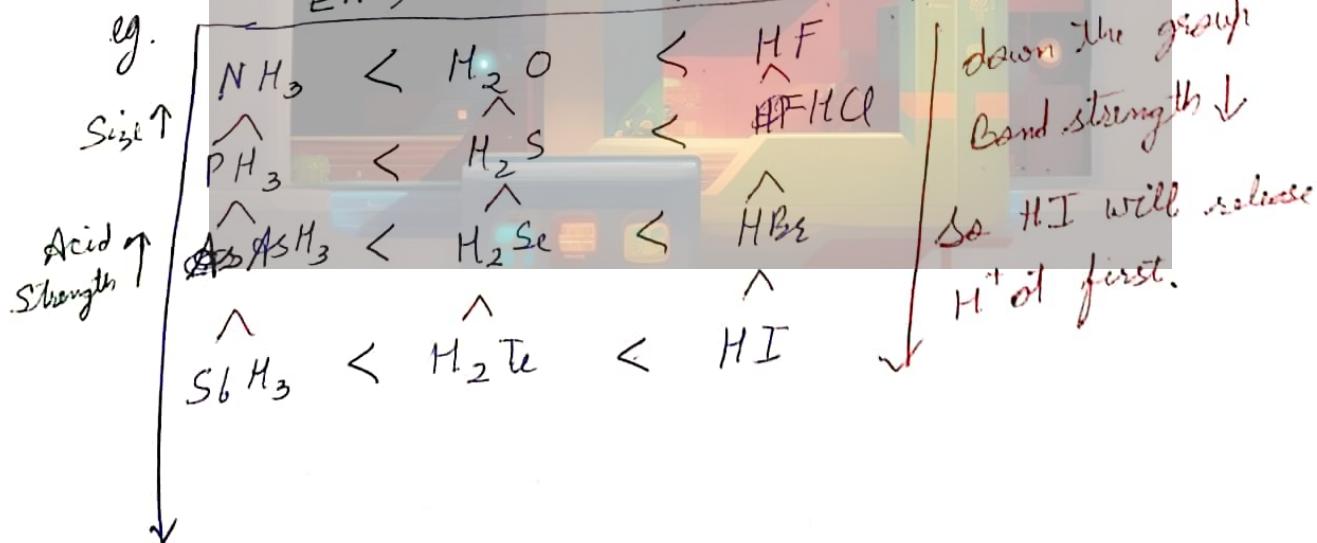
(152)



### Hydro Acids

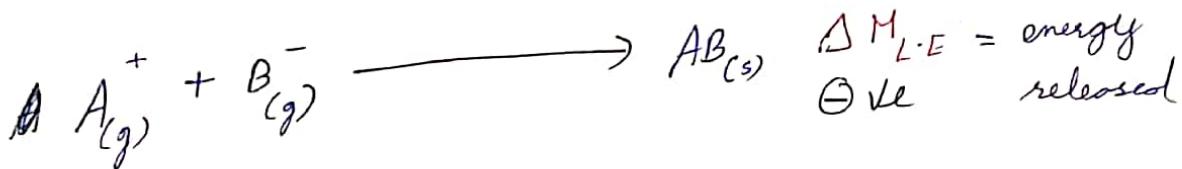
→ Acids which contains hydrogen with other non metal

ENT↑; Acid strength ↑

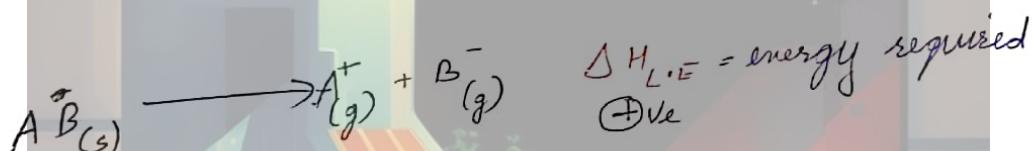


## \* Lattice Energy ( $\Delta H_{L.E.}$ )

→ It is the amount of ~~excess~~ energy released during the formation of 1 mole lattice/solid from constituent gaseous ions.



→ It is the amount of energy required to break one mole solid/lattice <sup>the into their constituent</sup> gaseous ions.



factors of L.E. :-

$$L.E \propto q_1 q_2 \quad \left\{ \begin{array}{l} q_1 \rightarrow \text{charge on cation} \\ q_2 \rightarrow \text{charge on anion} \end{array} \right\}$$

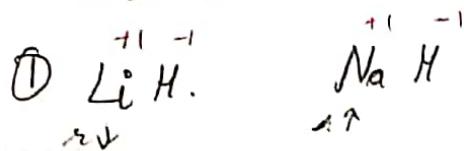
$$L.E \propto \frac{1}{r} \quad \left\{ r \rightarrow \text{internuclear distance} \right\}$$

$$r \approx r_A + r_C \quad \begin{matrix} \downarrow \\ \text{radius of} \\ \text{anion} \end{matrix} \quad \rightarrow \text{product of cation}$$

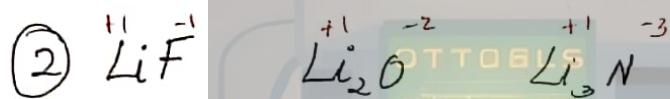
if  $|q_1 q_2|$  or amount of charge ↑;  $L.E. \uparrow$   
 if  $r \uparrow$ ;  $L.E. \downarrow$

(9, 9<sub>2</sub>) P; r↑; L.E.↑ { Phle charge & ka  
decreas for radius ka }

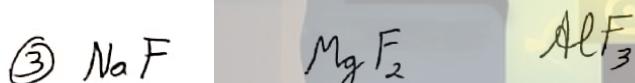
Q1. L.E. order?



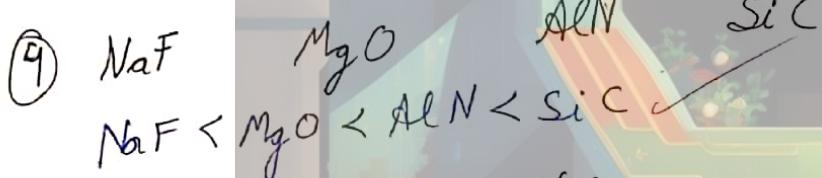
$$\text{LiH} > \text{NaH} \checkmark$$



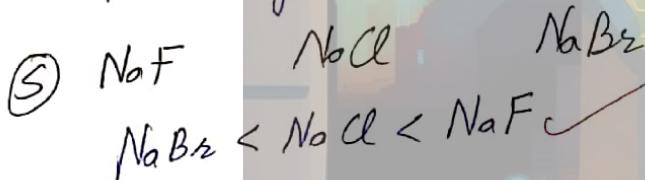
$$\text{LiF} < \text{Li}_2\text{O} < \text{Li}_3\text{N} \checkmark$$



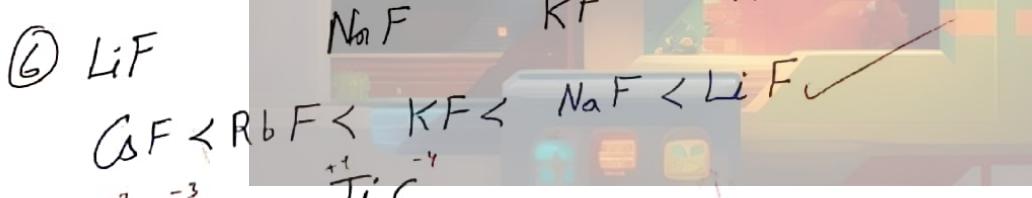
$$\text{NaF} < \text{MgF}_2 < \text{AlF}_3$$



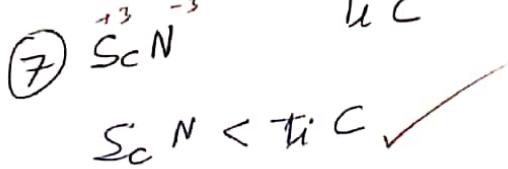
$$\text{NaF} < \text{MgO} < \text{AlN} < \text{SiC}$$



$$\text{NaBr} < \text{NaCl} < \text{NaF}$$



$$\text{CsF} < \text{RbF} < \text{KF} < \text{NaF} < \text{LiF}$$



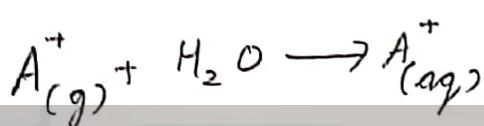
$$\text{ScN} < \text{TiC}$$

$\text{N}^{3-} \rightarrow \text{Nitride}$

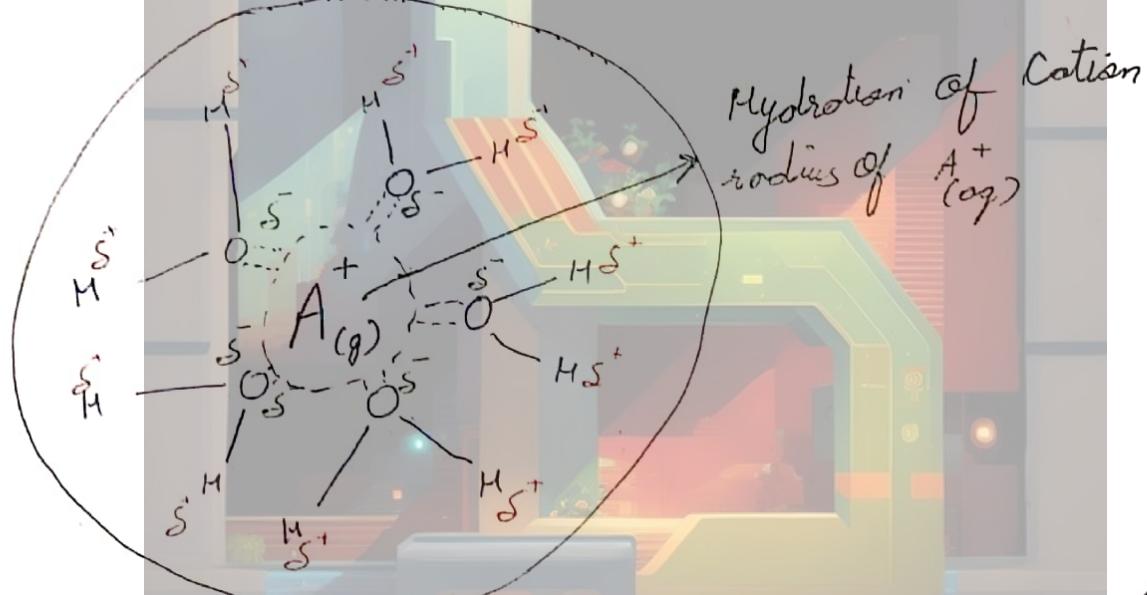
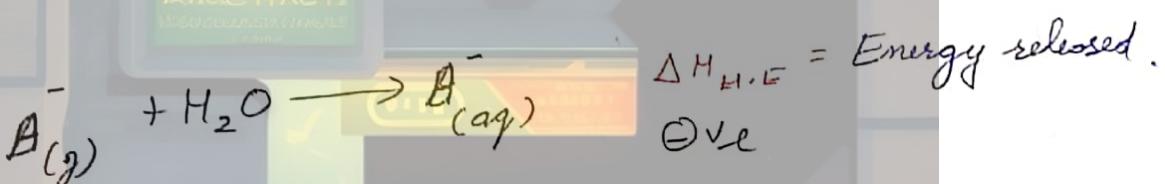
$\text{C}^{4-} \rightarrow \text{Carbide}$

## Hydration Energy

→ It is the amount of energy released when 1 mole of gaseous ions are interested with water (dissolve)



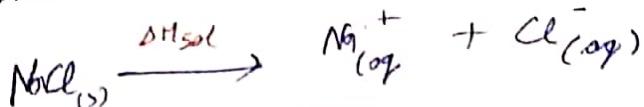
$\Delta H_{H.E}$  = Energy released  
Over



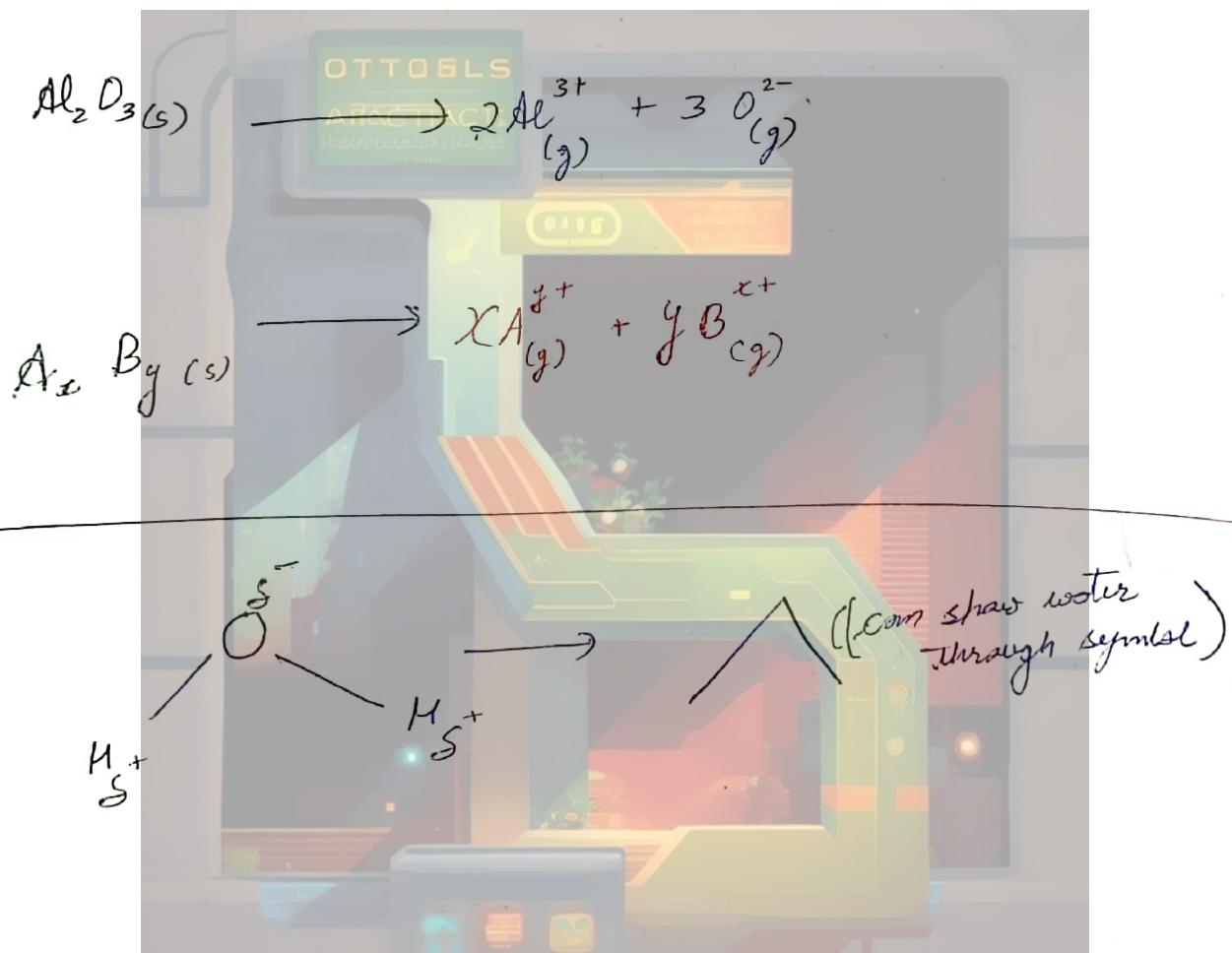
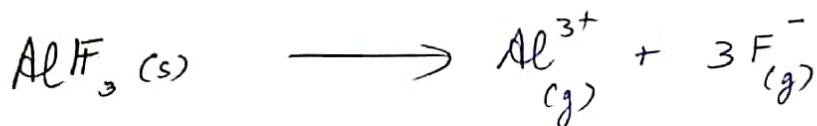
More water molecule interact ↑;  $\therefore$  hydration energy ↑.

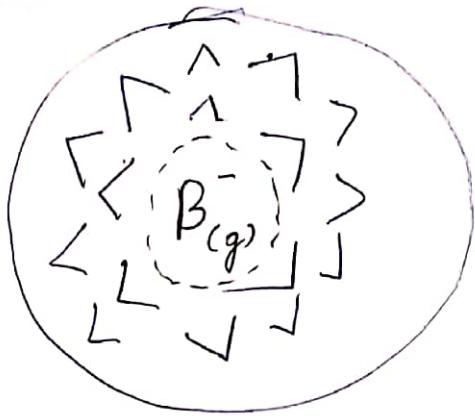
radius of aqueous ↑

Enthalpy of solution - ( $\Delta H_{sol}$ ) - amount of energy when 1 mole of solid is converted to constituent aqueous ions.



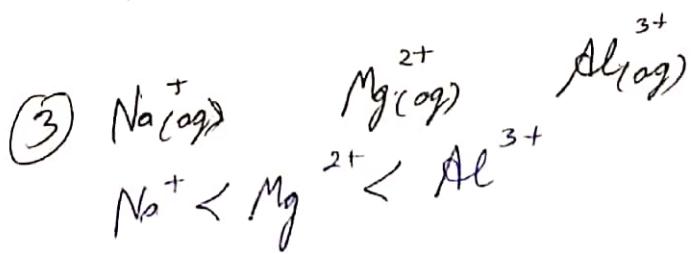
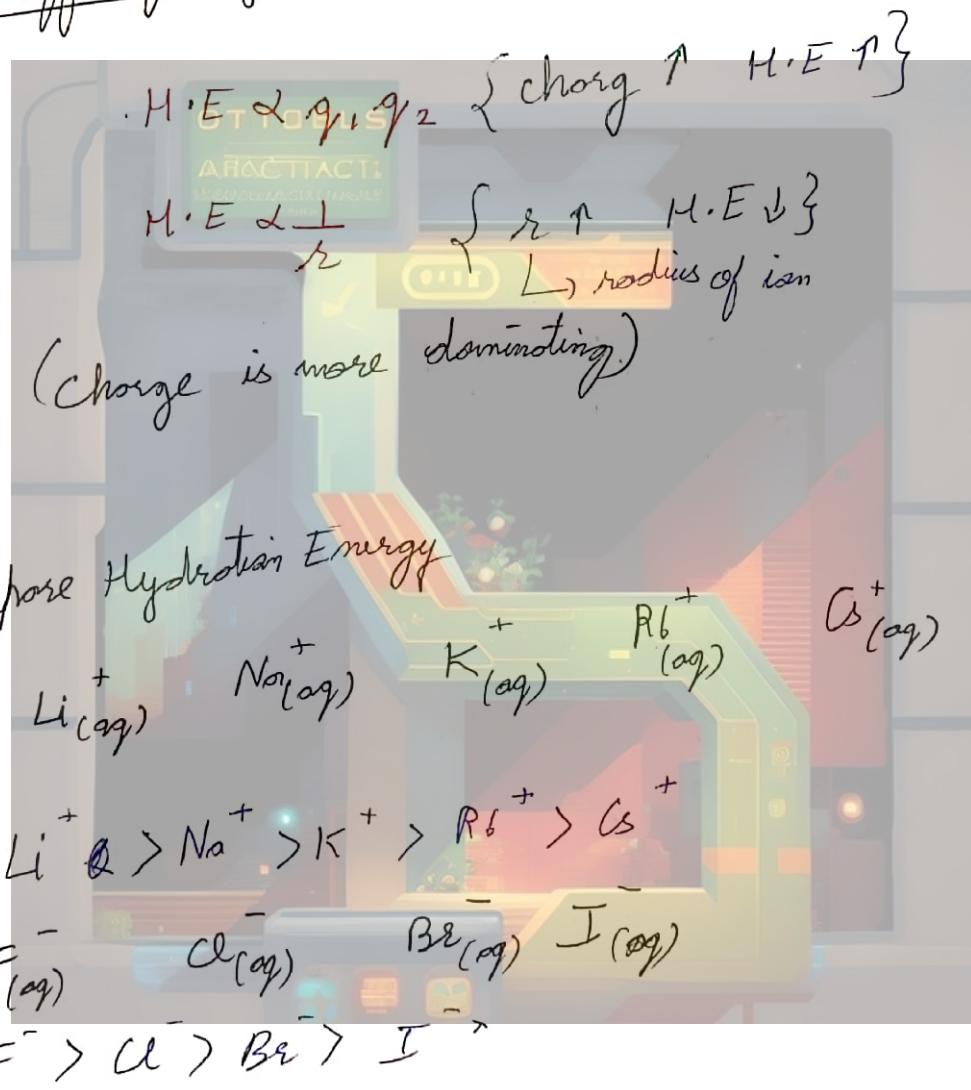
$$\Delta H_{sol} = \Delta H_{L.E} + \Delta H_{H.E}$$

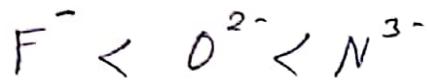
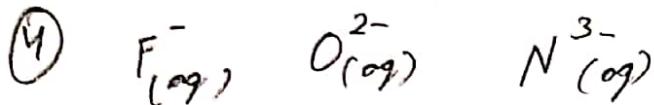




Hydration of anion

## Factors affecting Hydration Energy



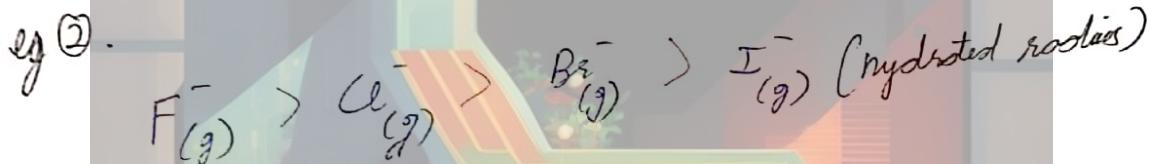
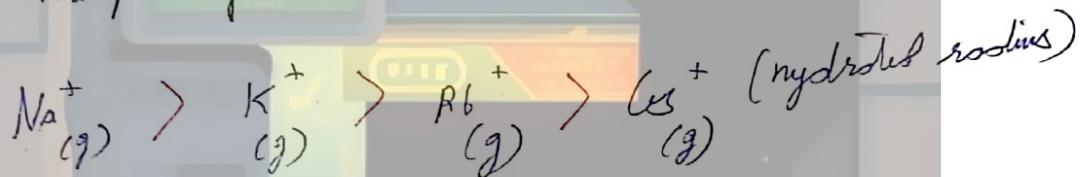


Application of hydration energy :-

① Hydrated radius -

$H \cdot E. \uparrow$ ; Number of water molecules  $\uparrow$  Hydrated Radius  $\uparrow$

e.g. Compare hydrated radius



Hydrated Radius  $\propto H \cdot E.$

② Ionic Mobility -  
 $\rightarrow$  Ionic mobility means movement of ions.

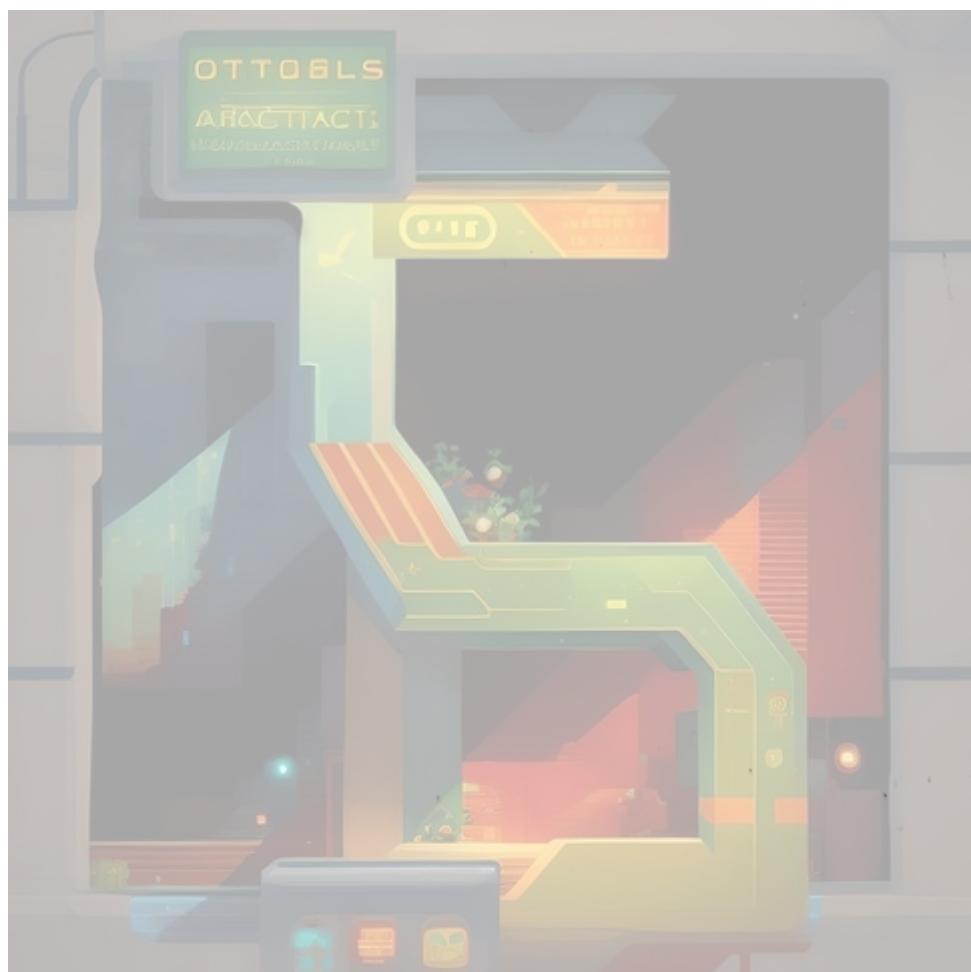
$H \cdot E. \uparrow$ ; more no. of  $H_2O$  interact  $\uparrow$

Hydrated radius  $\uparrow$ ; Movement of ions  $\downarrow$

~~H.E.~~  $\boxed{\text{Ionic Mobility} \propto \frac{1}{H \cdot E.}}$

H.W. 11-05-2024

O-Z, Mains & advance full



### ③ Electric Conduction

Ionic mobility & Electrical conductivity.

H.E.P Hydrated Radius ↑ Ionic mobility ↓ Electrical conductivity ↓

Conduction - Flow of Charge per unit time.

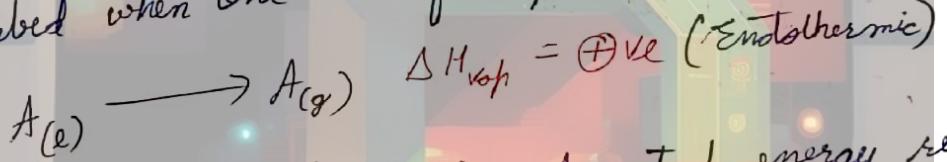
### \* Bond En-Haber Cycle

Imp Terms -

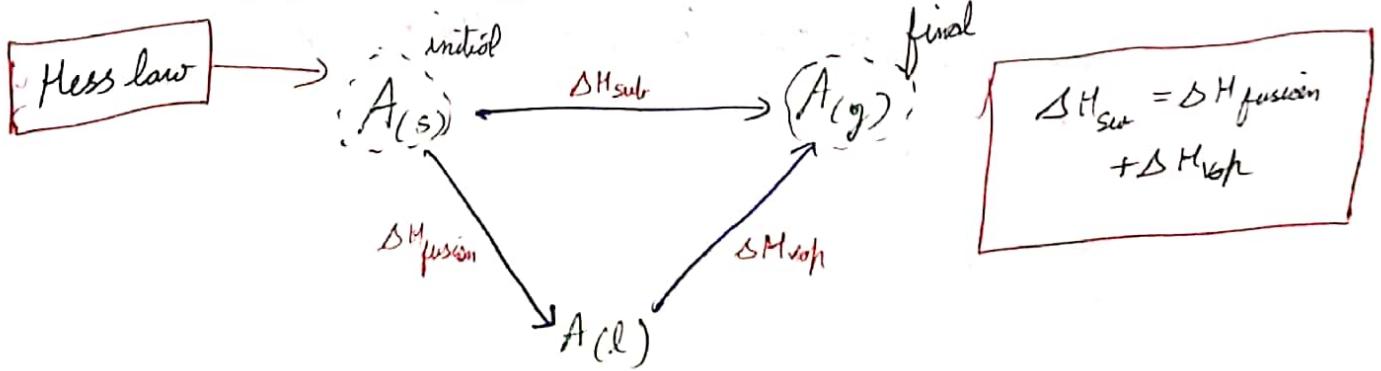
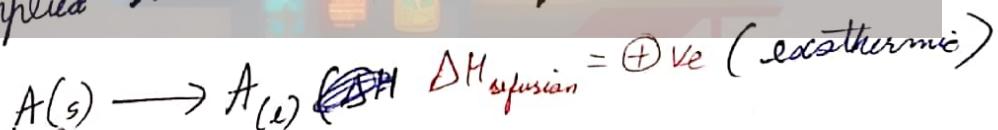
① Enthalpy of Sublimation ( $\Delta H_{\text{sub}}$ ) - Amount of energy required/ absorbed when 1 mole of solid is converted to gas.



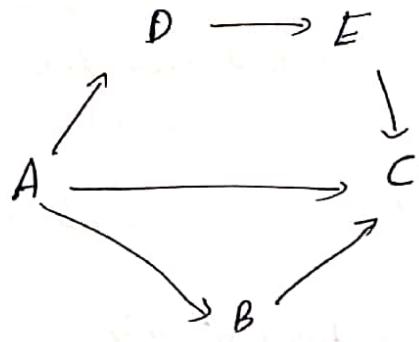
② Enthalpy of Vapourisation ( $\Delta H_{\text{vap}}$ ) - Amount of energy supplied/ absorbed when one mole of liquid is converted into gas.



③ Enthalpy of Fusion ( $\Delta H_{\text{fusion}}$ ) - Amount of energy required/ supplied to convert 1 mole of solid into liquid.



## Hess Law-



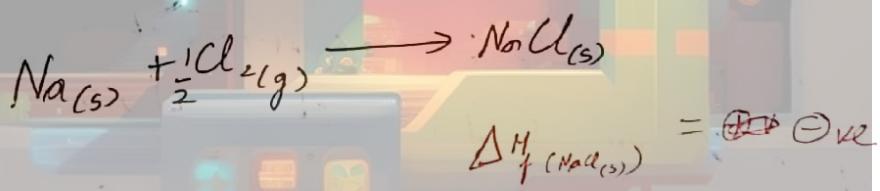
$$\Delta H_{AC} = \Delta H_{ADEC} = \Delta H_{ABC}$$

$$\Delta H_{AC} = \Delta H_{AO} + \Delta H_{DE} + \Delta H_{CE}$$

$$\Delta H_{AC} = \Delta H_{AB} + \Delta H_{BC}$$

\* Enthalpy only calculated from final & initial points & path not considered.

④ Enthalpy of formation ( $\Delta H_f$ ) - It is the change in enthalpy when 1 mole of ionic solid is formed by their constituent elements in their reference state/standard state.



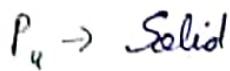
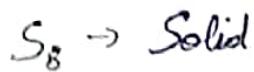
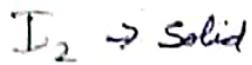
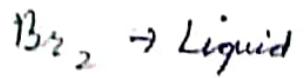
Standard states -

Metal  $\Rightarrow$  Solid State (Exception -  $Hg$  (Mercury)  $\Rightarrow$  Liquid)

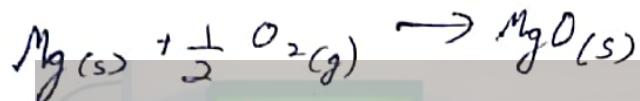
$O_2 \Rightarrow$   
 $Cl_2 \Rightarrow$   
 $N_2 \Rightarrow$   
 $H_2 \Rightarrow$

Gas

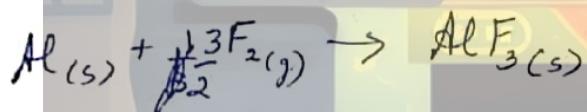
(162)



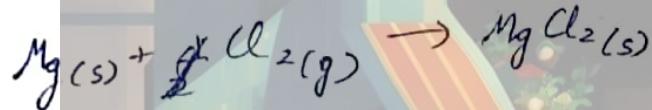
EgQ. ①  $\Delta H_f (\text{MgO}_{(s)})$



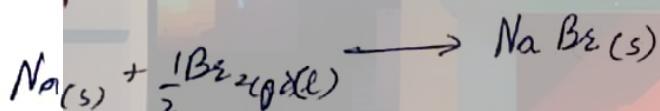
②  $\Delta H_f (\text{AlF}_{3(s)})$



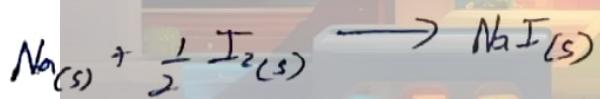
③  $\Delta H_f (\text{MgCl}_{2(s)})$



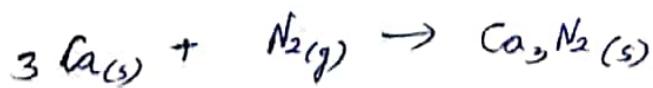
④  $\Delta H_f (\text{NaBr}_{(s)})$



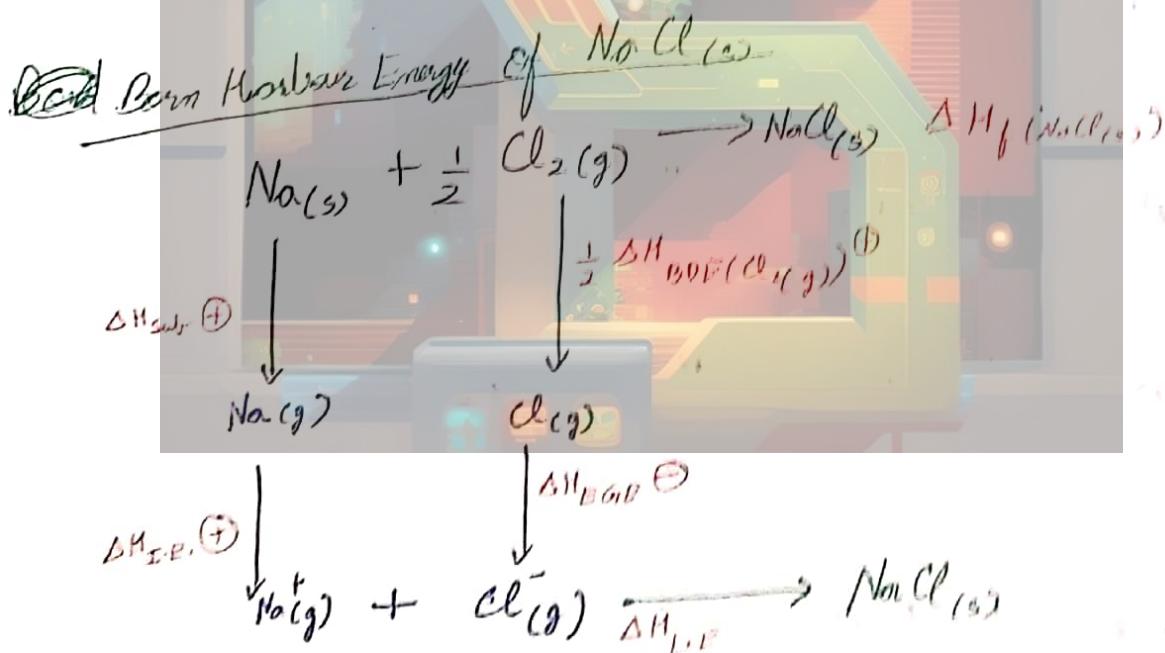
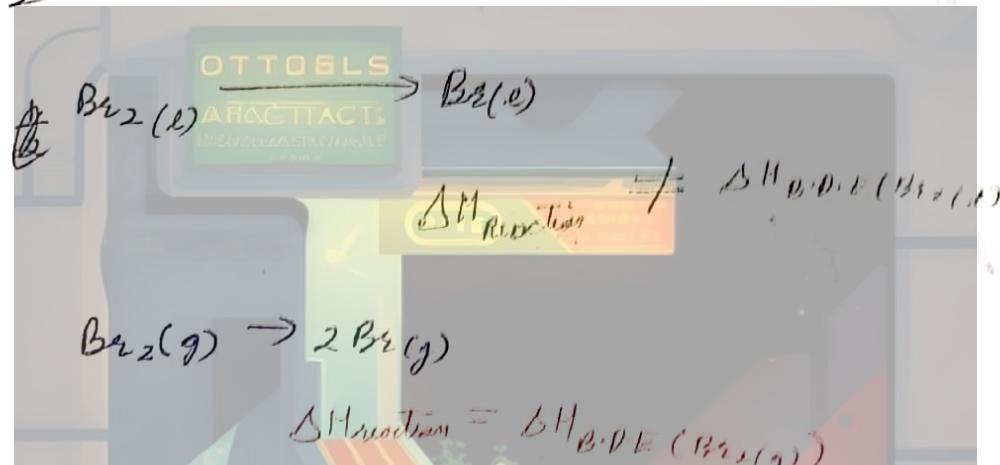
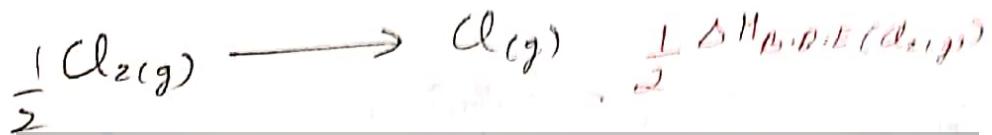
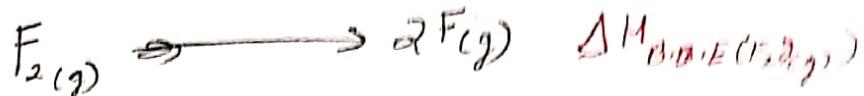
⑤  $\Delta H_f (\text{NaI}_{(s)})$



⑥  $\Delta H_f (\text{Ca}_3\text{N}_{2(s)})$



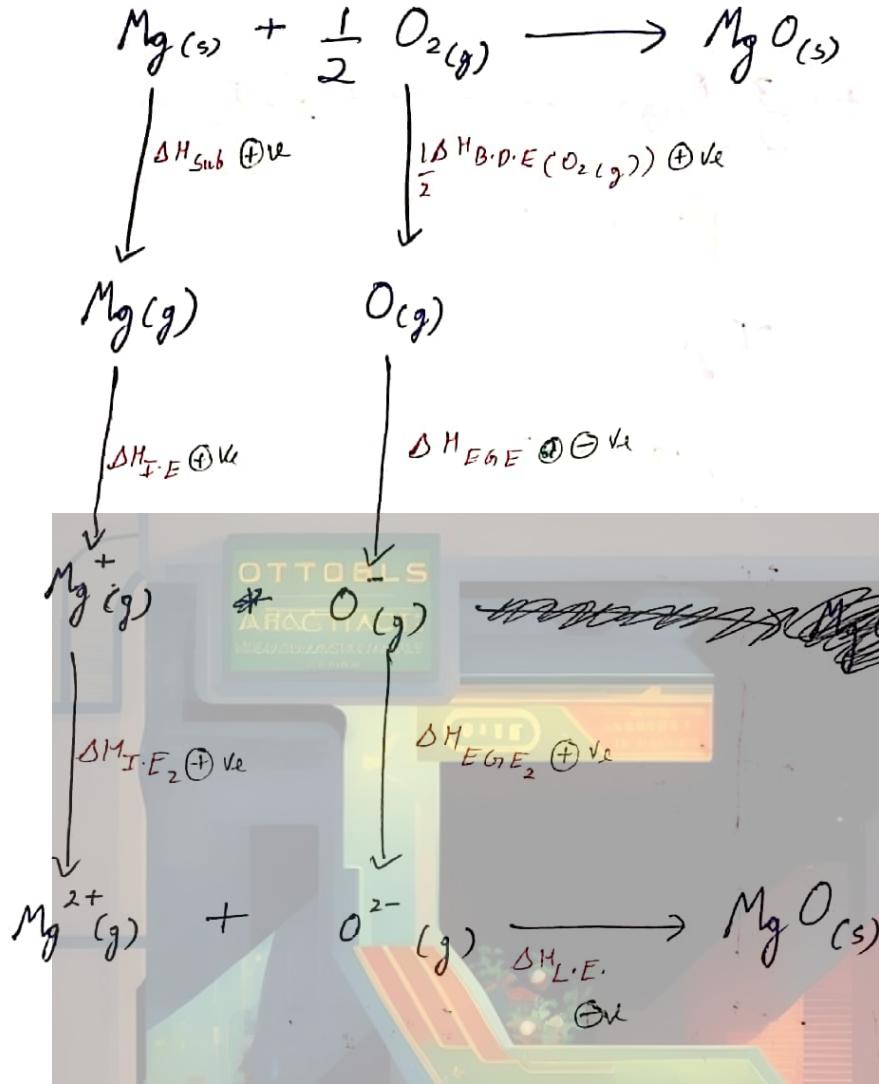
⑤ Bond Dissociation energy (B.D.E) - Amount of energy supplied to break one mole bond of gaseous molecules into their constituent gaseous atoms.



$$\Delta H_f(NaCl_{(s)}) = \Delta H_{\text{sub}(Na_{(s)})} + \Delta H_{I.P.}(Na_{(g)}) - \frac{1}{2} \Delta H_{B.D.E}(Cl_{2(g)}) + \Delta H_{B.G.B}(Cl_{(g)})$$

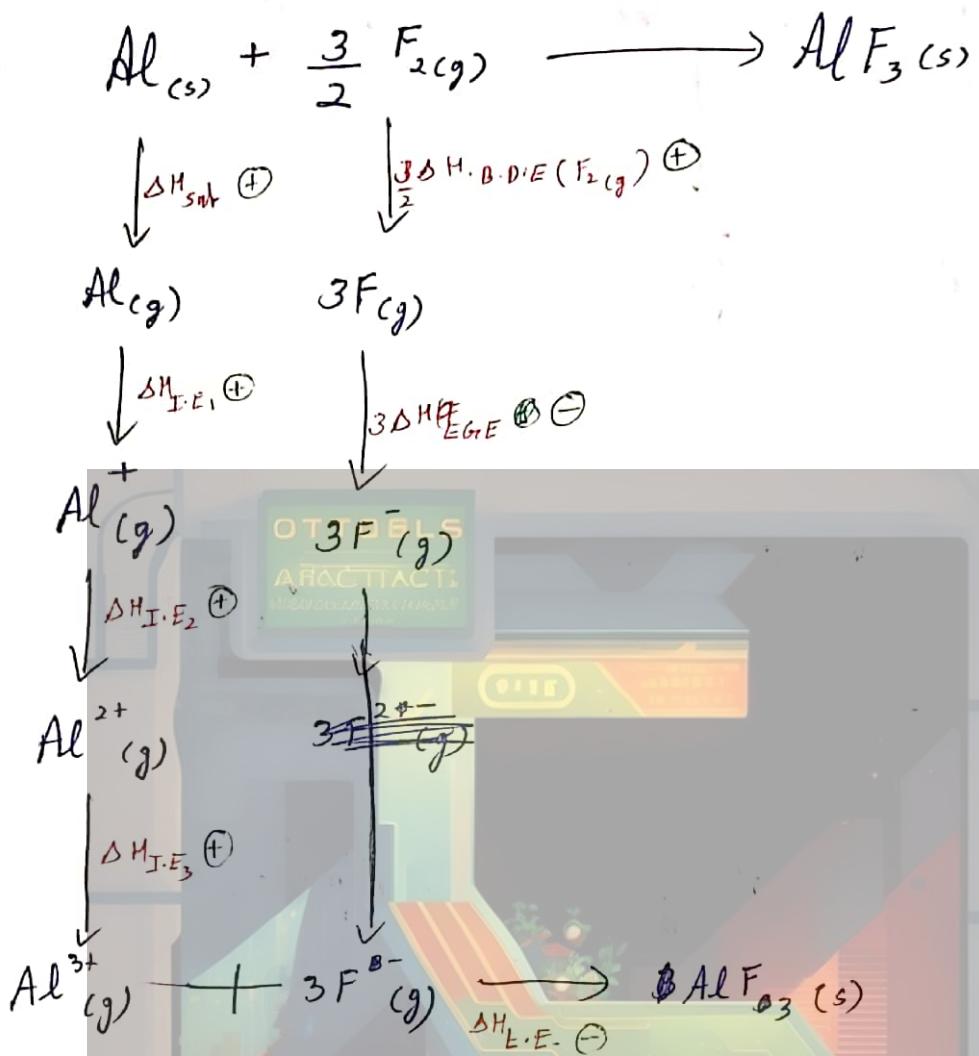
$$+ \Delta H_{L.F.}(NaCl_{(s)})$$

(2) write Born-Haber cycle of  $MgO_{(s)}$



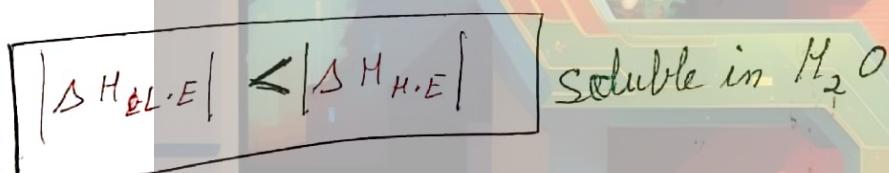
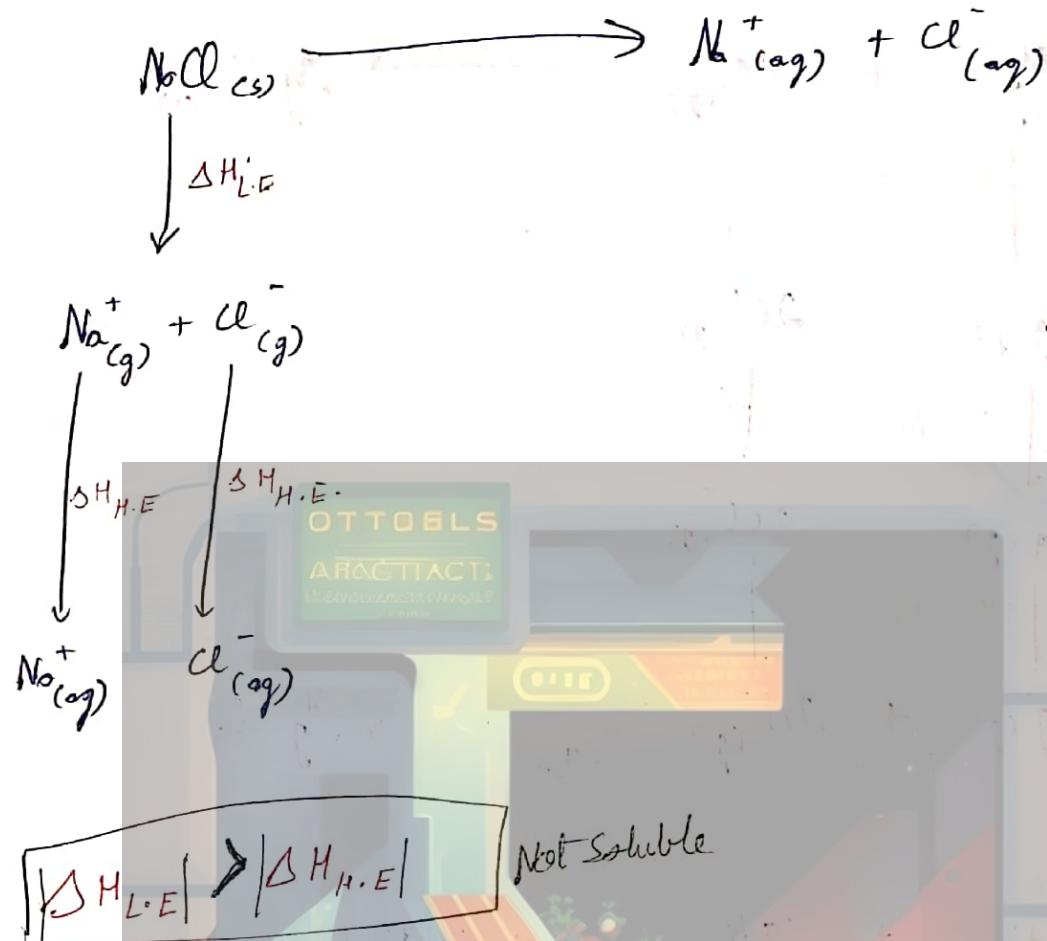
$$\begin{aligned}
 \Delta H_f(MgO_{(s)}) = & \Delta H_{\text{Sub}}(Mg_{(s)}) + \Delta M_{I.E.}(Mg_{(g)}) + \Delta H_{I.E.}(Mg^+_{(g)}) \\
 & + \frac{1}{2} \Delta H_{\text{B.O.E}}(O_{2(g)}) + \Delta H_{E.G.E}(O_{(g)}) + \Delta H_{E.G.E_2}(O^+_{(g)}) \\
 & + \Delta H_{L.E.}
 \end{aligned}$$

Q Born Haber cycle for  $\text{AlF}_3(s)$



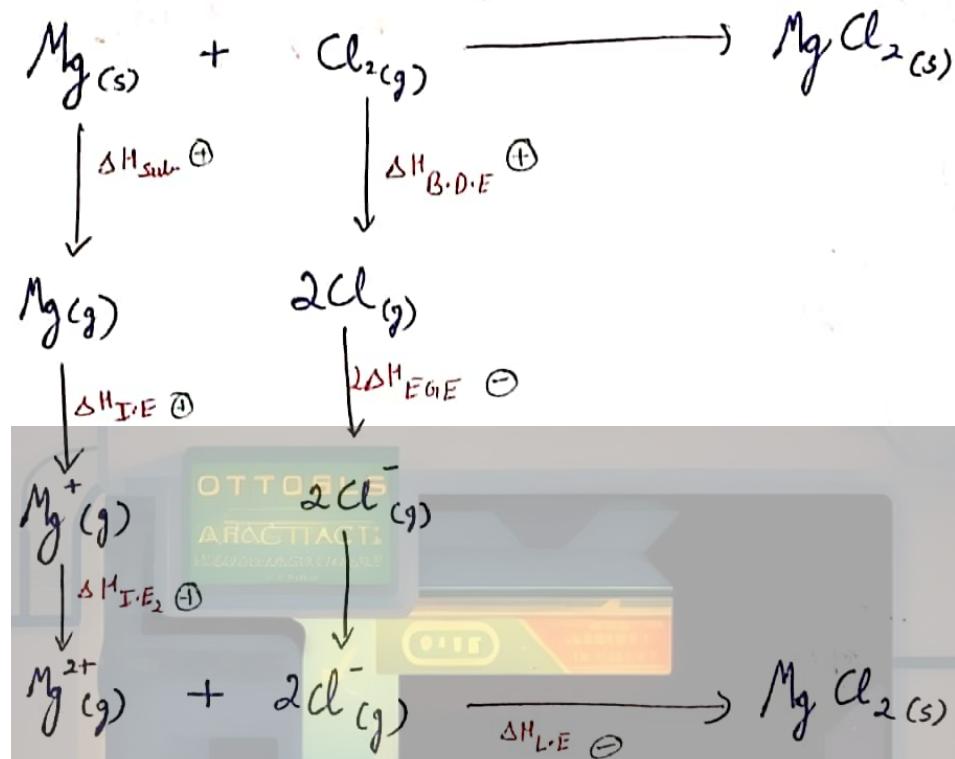
- Q ④  $\text{MgCl}_2(s)$  H.W. 13-0 S-2024  
Race - till 1+
- ⑤  $\text{AlN}(s)$  S-2
- ⑥  $\text{Ca}_3\text{N}_2(s)$

## Solubility of Ionic compound in $H_2O$

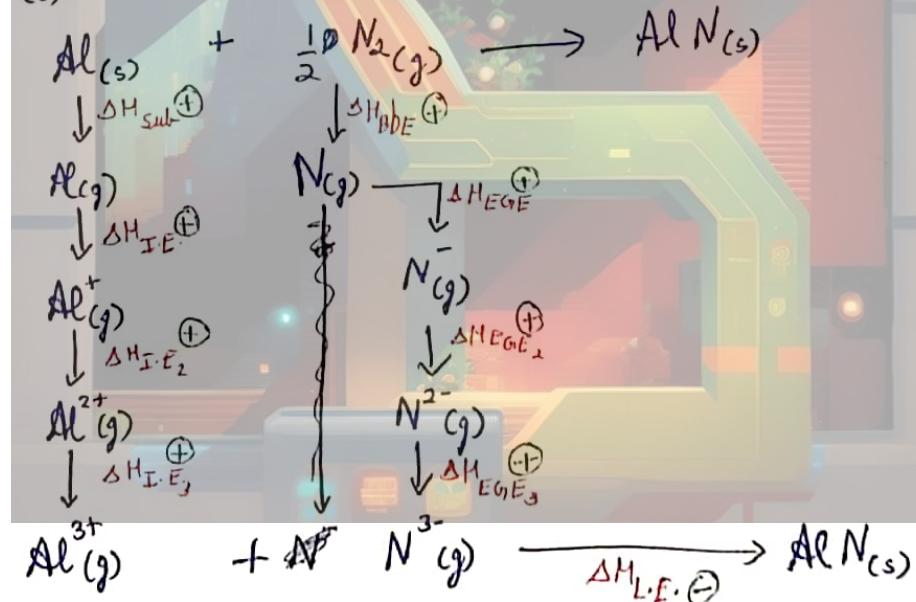


H.W.

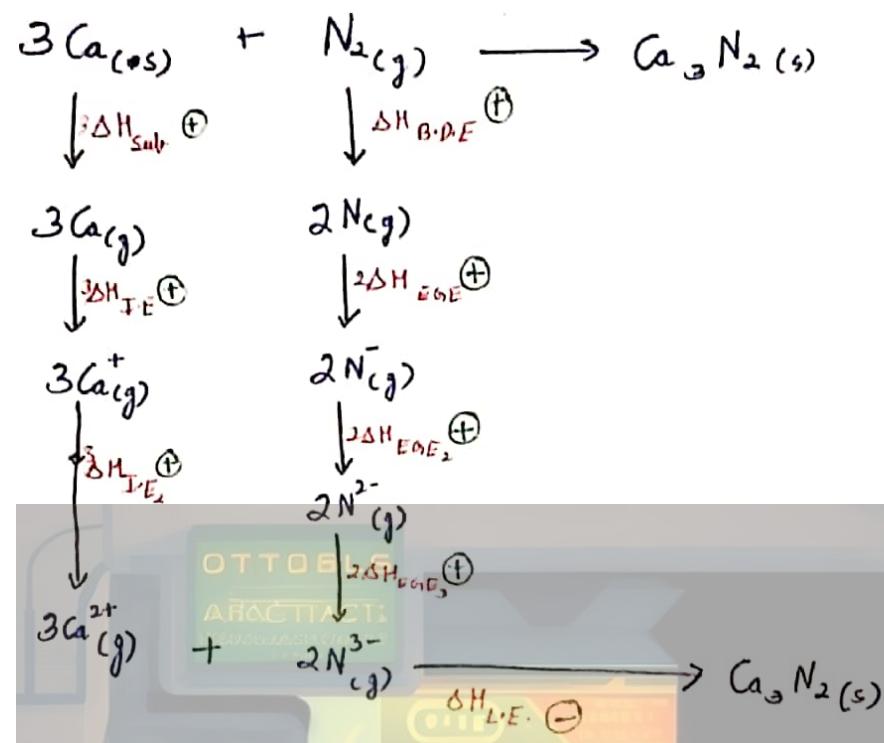
①  $MgCl_2$



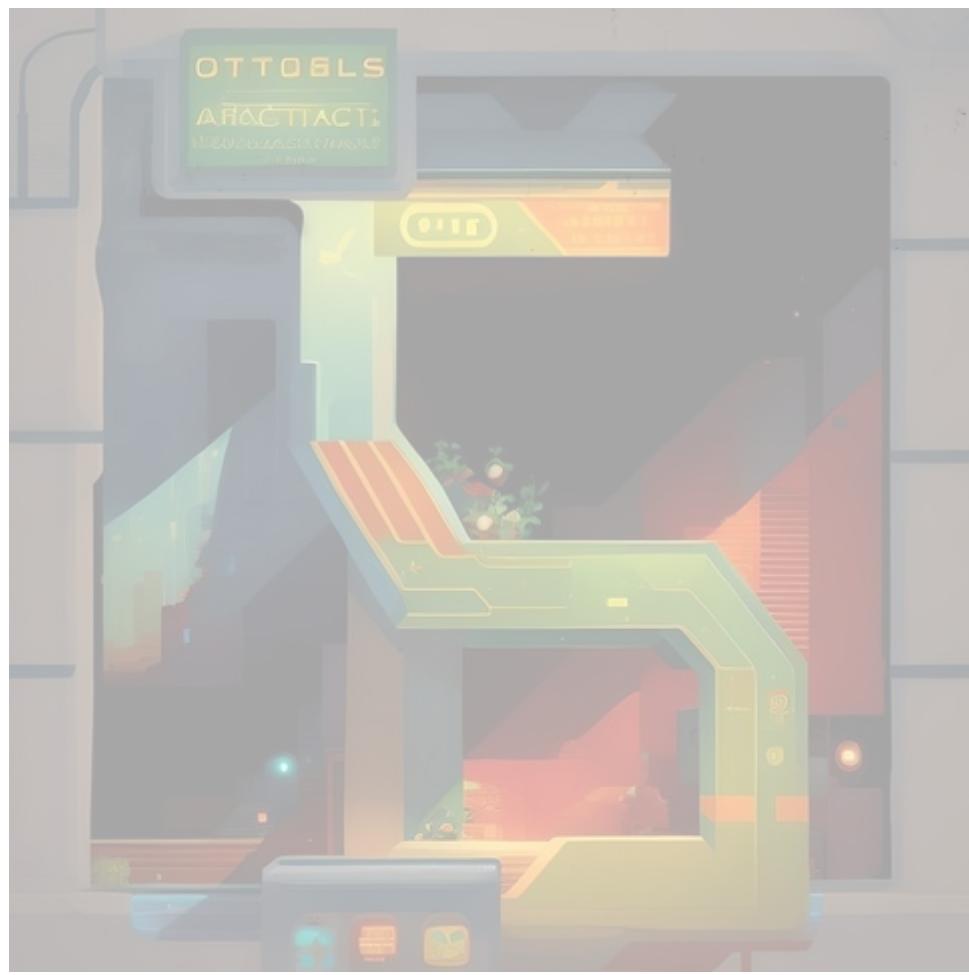
②  $AlN_{(s)}$



③  $\text{Ca}_3\text{N}_2$



(169)

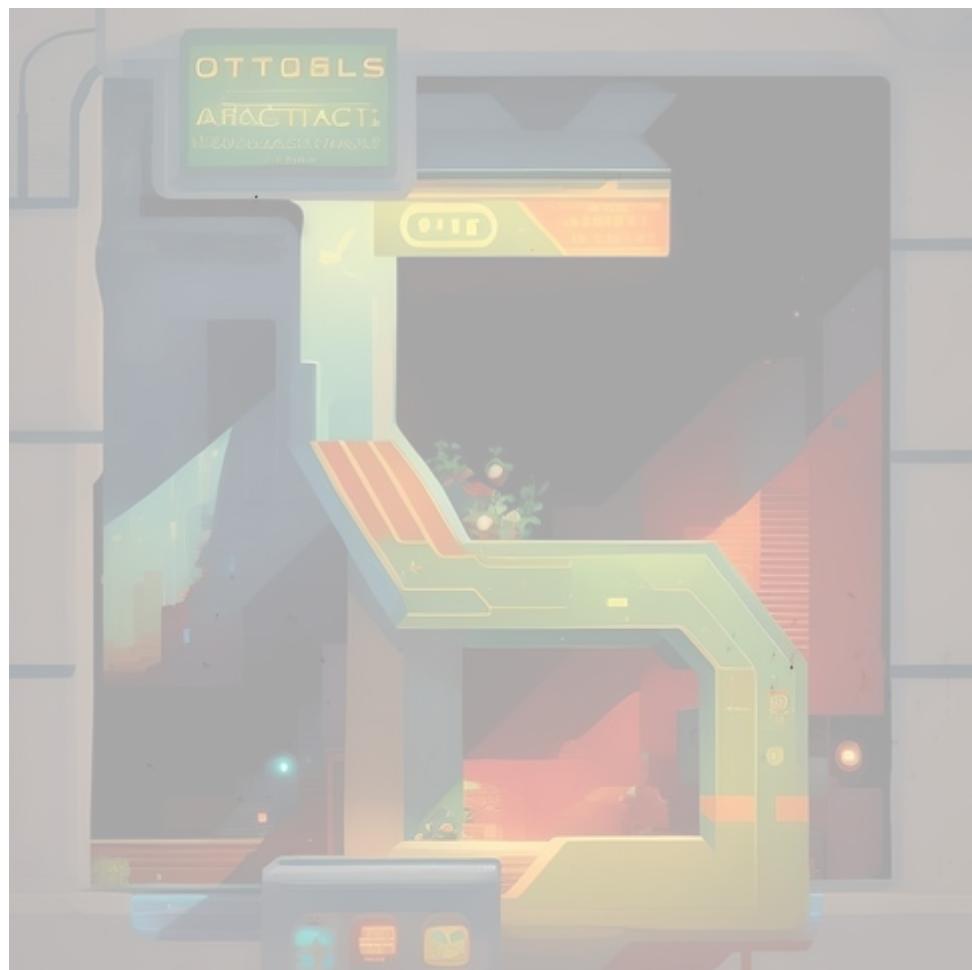




(17)



(172)



(173)