

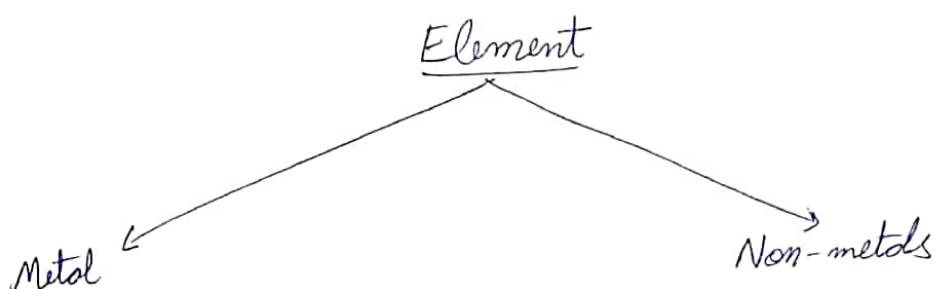
Periodic Table & Periodic Properties

→ 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.

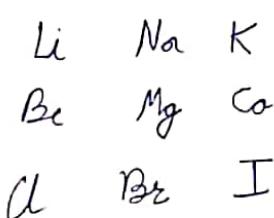
Development of periodic table:-

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 ~~tria~~ triad.
→ In Döbereiner's triad, atomic mass of central element is nearly equal to average atomic mass of 1st & 3rd 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	81.25	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	81.25 80

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

Q1. Multi Correct

If three element X^{20} , Y^{42} & Z^A
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	Re	Ca	Ma	Pa	Dha	Ni	

8

Sa

Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca	(Xe)				

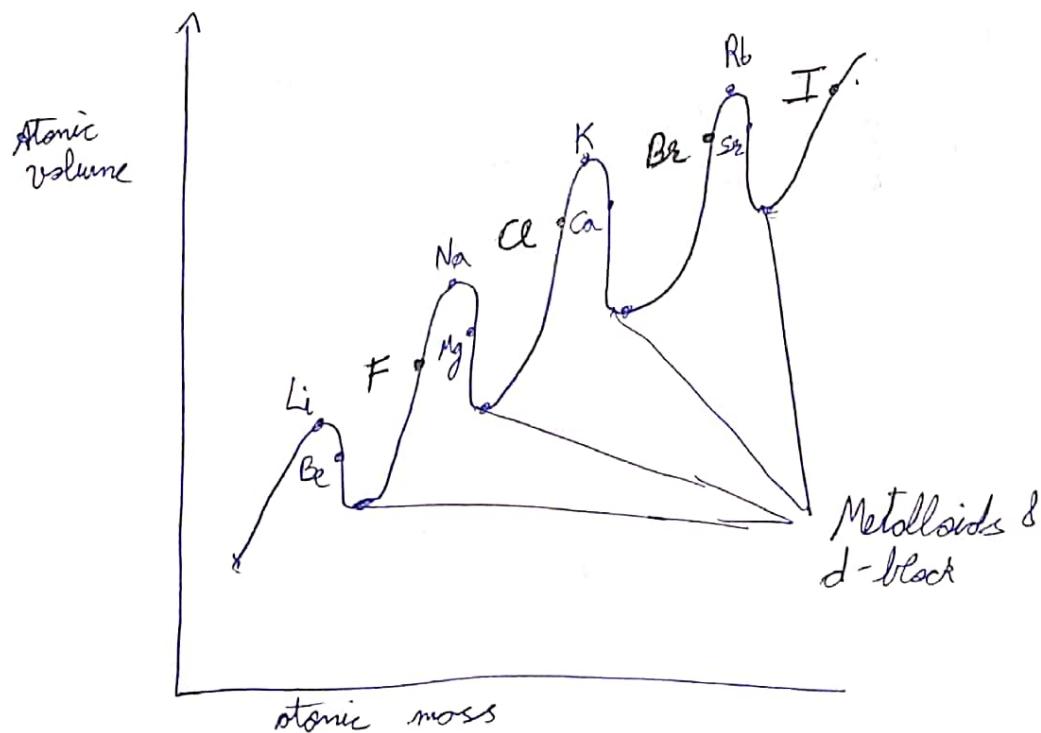
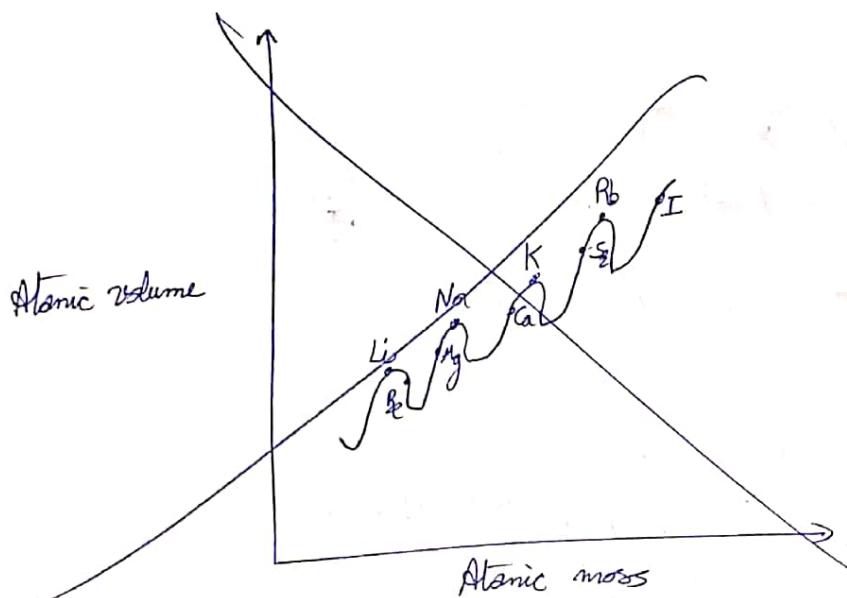
* * * Noble gases were not discovered yet

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^{th} element instead of 8^{th} element.

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

4. Lanthanides 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) 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	H																		
2	Li		B		B		A		B		A		B		A		B		
3	Na		Mg		Al		Si		P		S		Cl						
4	K		Cu		Ca	Zn	Ga		Se	Ge	Tl	As	V	Se	Cr	Br	Mn	Ex	Ca
5	Rb	Ag	Sn	Cd	In	Y	Sn	Zn	SB	Nb	Te	Mo	I	Ec	Ru	Rh	Pd	Ni	
6	Cs	Au	Ba	Hg	Bi		Bi								Os	In	Pt		
7	F _n		Pa																

1	Zero Group
2	He
3	Ne
4	Ar
5	Kr
6	Xe
7	Rn
8	

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 8th group was further divided into 2 sub-groups.
3. Subgroup A 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 (μ n)

Modern Name
Gallium (Ga)
Germanium (Ge)
Scandium (Sc)
Technetium (β Tc)

Si - Ge Zf Al - Ge
 सिलिकन - गेलीकन

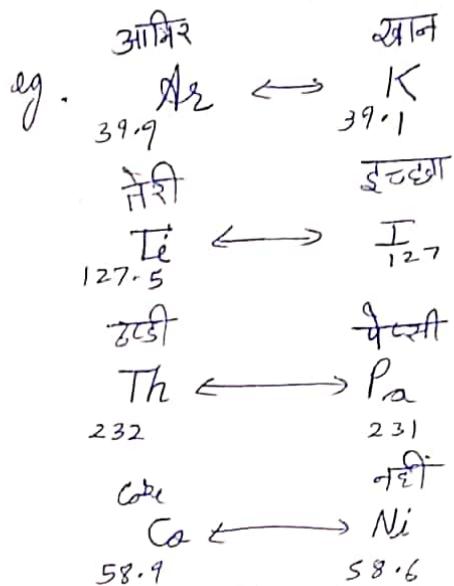
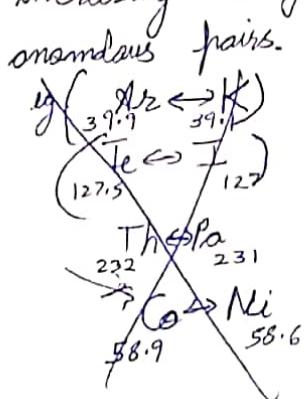
B - Sc Mn-Tc
 B. Sc नहीं M. Tech वै

3. Correction of doubtful atomic weights

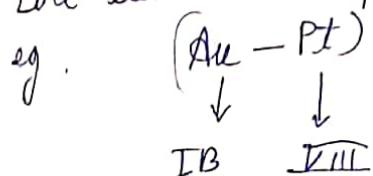
U, Be, In, Au, Pt
 यू बी, इन, ऑर्डर प्लॉटनियम

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.



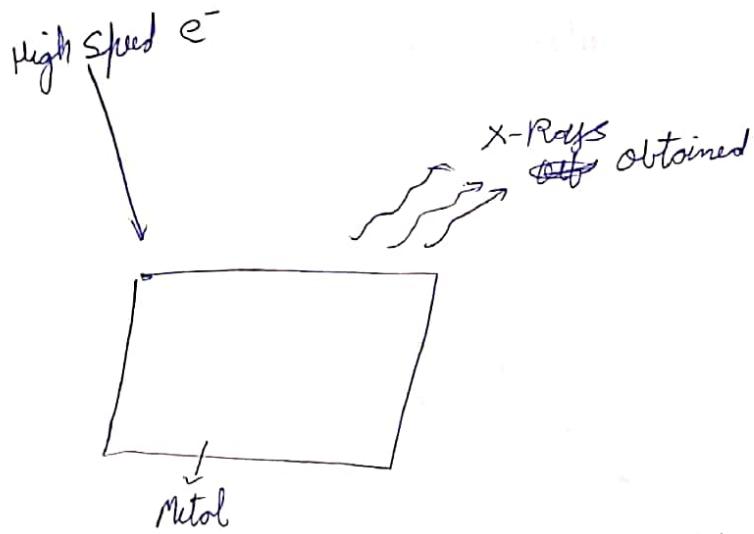
- Like elements were placed in different groups



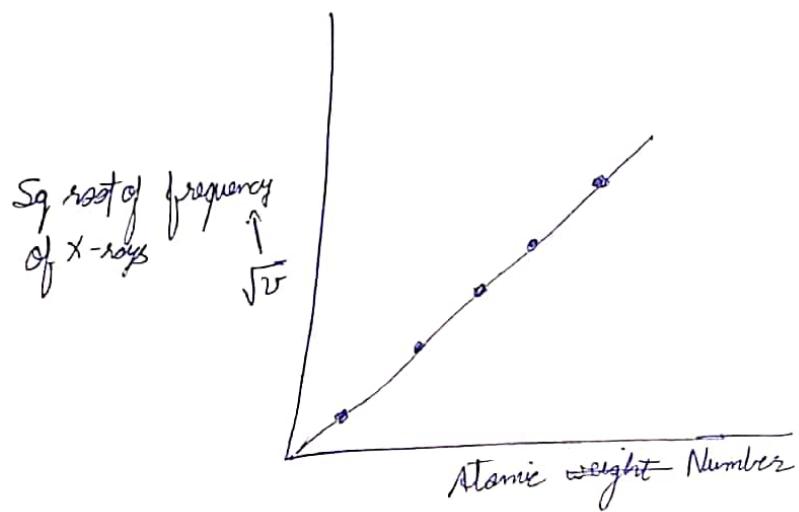
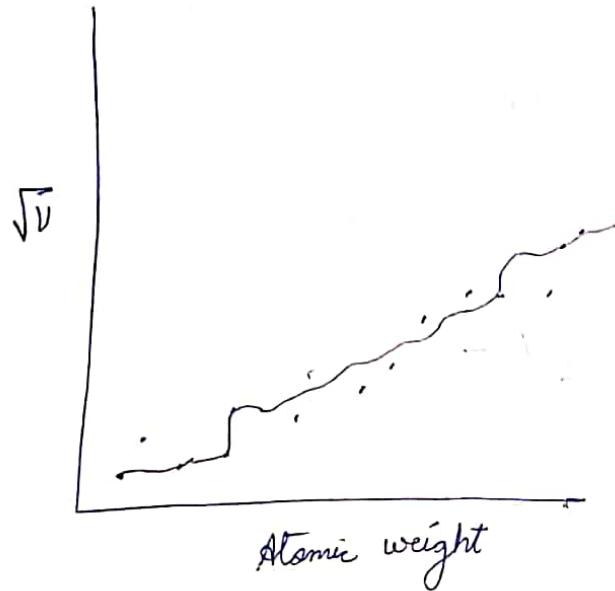
- Unlike elements were placed in same group.

	I-A
Li	
Na	
K	Highly reactive
Rb	
Cs	
	IB
	Cu
	Ag
	Al
	coinge metals (less reactive)

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.



$$\sqrt{\nu} \propto z$$

$$\boxed{\sqrt{\nu} = \alpha(z-b)}$$

z - atomic number

ν = frequency of X-ray

α, b = Moseley's constant

→ 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 ($a=1$, $b=2$)

$$\sqrt{625} = 25$$

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

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

$$25 = z-1$$

~~$$z=27$$~~

$$z=27$$

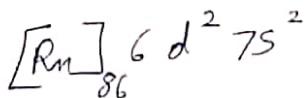
Cobalt (Co)

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.

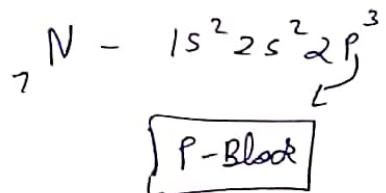
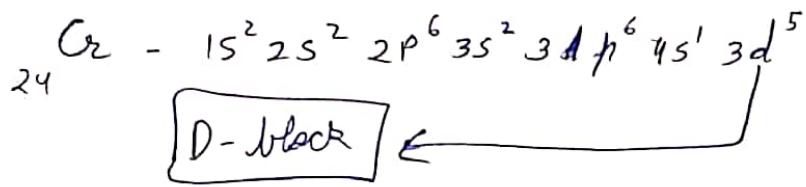
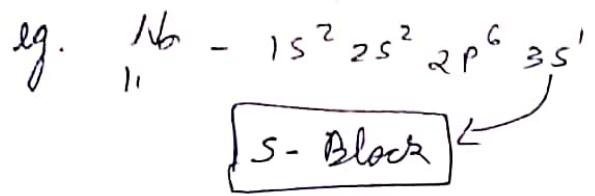
Deciding the block of an element -

- 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	\rightarrow Non-metal	संयुक्ती
$2s^1$	Li		ली
$3s^1$	Na		नाना
$4s^1$	K		कैरी
$5s^1$	Rb		रबी
$6s^1$	Cs	\rightarrow Alkali metals (Highly reactive)	सेसी
$7s^1$	F ₂		फॉर्सियाद

Group II (IIA)

Config. ns^2 (valence shell $e^- = 2$)

4s²		
$2s^2$	Be	देट
$3s^2$	Mg	मैग्नीयम
$4s^2$	Ca	कैरी
$5s^2$	Sr	सेरियम
$6s^2$	Ba	बैरियम
$7s^2$	Rs	रोज़ियम

Alkaline earth metals

Note - Group 13 of Group 15 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
$7P^1$	

बोरन

आल

गाल

In

टीला

→ Boron family

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

काढ़े

गृहिता

जी

जी

मुनो

प्रभु

काढ़े

गृहिता

जी

जी

मुनो

प्रभु

- Carbon Family

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

config - $nS^2 nP^3$

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

Nitrogen family
(pnictogens)

Nepal

Pakistan

Australia

Sab

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

जी

जी

(69)

Group-17 (VIIA) (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		$\frac{\text{At}}{\text{At}}$

Silky / Astma

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

config - $ns^2 np^6$

~~Group~~ $1s^2$ He (s-block element)

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

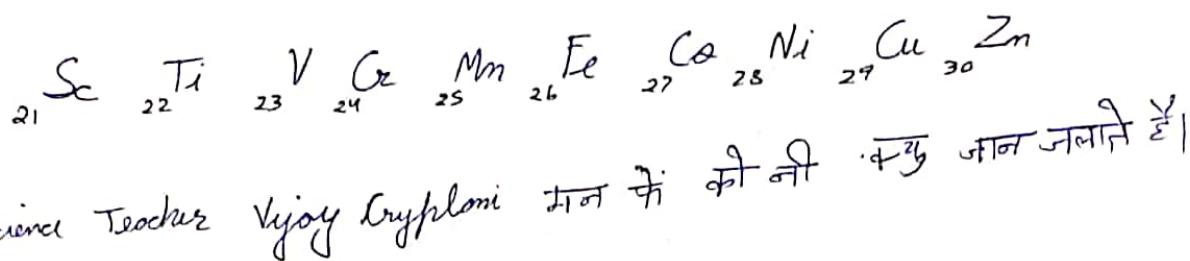
Noble gases
(inert gases) $\frac{\text{He}}{\text{He}}$
 $\frac{\text{Ar}}{\text{Ar}}$
 $\frac{\text{Kr}}{\text{Kr}}$
 $\frac{\text{Xe}}{\text{Xe}}$
 $\frac{\text{Rn}}{\text{Rn}}$

Note:-

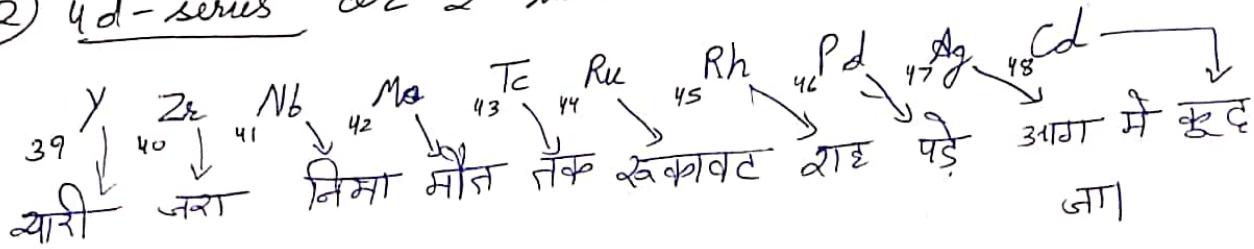
- Group 13, 14, 15, 16, 17 & 18 are known as p-block elements.
except (Helium)
 - Helium is s-block element.
 - Group 18 is known as noble gases/inert gases.
 - Except group 18 elements all s-block and p-block elements are known as normal or representative elements.
- Representative elements - Outermost shell of these elements is incomplete.
The number of e^- in outermost shell is less than 8.

D-block elements :-

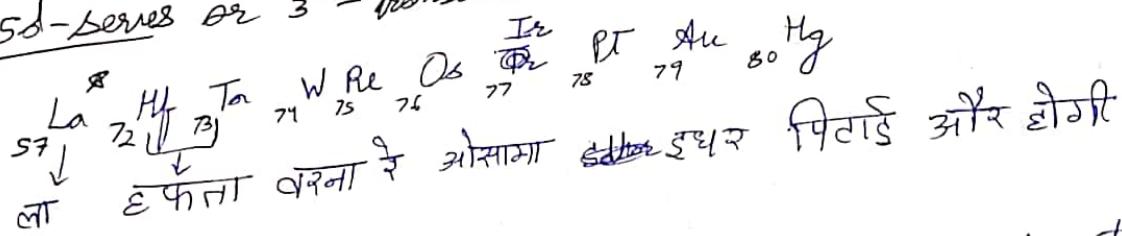
① 3d-series or Ist transition series elements.



② 4d-series or 2nd transition transition series elements.

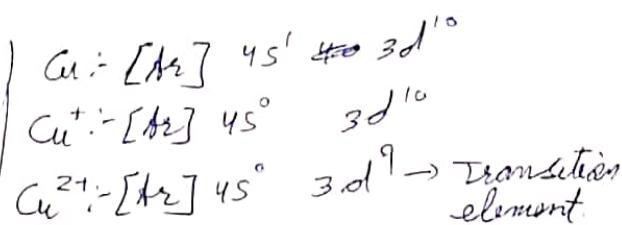
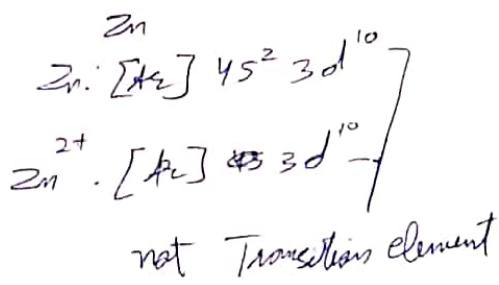


③ 5d-series or 3rd transition elements.



Note:- Elements of these blocks are called transition elements

- Elements of these blocks are those elements which have incompletely filled d subshell either in their ground state or any of their cationic state found in nature
- 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

${}_{57}^{7}\text{La}$	${}_{58}^{7}\text{Ce}$	${}_{59}^{7}\text{Pr}$	${}_{60}^{7}\text{Nd}$	${}_{61}^{7}\text{Pm}$	${}_{62}^{7}\text{Sm}$	${}_{63}^{7}\text{Eu}$	${}_{64}^{7}\text{Gd}$
लान्थनिड	सीरियस	प्रैटिया	नेडिया	पीमे	सीमे	युए	गोड

${}_{65}^{7}\text{Tb}$	${}_{66}^{7}\text{Dy}$	${}_{67}^{7}\text{Ho}$	${}_{68}^{7}\text{Er}$	${}_{69}^{7}\text{Tm}$	${}_{70}^{7}\text{Yb}$	${}_{71}^{7}\text{Lu}$)
तेब	डाइ	होमा	एरि	टीम	युबी	लूबुलू

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

${}_{89}^{10}\text{Ac}$	${}_{90}^{10}\text{Th}$	${}_{91}^{10}\text{Pa}$	${}_{92}^{10}\text{U}$	${}_{93}^{10}\text{Np}$	${}_{94}^{10}\text{Pu}$	${}_{95}^{10}\text{Am}$	${}_{96}^{10}\text{Cm}$	${}_{97}^{10}\text{Bk}$	${}_{98}^{10}\text{Cf}$	${}_{99}^{10}\text{Es}$
D-block element	थार्मिट	पॉर्प	उन्हीं अंकों के लिए	नेप्सिया	पॉर्प	अमेरिका	कॉम्पोनेंट	बॉक्सी	फॉर्मेन्ट	इंडियन

${}_{100}^{10}\text{Fm}$	${}_{101}^{10}\text{Md}$	${}_{102}^{10}\text{No}$	${}_{103}^{10}\text{Lr}$)
फॉर्मेन्ट	मॉडिट	निकल	लॉर्सो

Note:-

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

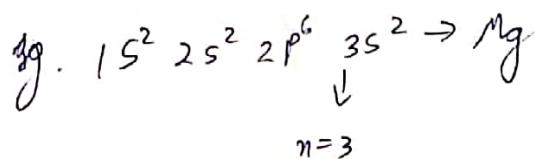
2. Lanthanide series elements & Actinide series elements are

F-block elements.

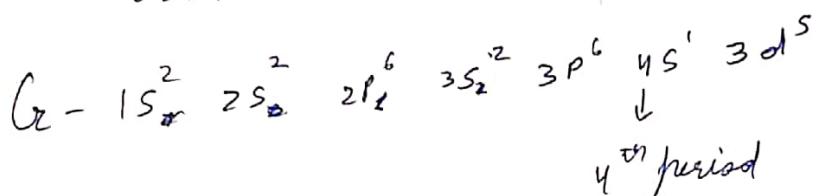
3. A Lanthanide series starts from ${}_{57}^{7}\text{Ce}$ to ${}_{71}^{7}\text{Lu}$

4. Actinide series starts from ${}_{90}^{10}\text{Th}$ to ${}_{103}^{10}\text{Lr}$

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



3rd Period



No. of elements in a specific period.

Period	Subshell	No. of element	Name
1 st Period	1s	2	Shortest
2 nd Period	2s 2p	10	Short
3 rd Period	3s 3p	10	Short
4 th Period	4s 3d 4p	18	long
	5s 4d 5p	18	long
5 th Period	6s 4f 5d 6p	32	longest
6 th Period	7s 5f 6d 7p	32	elongated
7 th 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 $2s, 2p$

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

$2p - \textcircled{9} 9e^- \rightarrow 9$ elements

Total elements $\rightarrow \boxed{12 \text{ elements}}$ find total no. of

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

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

$6s \rightarrow 3e^-$

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

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

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

Total $e^- = 48$

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

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

$$\begin{array}{ccccccc} 10s & & 6f & 7g & 8f & 9d & 10p \\ \downarrow & & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 3e^- & 33e^- & 27e^- & 21e^- & 15e^- & 9e^- & \rightarrow 108e^- \end{array}$$

$\boxed{\rightarrow 108 \text{ elements}}$

Q4. Find atomic no. of element present in 8th period group 17.

$$118 + 17 = 135$$

7th period total = 118 elements

$$\cancel{17^{\text{th}} \text{ group}} = 17$$
$$\cancel{118 + 17} = \boxed{+ 35^{\text{th}} \text{ element}} + 18$$
$$\boxed{= 153 \text{ element}}$$

18th group \rightarrow 50th element of period
17th group \rightarrow 49th element of period

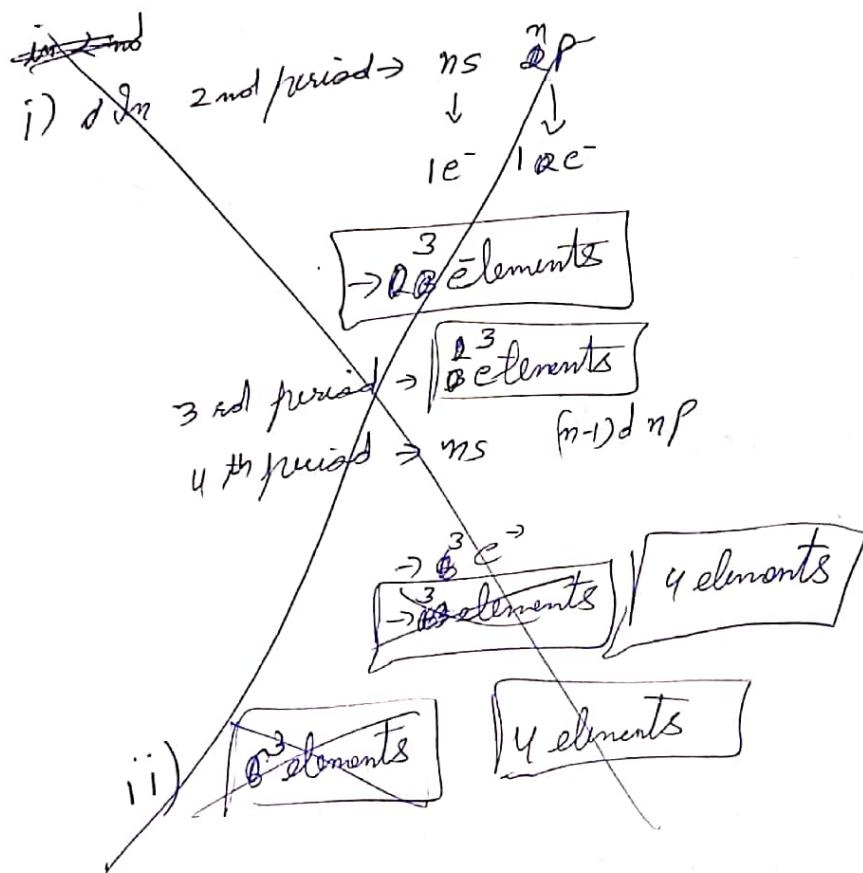
$$118 + 49 - \cancel{68} = 167$$

$\boxed{Z = 167}$

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

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

ii) elements in 3rd shell



$$\begin{array}{ll} i) & \begin{array}{c} n=1 \\ n=2 \\ n=3 \end{array} & \begin{array}{c} 1s \\ 2s \\ 3s \end{array} & \begin{array}{c} 1p \\ 2p \\ 3p \end{array} & \begin{array}{c} 3d \\ 4f \end{array} \end{array}$$

2nd period $\sim 2s \sim p$

$$\text{Total } e^- = 8$$

3rd period \rightarrow 3s 2d 3p

\rightarrow 18 elements

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

3d 4p

\rightarrow 18 elements

ii)

$n=3 \rightarrow 3s \quad 3p \quad 3d \quad 3f$

$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$

2 6 10 14

\rightarrow 32 elements

Q 5. In other universe, if O.N. same except

$l \rightarrow 0 \text{ to } (n+1)$

$m \rightarrow -l \text{ to } +l$

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

Then, calculate

no. of elements in 2nd period

no. of elements in 2nd shell

no. of elements in 2nd shell

2nd period \rightarrow 2s

1d 2p

\downarrow

2nd shell

\downarrow

7

\downarrow

5

$3 \times 3 = 9 e^-$

$3 \times 7 = 21 e^-$

$3 \times 5 = 15 e^- = 45 e^-$

$= 45 \text{ elements}$

2nd Shell $\rightarrow n=2$

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

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

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

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

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

= 24 orbitals

$2^4 \times 3 \rightarrow 72 e^-$
72 elements

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 Uronic elements - After Uranium element, atomic no. 92
excluded ($Z=92$) or (Np , $Z=93$) are known as Trans \uparrow Uronic elements including
3. Typical elements - 2nd & 3rd period elements are known as typical elements

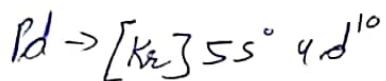
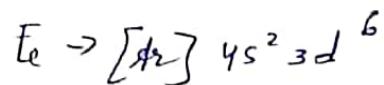
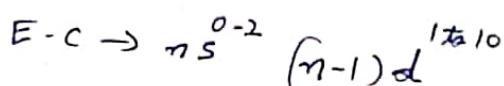
Classification of elements according to Block :-

1. S-Block elements - last e⁻ enters in ~~s-block~~
S-Subshell,
General electronic Config nS^{10-2}
 nS^1 or nS^2

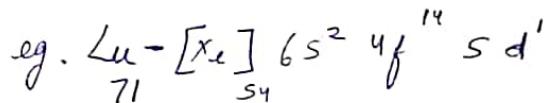
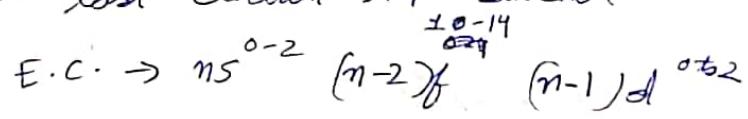
e.g. Li - $1S^2 2S^1$
Mg : [Ne] $3S^2$

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 - $ns^1 \rightarrow$ 1st group H, Li, N, K, Rb, Cs, Fr
 (except Helium) $ns^2 \rightarrow$ 2nd group Be, Mg, Ge, Sr, Ba, Ra

no. of electron in valence shell = Group no. (for S-Block)

→ P-Block -

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

eg $S \rightarrow [Ne] 3s^2 3p^4 \rightarrow 12 + 6 \rightarrow 16^{\text{th}} \text{ group}$

$N \rightarrow [He] 2s^2 2p^3 \rightarrow 12 + 3 \rightarrow 15^{\text{th}} \text{ group}$

③ Group no. of D-block elements

Group no. \rightarrow no. of nsc^- + no. of ~~no.~~ $(n-1)d^e^-$

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

group $\rightarrow 1+5 \rightarrow 6^{th}$ group.
 \rightarrow D-block.
 \rightarrow 4th period.

e.g. 2. Fe $\rightarrow [Ar] 4s^2 3d^6$
 group $\rightarrow 6+2 \rightarrow 8^{th}$ group.
 \rightarrow D-block.
 \rightarrow 4th period.

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

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

32 \rightarrow ~~no.~~ $[Ar] 4s^2 3d^{10} 4p^2$ 27 \rightarrow $[Ar] 4s^2 3d^7$
 \rightarrow P-block
 \rightarrow 4th period
 \rightarrow 14th group

\rightarrow D-block
 \rightarrow 4th period
 \rightarrow 9th group

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

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

2 $\rightarrow 1s^2$
 \rightarrow S-block
 \rightarrow 1st period
 \rightarrow 1st group

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

IUPAC Nomenclature of elements

(atomic num. > 100)

→ 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
+		

Ex ① - $Z=118$ (Uuo)
with Ununoctium

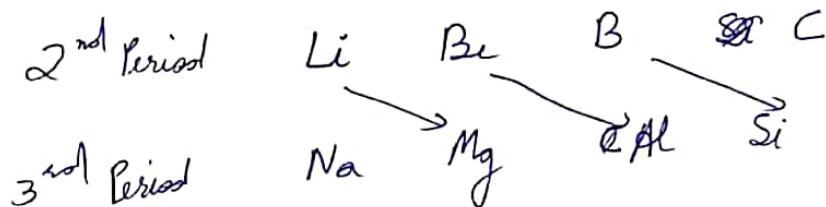
④ $Z=115$ (Uup)
Ununpentium

② - $Z=104$ (Uumg)
Unnilquadium

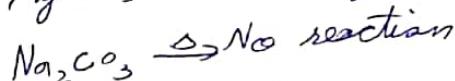
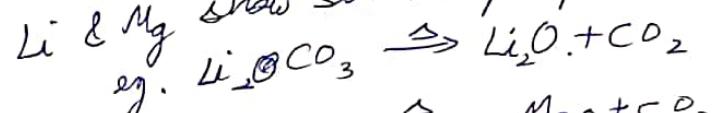
③ $Z=110$ (Uun)
Ununnilium

Diagonal Relationship

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



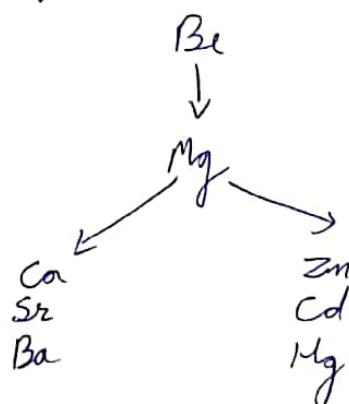
Li & Mg show similar properties -



BeO Both are
 Al_2O_3 Amphoteric

Bridge Element

→ Elements Mg of 3rd period is bridge element



→ 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.

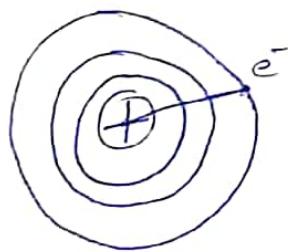
Periodic Properties

→ 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 radius



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

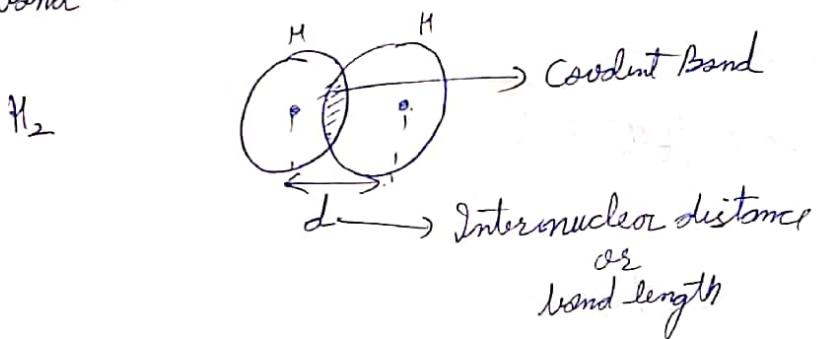
→ It is impossible to calculate exact value of radius or actual value of atomic size

→ 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 →

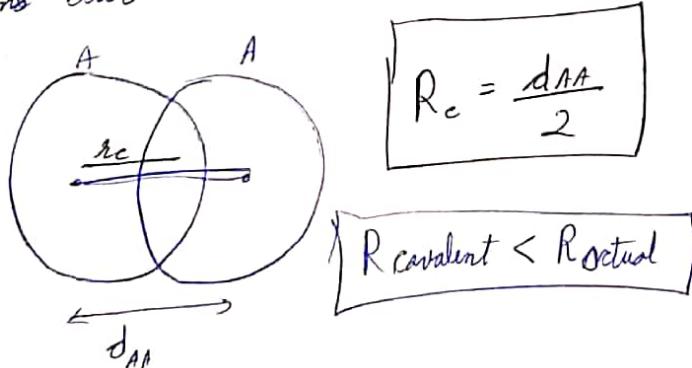
→ It is defined for those elements which are bonded with covalent bond



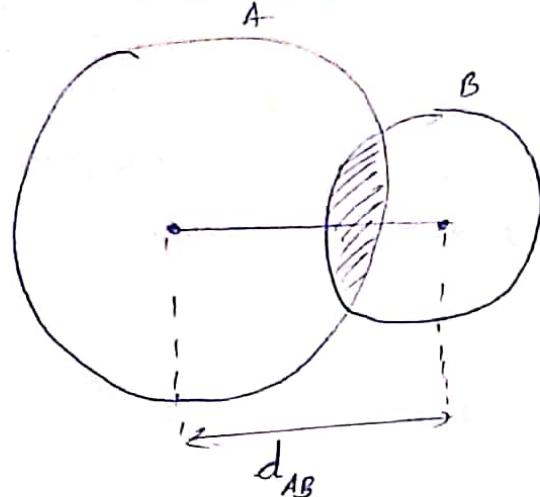
→ Bond length - It is interatomic distance between two atoms in a bonded state.

Covalent radius

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



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



Schoeniger-Stevenson Equation -

$$d_{AB} = \gamma_A + \gamma_B - 0.09 |EN_A - EN_B|$$

γ - 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 \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 \AA° & Cl_2 molecule is 10 \AA° ; given EN_H is 2.01 & EN_{Cl} is 3 .

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

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

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

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

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

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

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

$$d_{HCl} = 1 + \frac{5}{6} - 0.09 (2.01 - 3)$$

$$= 7.5 - 0.09 (0.9)$$

$$= 7.5 - 0.081$$

$$= 7.009$$

$$- 0.081$$

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

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

$$EN_A = 2$$

$$EN_B = 1.5$$

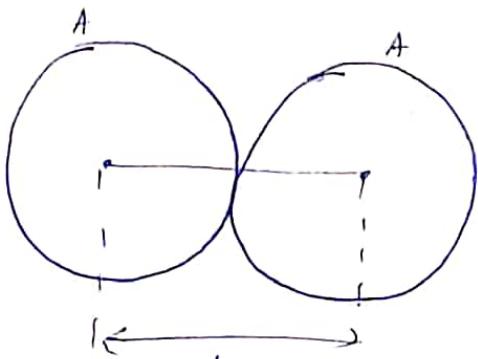
$$d_{AB} = 15 + 20 - 9(2 - 1.5)$$

$$= 35 - 9(0.5)$$

$$= 35 - 4.5$$

$$= 30.5\text{ fm}$$

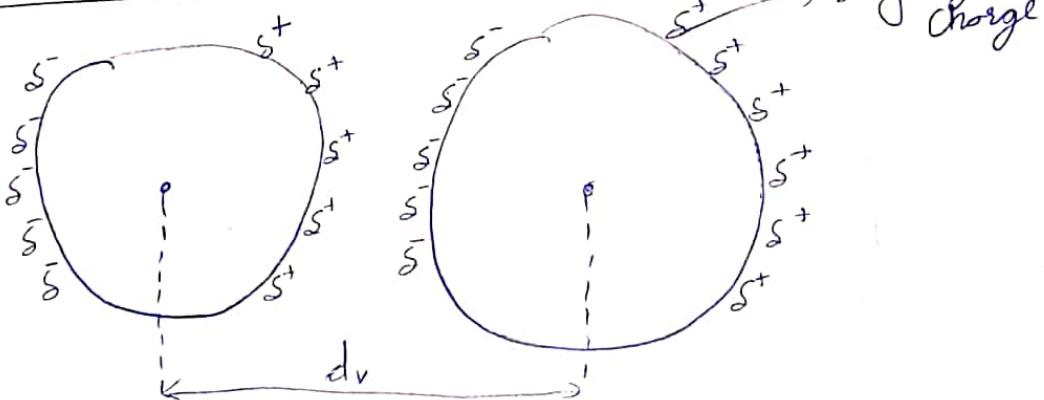
② Metallic Radius/Crystal Radius - It is half the internuclear distance between two identical atoms bonded by a metallic bond.



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

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

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

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

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

②

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

$n \uparrow$, Size \uparrow

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

$n \uparrow$
Size \uparrow (in general)

bottom

for S or P block -

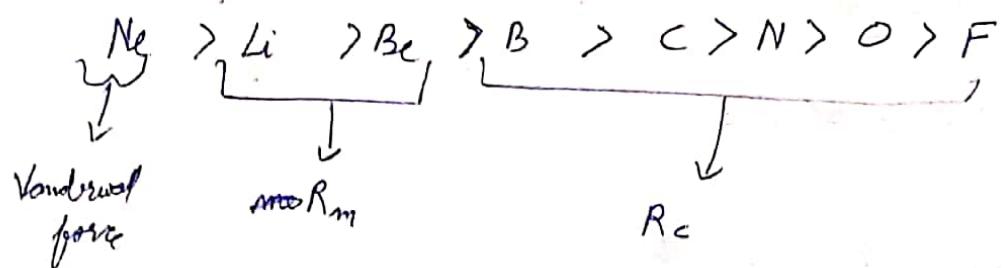
(In Period)

1st 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*

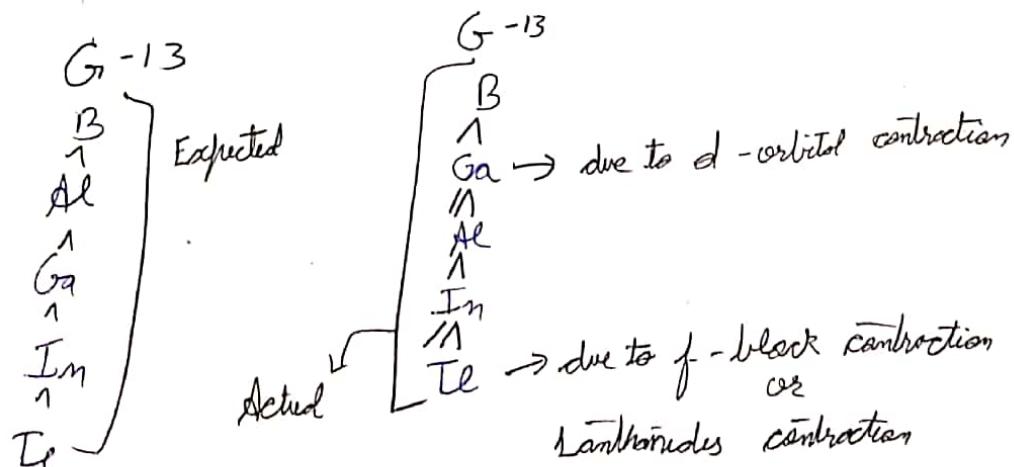


3rd Period - $\text{Ar} > \text{Na} > \text{Mg} > \text{Al} > \text{Si} > \text{P} > \text{S} > \text{Cl}$

~~Q2~~ Variation along the group -

G 1	G 2	G 13	G 14	G 15	G 16	G 17	G 18
H		E	C	N	O	F	He
Li	Be	X	Si	P	S	Cl	Ne
Na	Mg	C	Ge	As	Se	Bz	Ar
K	Ca	E	Ge	As	Te	I	Kr
Rb	Sr	P	Sn	St	Po	Ast	Xe
Cs	Ba	F	Pb	Bi			Rn
		O					

Ans



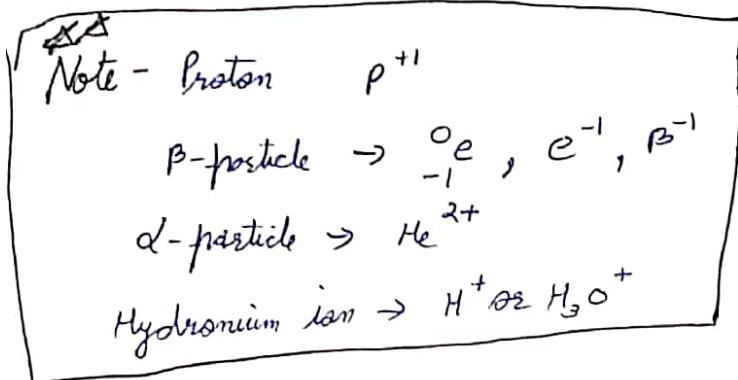
D-Contraction - Due to poor shielding of D-subshell or D-electrons, effective nuclear charge increases and hence size of atom decreases.

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

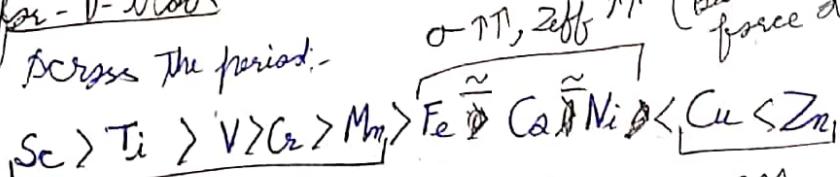
H.W. 21/04/2025

Topic 1-4

$$\boxed{\begin{aligned} \text{Size of atom} &= 10^{-10} \text{ m} \\ \text{nucleus} &= 10^{-14} \text{ m} \\ p/n/e^- &= 10^{-15} \text{ m} \end{aligned}} \quad \text{approx}$$



for D-block - across the period -

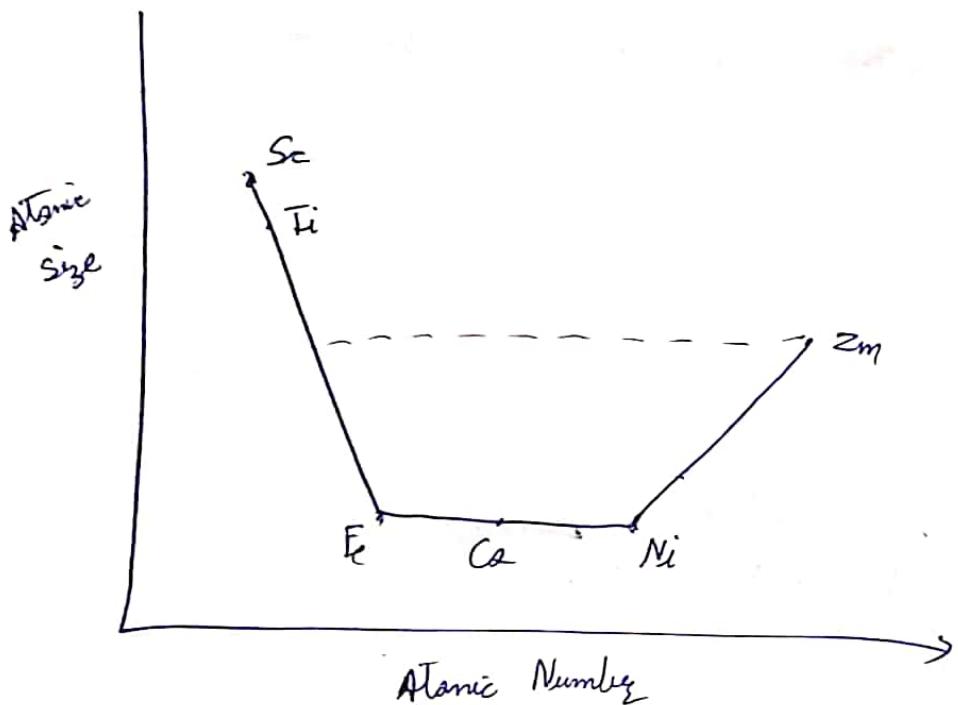


$\sigma \uparrow, Z_{\text{eff}} \uparrow$

Size \downarrow
(attraction force dominant)

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

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



(~~more~~)

variation along the groups

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

$Sc < Y < La$

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

	G 4-12											
$f \rightarrow s$	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn			
$s \rightarrow f$	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd			
$d \rightarrow f$	La	Hf	Ta	W	Re	Os	I ₂	Pt	Au	Hg		
	1s	1s	1s	1s	1s	1s	1s	1s	1s	1s		

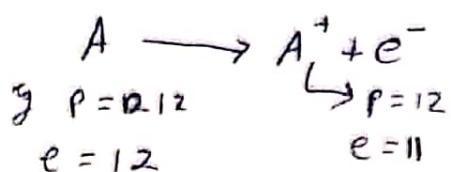
Almost equal

2 3

(92)

Ionic Radius (Cations or Anions)

Cation -



Attraction \uparrow , Size \downarrow

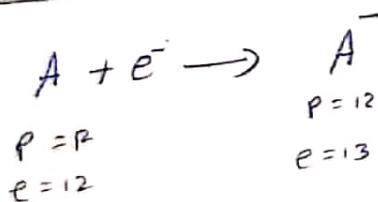
$\boxed{\text{Size of atom} > \text{Size of cation}}$

Radius order:-

$$[A > A^+ > A^{2+} > A^{3+}]$$

Eg $Na > Na^+$
 $Mg > Mg^{2+}$
 $Al > Al^{3+}$

Anion -



Attraction \downarrow , Size \uparrow

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

Radius order

$$[A < A^- < A^{2-} < A^{3-}]$$

Note :- Size

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

e.g. $N < N^{3-}$

$$O < O^{2-}$$

$$F < F^-$$

Size or Radius comparison between iso-electronic species.

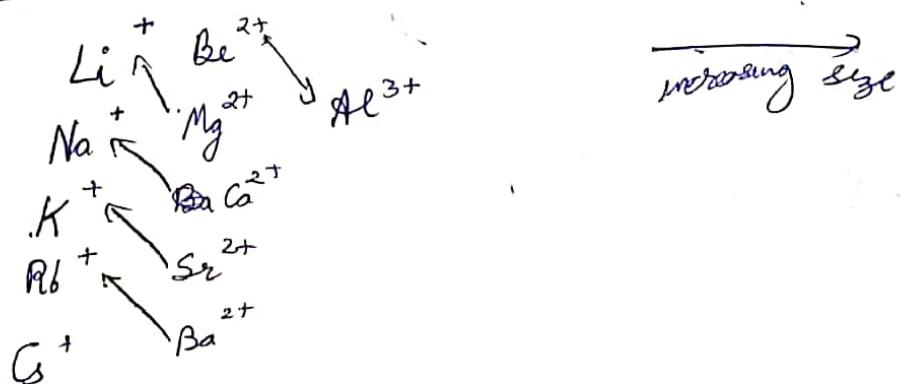
$$N^{3-} > O^{2-} > F^- \rightarrow Na^+ > Mg^{2+} > Al^{3+}$$

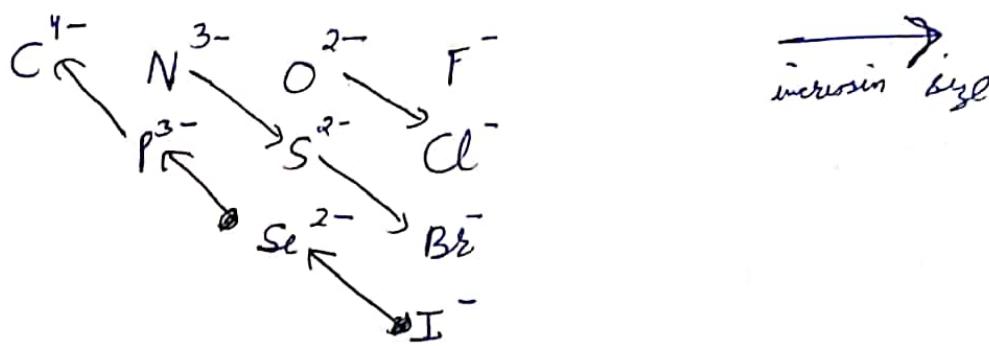
$Z \uparrow$ iso-electronic

$\sigma = \text{some}$
 $Z \uparrow P, \text{Size} \downarrow$

e.g. $P^{3-} > S^{2-} > Cl^- > K^+ > Ca^{2+}$
iso electronic

Some Mixed Order.





① Radius Order?

① K, Rb, Cs

$$\textcircled{1} \quad K < Rb < Cs \checkmark$$

② Be, F, O, N, Ne

$$\textcircled{2} \quad Ne > Be > O > N > F \cancel{> Ne} \checkmark$$

③ Mg, Na, K, Rb

$$Mg < Na < K < Rb \checkmark$$

④ Sb, P, As, S

$$S < P < As < Sb \checkmark$$

⑤ P, As, Cl, S

$$Cl < S < P < As \checkmark$$

⑥ Sc, V, Mn

$$Sc > V > Mn \checkmark$$

⑦ Fe, Co, Ni

$$Fe \approx Co \approx Ni \checkmark$$

⑧ Cu, Zn

Cu < Zn ✓

⑨ Fe, Fe^{2+} , Fe^{3+}

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

⑩ O, O^{-1} , O^{2-}

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

⑪ Pd, Ni, Pt

Ni < Pd \simeq Pt ✓

⑫ V, Ta, Nb

V < Nb \simeq Ta ✓

⑬ Sb, S, Se, Te

S < Se \simeq Te < Sb ✓

⑭ Xe, Rn, Kr

Kr < Xe < Rn ✓

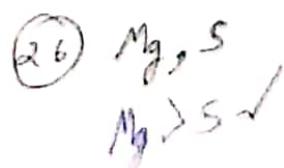
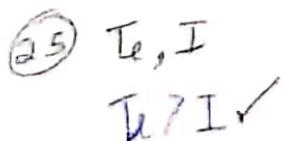
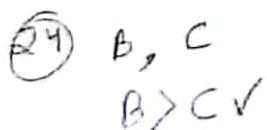
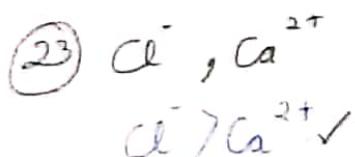
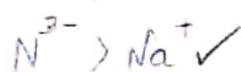
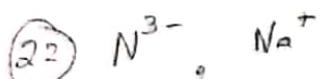
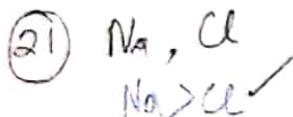
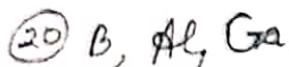
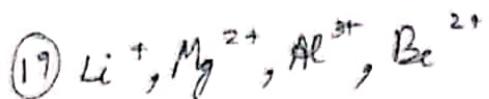
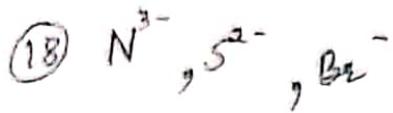
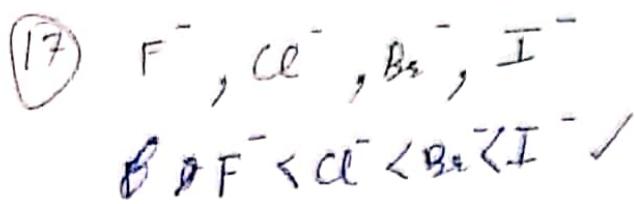
⑮ $\text{A}^+, \text{A}^{2+}, \text{A}^{2-}, \text{A}^-, \text{A}^0$

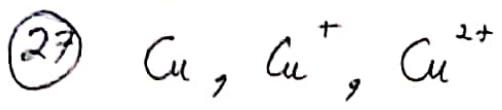
$\text{A}^{2-} > \text{A}^- > \text{A}^0 > \text{A}^+ > \text{A}^{2+} \checkmark$

⑯ μ^- , $\text{Li}^{\oplus +}$

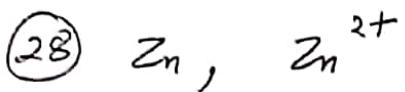
$\mu^- > \text{Li}^+ \checkmark$

⑰





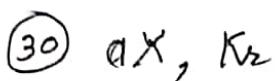
$$\text{Cu} > \text{Cu}^+ > \text{Cu}^{2+} \checkmark$$



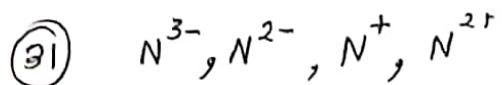
$$\text{Zn} > \text{Zn}^{2+} \checkmark$$



$$\text{P} < \text{As} \checkmark$$



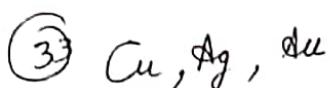
$$\text{Kr} < \text{Ar} \checkmark$$



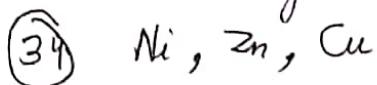
$$\text{N}^{3-} > \text{N}^{2-} > \text{N}^+ > \text{N}^{2+} \checkmark$$



$$\text{Ge} < \text{Mg} \simeq \text{W} \checkmark$$



$$\text{Cu} < \text{Ag} \simeq \text{Au} \checkmark$$

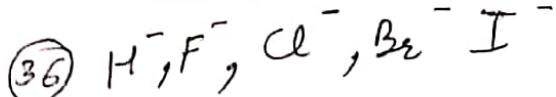


$$\text{Ni} < \text{Cu} < \text{Zn} \checkmark$$



$$\text{Cl}^- > \text{Cl} > \text{Cl}^+ \checkmark$$

* High repulsion
bcs of extra e-



$$\text{H}^- < \text{F}^- < \text{Cl}^- < \text{Br}^- < \text{I}^- \checkmark$$

(38)

H.W. 29-04-2024

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

O-2 (Q1,2)

S-1 (Q13)

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

JA (2,6)

Note - Largest Cation - Cs^+

Smallest cation - H^+

Largest mono negative anion = I^-

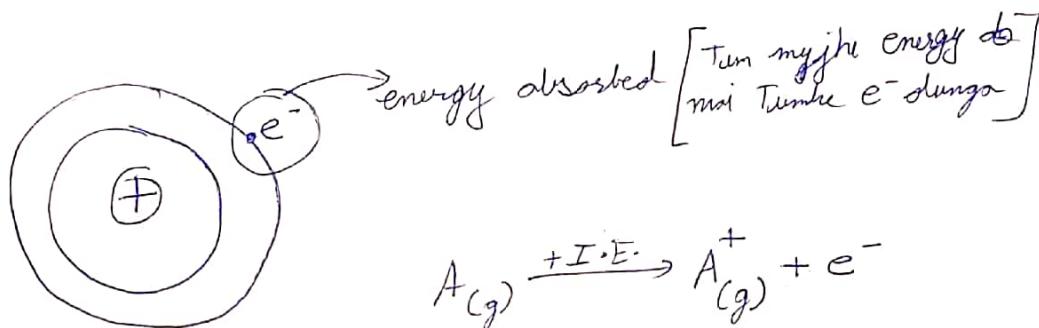
Second - largest mono negative anion = H^-

Smallest mono - negative anion = 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. :- KJ/mol \rightarrow $e.v/mol$, $Kcal/mol$, J/mol , Cal/mol
↓
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

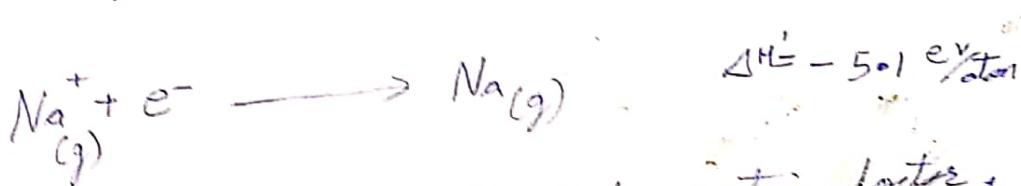
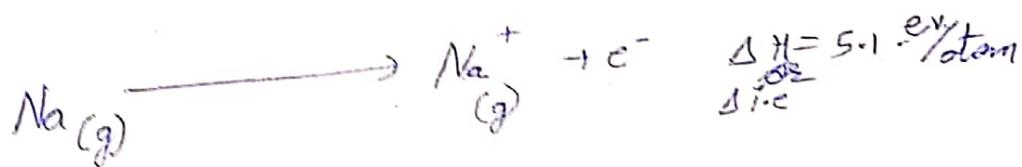
$\Delta H = \text{② } \text{Ve} \rightarrow$ Exothermic Reaction \rightarrow Energy released.

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

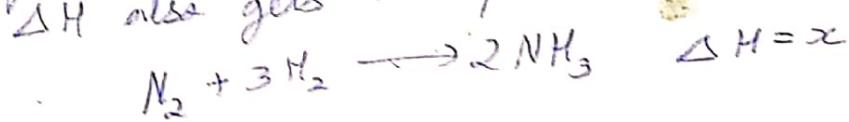
Properties of Enthalpy of reactions :-

Properties of Enthalpy of reactions :-

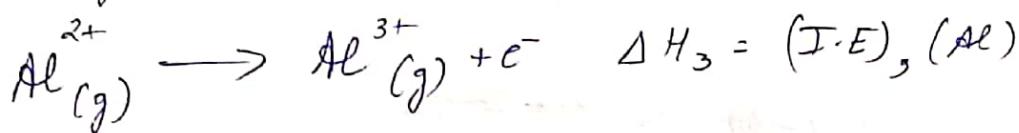
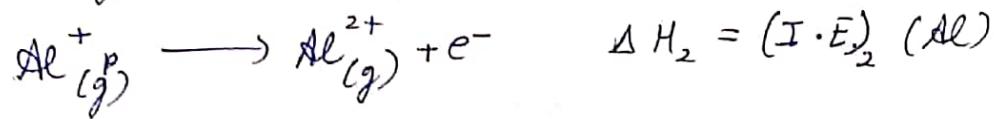
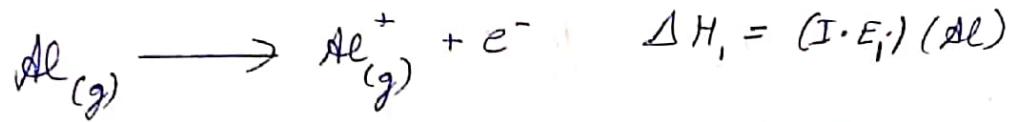
- ① If the reaction is reversed, the sign of ΔH is also reversed.



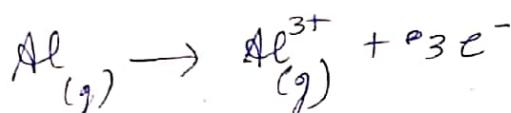
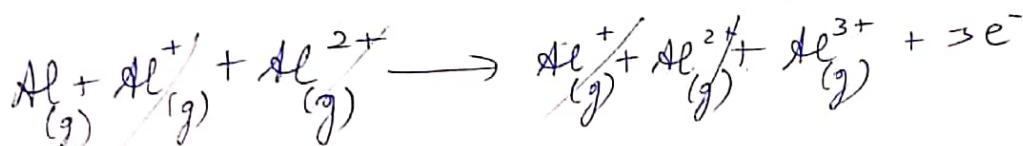
- ② If the reaction is multiplied by certain factor, then ΔH also gets multiplied by that factor.



③ If two or more than two reactions are added, their ΔH are also added

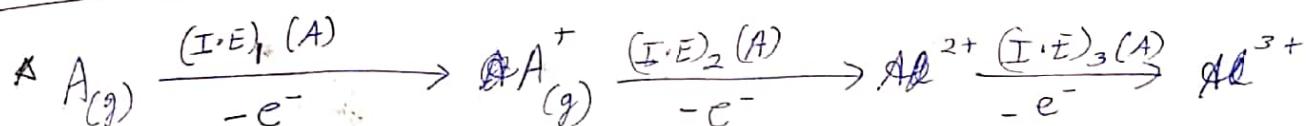


Adding the three



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

Successive Ionisation Energy =



$$(I \cdot E)_1(A) = (I \cdot E)_{\text{of}}(A^+)$$

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

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.E₁(B)
- B) I.E₆(B)
- C) I.E₇(B) ✓
- D) I.E₅(B²⁺) ✓

- E) I.E₄(B³⁺) ✓
- F) I.E₃(B⁴⁺) ✓
- G) I.E₁(B⁵⁺)
- H) I.E₁(B⁶⁺) ✓
- I) I.E₂(B⁵⁺) ✓
- J) I.E₆(B⁺¹) ✓

Q

Valence e⁻ calculation

~~(I.E)₁(x)~~

Q. An element X, find valence shell e⁻

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

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

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

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

sudden drastic change, means shell change

valence shell has 2e⁻

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. \rightarrow

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

$$Z_{eff} \uparrow \wedge I.E. \uparrow \\ \text{Size} \downarrow$$

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

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⁻ config:- Half & fully filled e⁻ config are more stable hence process of e⁻ removal will be difficult for such configuration -

Variation along period - Variation of ionization energy across period.

Left $\xrightarrow[\text{increase ionisation energy}]{\text{Z eff} \uparrow; \text{size} \downarrow; \text{I.E} \uparrow}$ Right

Period 1 :- H < He (max I.E is of He)

Period 2 :- Li < Be < B < C < N < O < F < Ne (Expected)
 $2s^1$ $2s^2$ $2p^1$ $2p^2$ $2p^3$ $2p^4$ $2p^5$ $2p^6$ - fully filled
 Penetration power
 Half filled

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.

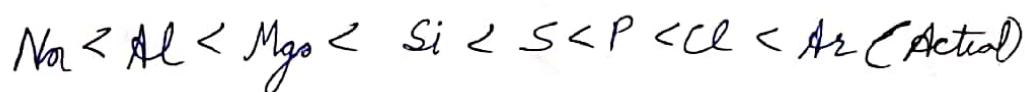
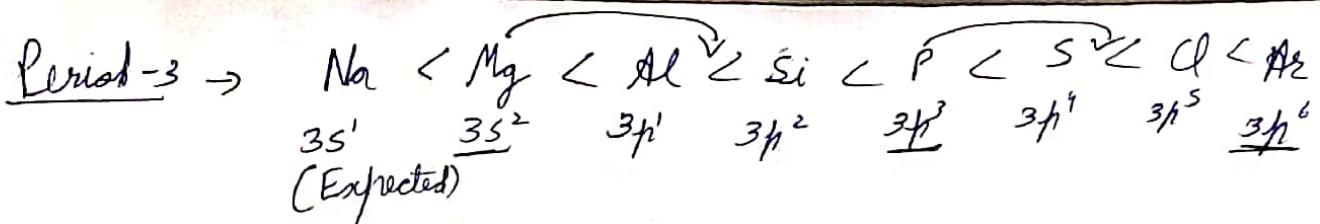
The configuration of Be is $1s^2 2s^2$ which is more stable configuration therefore to remove an e^- from Be its stability should be broken first which requires energy. Also now e^- will be removed from ~~2s~~ $2s$ which is closer to nucleus thereby requiring more energy.

Mence Overall energy requirement is high.

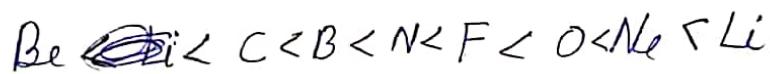
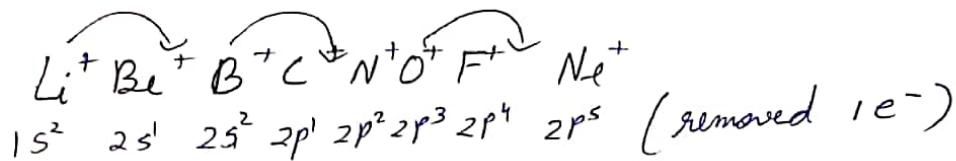
② In case of Nitrogen and oxygen, Nitrogen has half filled stability therefore to remove an electron more energy is required.

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

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

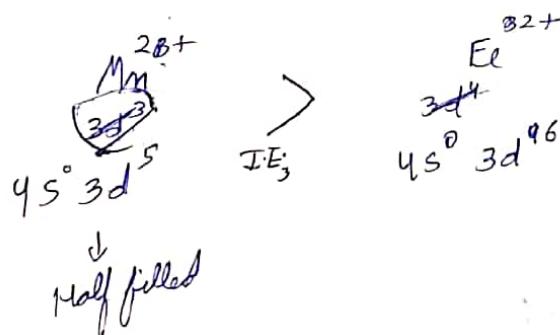


Note - In a periodic table He has highest Ionisation Energy.

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

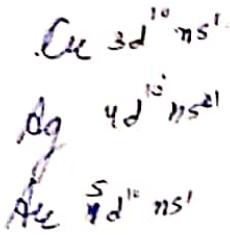
③ In D-block from left to right no regular order was observed hence need not to study

Q2. $I.E_3$ Mn $I.E_3$ Fe



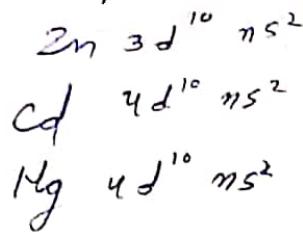
I.E.
Q3.

Group 11

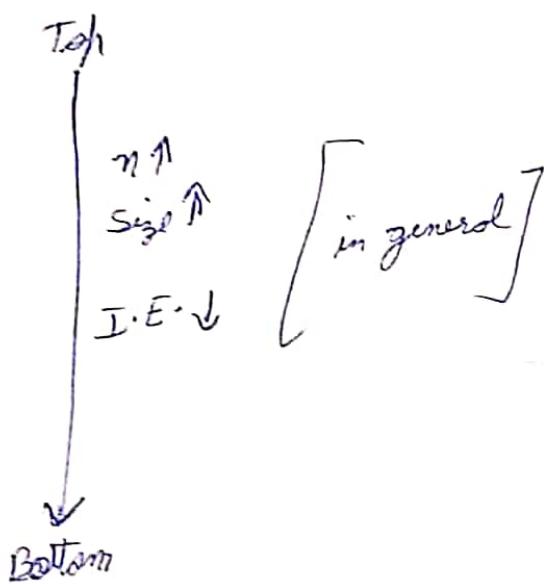


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Group 12



Variation of I.E. down the group:-



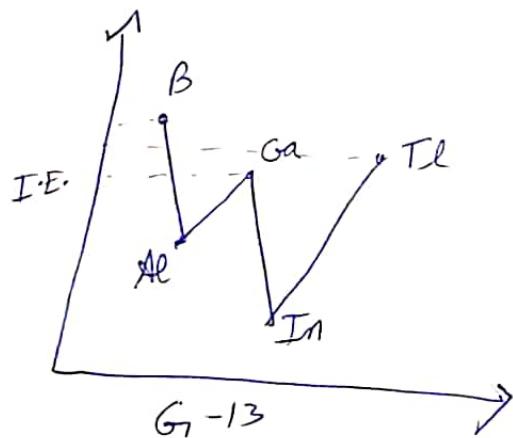
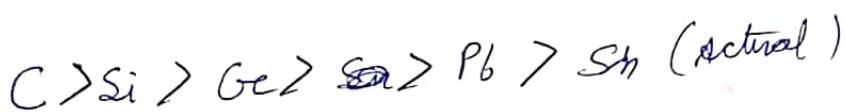
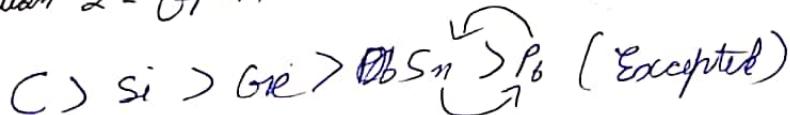
G 1	G 2	G 13	G 14	G 15	G 16	G 17	G 18
Li	Be	E	C	N	O	F	Ne
✓	✓	X	✓	✓	✓	✓	✓
Na	Mg	E	Si	P	S	Cl	Ar
✓	✓	C	✓	✓	✓	✓	✓
K	Ca	T	Ge	As	Se	Br	Kr
✓	✓	T	✓	✓	✓	✓	✓
Rb	Sr	I	Pb	Sb	Te	I	Xe
✓	✓	R	✓	✓	✓	✓	✓
Cs	Ba		V	Bi	P	At	Rn
			Sn				

Exception 1 - G₁-13



		Actual
B	1	
Al	5	
Ga	3	
In	2	
Tl	4	

Exception 2 - G₁-14



Explanation (Exception 1) — In Boron family, Due to lanthanides and D-~~state~~ contraction in Tl, its Z_{eff} 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								
La	Hf	Ta	W	Re	Os	Ta	Pt	Ag	Pt

I_{so} - Protonic :-

$$\frac{A < A^+ < A^{2+}}{Z \text{ same} \quad e^- \downarrow}$$

~~Z_{eff} same~~ $\alpha \downarrow$

~~α~~ $Z_{\text{eff}} \uparrow$

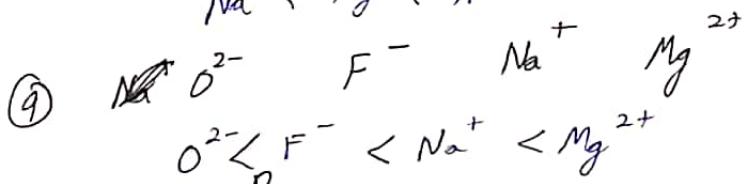
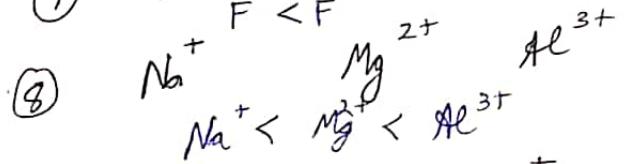
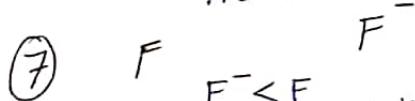
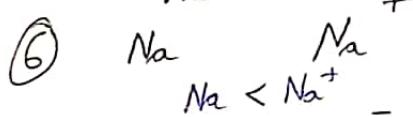
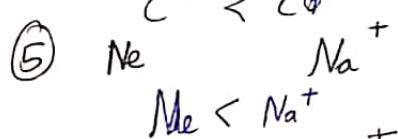
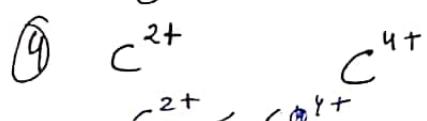
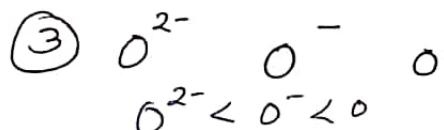
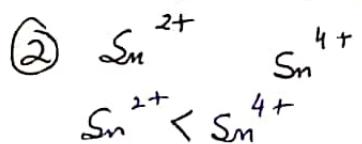
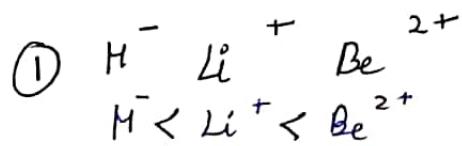
I.E. \uparrow

e.g. $E_e < E_e^{2+} < E_e^{3+}$

I_{so} Electronic :- $\frac{{}_3Li^+ > {}_2He^{2+}}{e^- \rightarrow \text{same}}$

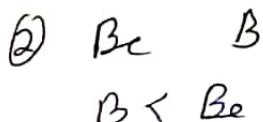
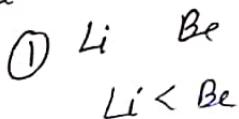
$\alpha \rightarrow \text{same}$

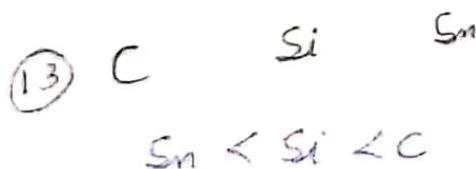
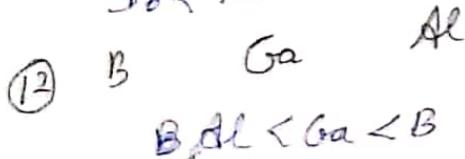
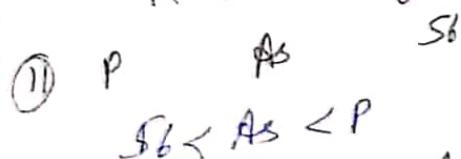
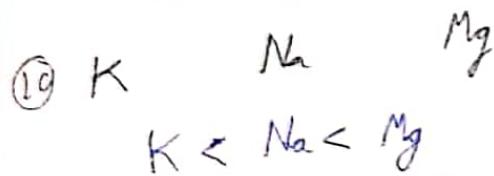
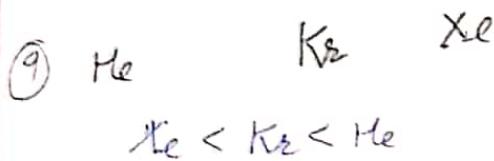
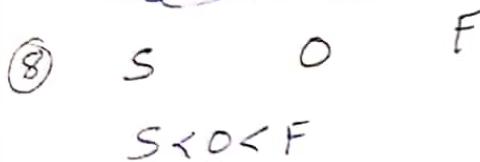
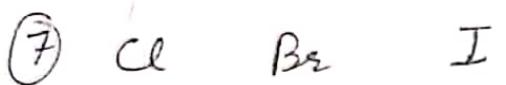
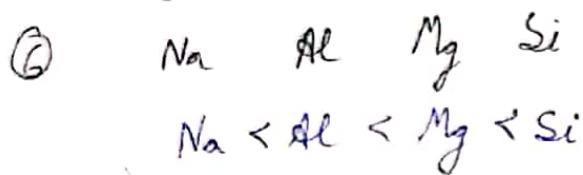
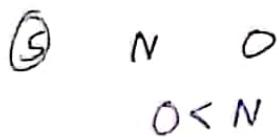
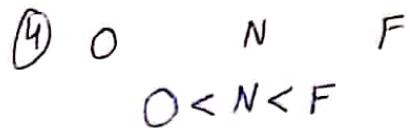
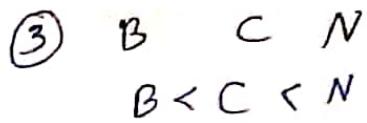
$Z \downarrow \quad Z_{\text{eff}} \downarrow \quad E.E \downarrow$

Q1 I.E order

~~Li Be~~

Q2:





(14) Ge Mn

Ge < Mn ✓

(15) V Nb Ta

V Ta > Nb ≈ V ✓

(16) Sc Y La

Sc > Y > La ✓

(17) H⁻ Li⁺ Be²⁺

H⁻ < Li⁺ < Be²⁺ ✓

Application of I.E -

As ionisation energy increases, metallic character decreases

I.E. ↑, M.C. ↓

(Ex-1) Li > Na > K > Rb > Cs [I.E: order]

Metallic character order

Li < Na < K < Rb < Cs

I.E. ↓, M.C. ↑

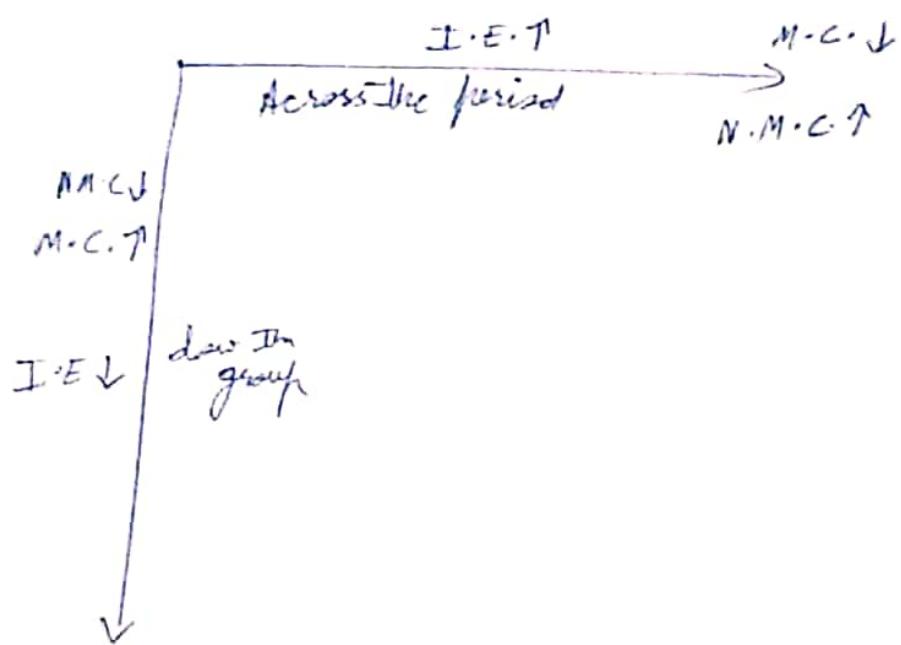
Eg 2. Be < B
2s 2p

Eg 3. Be < Mg

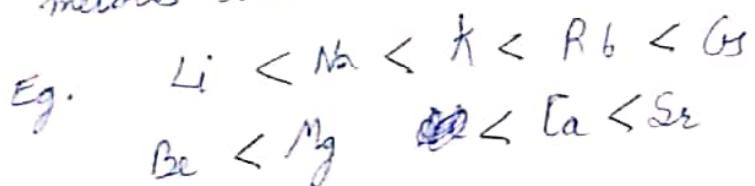
(113)

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

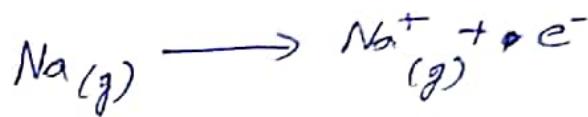
$$I.E \uparrow \quad N.M.C \uparrow$$



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



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



Reduction \rightarrow Addition of e^- .



Oxidizing Power \rightarrow

Oxidizing 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)

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

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

⑤ a) If

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

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

<u>Na</u>	<u>e% atom</u>
Na^{+}	IE_1
Na^{2+}	IE_2
	IE_3

05.1 41.2 71.62

) 36.1 Na^{+} more stable

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

then higher oxidation will be more stable

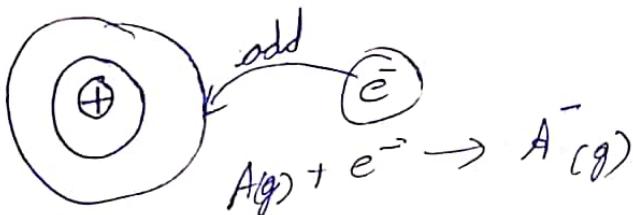
Eg2. $(\text{I.E})_2 - (\text{I.E})_1 = 7.4 \text{ eV/atom} < 11 \text{ eV/atom}$

(Mg)

Mg^{2+} is more stable than Mg^+

12

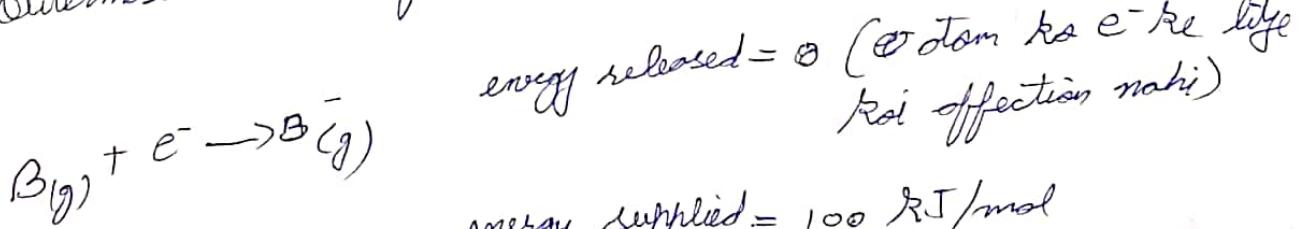
Electron Affinity (E.A.) - amount of energy released when an electron is added to the valence shell of an isolated gaseous atom or ion.



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

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

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 supplied = 100 kJ/mol

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

↓
endothermic
(e⁻ zakhordasti aya)

at 0K (0 Kelvin)

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

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

② $\Delta H_{Eg} = +\text{Ve}$; $E \cdot A = -\text{Ve}$ 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.

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

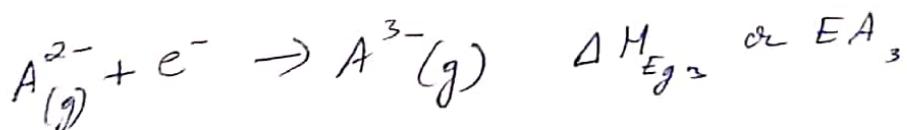
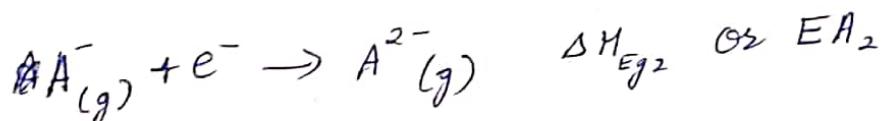
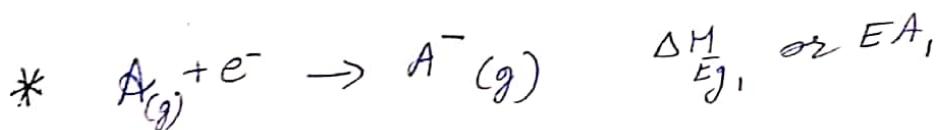
$$\Delta H_{Eg_1} = +\text{Ve}$$

$$E \cdot A_1 = -\text{Ve}$$

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

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

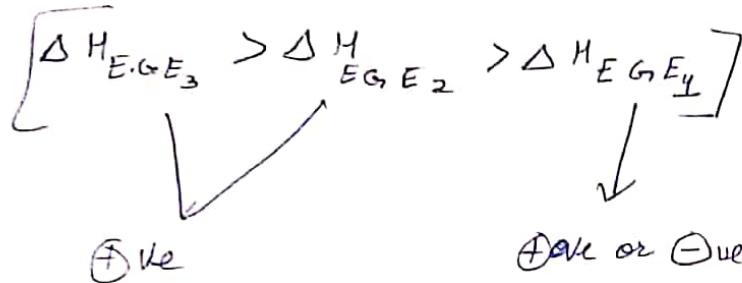
$$E \cdot A_1 = +\text{Ve}$$



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.

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

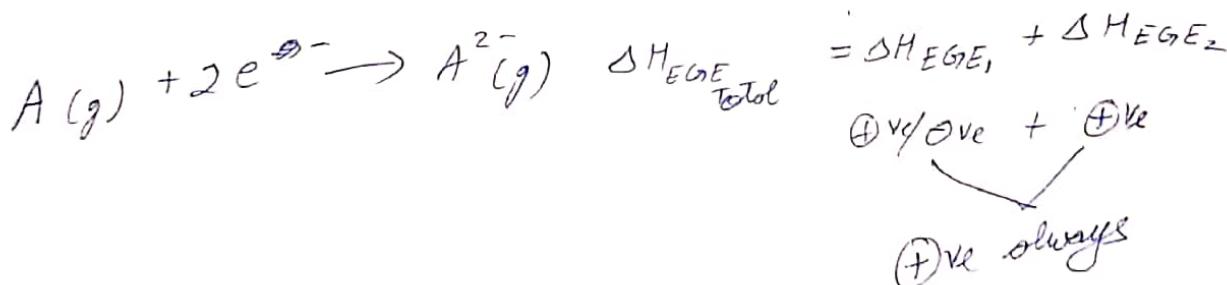
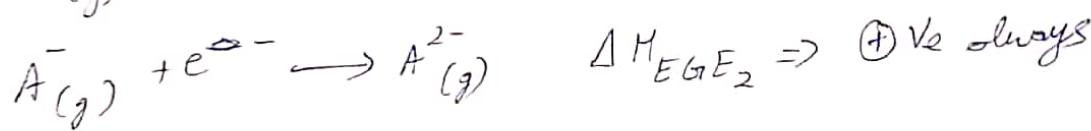
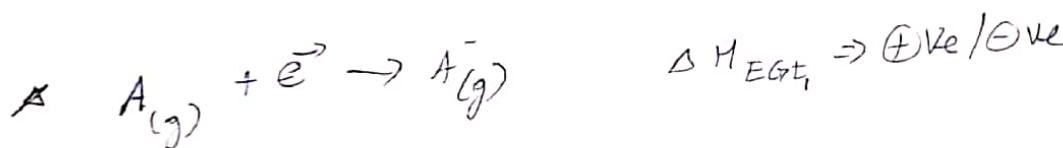


Note- E_{A^-} can be positive or negative

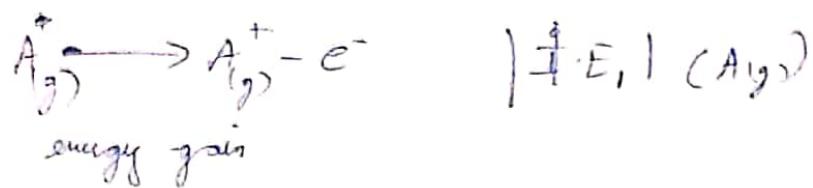
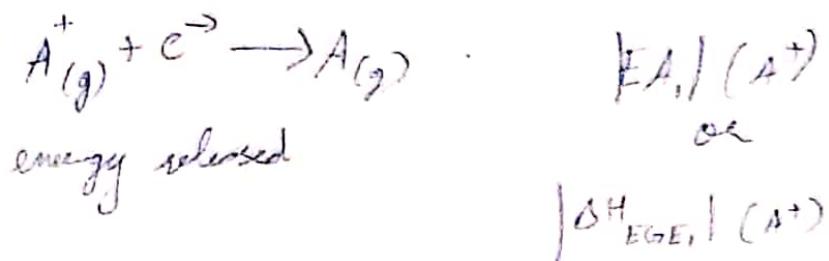
\downarrow

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

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



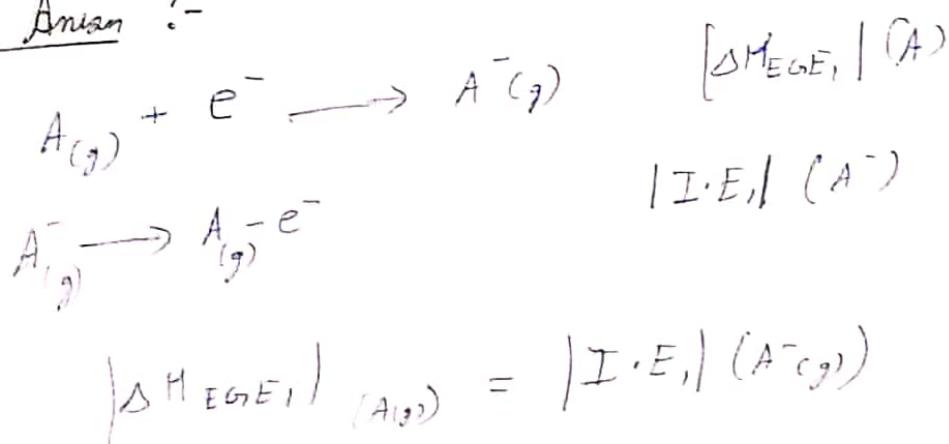
For Cations :-



$$|\Delta H_{E.G.E.1}(A^+) = |I.E_1(A)|$$

$$|EA_1(A^+) = |I.E_1(A)|$$

For Anions :-



$$|\Delta H_{E.G.E.1}|_{(A_{(g)})} = |I.E_1(A_{(g)})|$$

~~Trends in E.G.~~

Trends in E.G.

- ① $Z_{\text{eff}}:$ $Z_{\text{eff}} \uparrow$ Attractiv \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: $ns > np > nd > nf$
 की नुकसान की प्रक्रिया इन्हें अधिक अवश्यकता है।
- ④ Half filled & fully filled - for such atoms E.A. is very less or ~~more~~ in magnitude.

In Periodic Table

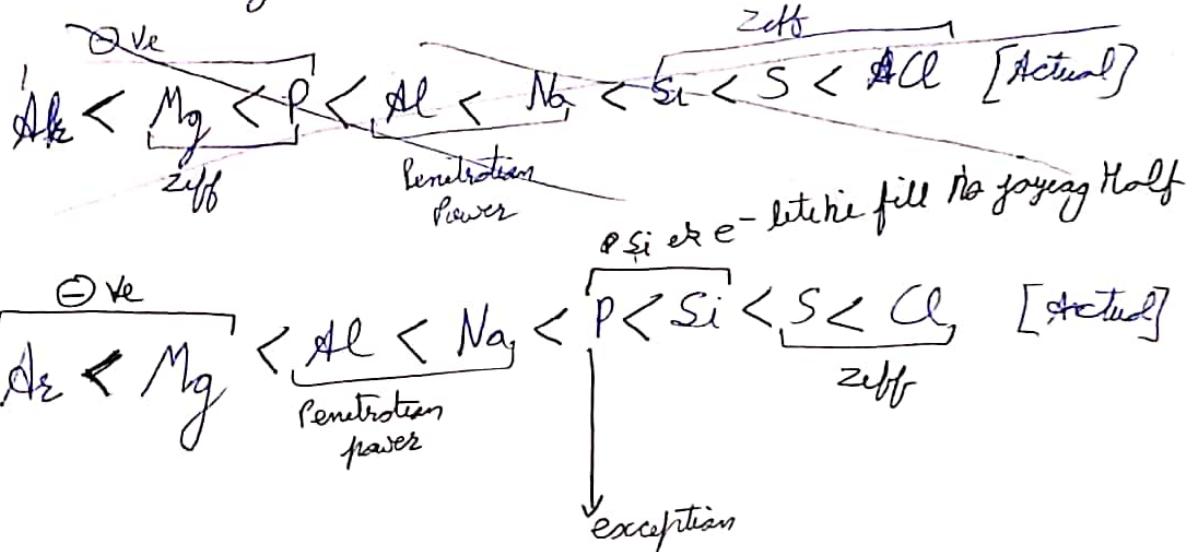
$Z_{\text{eff}} \uparrow$; E.A. \uparrow (in general)

Period - 2 $\overbrace{\text{Li} < \text{Be} < \text{B} < \text{C} < \text{N} < \text{O} < \text{F} < \text{Ne}}$ (Expected)

$\overbrace{\text{Ne} < \text{Be} < \text{N}}^{\text{E.A. } \Theta \text{ Zeff}} < \underbrace{\text{B} < \text{Li} < \text{C} < \text{O} < \text{F}}_{\text{Penetration power}} \text{ (Expected)}$

Period - 1 H > He

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



Top

$n \uparrow$; EA \downarrow

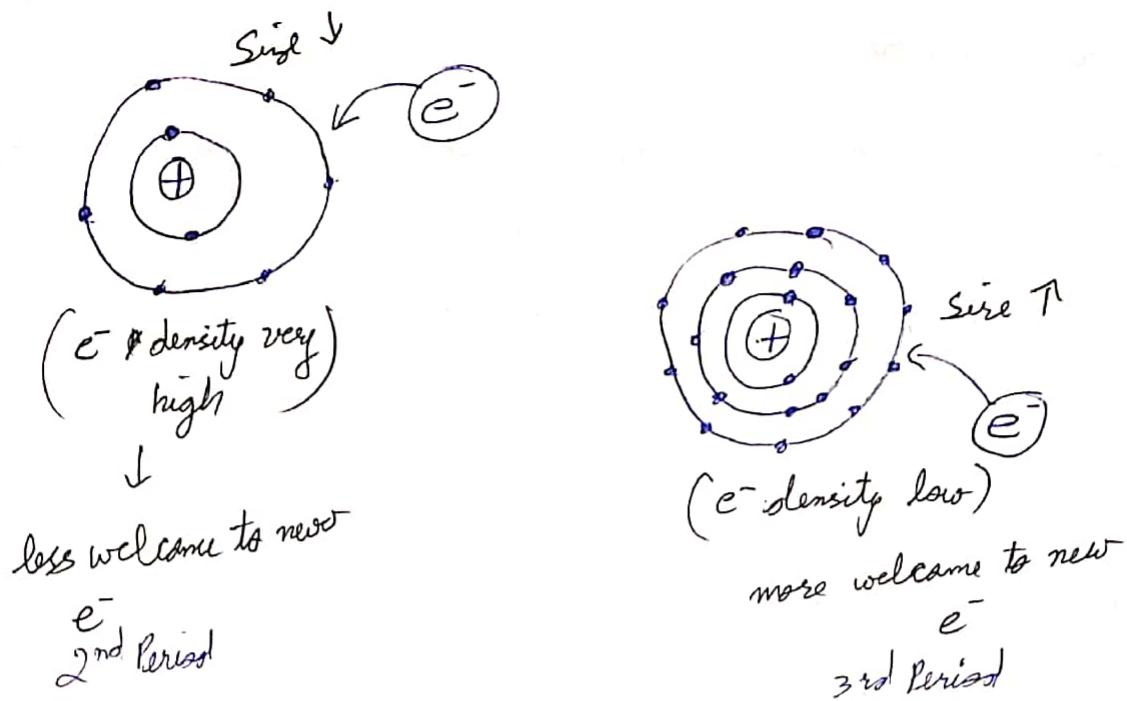
Bottom

S-Block: $\text{Li} > \text{Na} > \text{K} > \text{Rb} > \text{Cs}$

$\text{Be} > \text{Mg} > \text{Ca} > \text{Sr}$

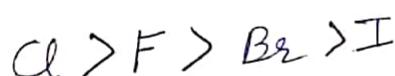
2nd Period :- $\text{B} \quad \text{C} \quad \text{N} \quad \text{O} \quad \text{F}$
 3rd Period :- $\text{Al} \quad \text{Si} \quad \text{P} \quad \text{S} \quad \text{Cl}$

Reason:-



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

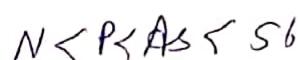
Halogen Family:-



Oxygen Family:-



Nitrogen:-



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

Note:-

- ① Oxygen and Nitrogen shows least e⁻ affinity in their respective groups.
 - ② Chlorine has highest e⁻ 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 ✓

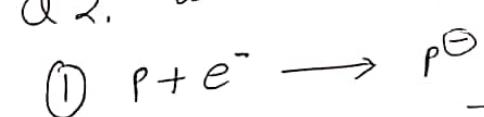
⑩ O, F, Cl
O < F < Cl ✓

⑪ N, O, F
N < ~~O~~ O < F ✓

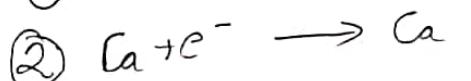
⑫ C, O
C < O ✓

⑬ O, N
N < O ✓

Q2. Write the sign of ΔH in the following.



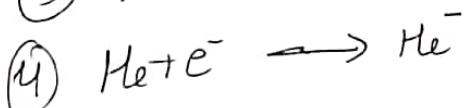
$$\Delta H = \Theta Ve \checkmark$$



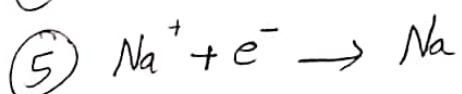
$$\Delta H = \Theta Ve \checkmark$$



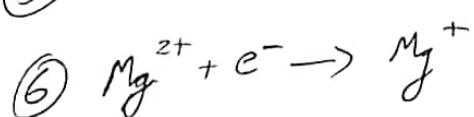
$$\Delta H = \oplus Ve \checkmark$$



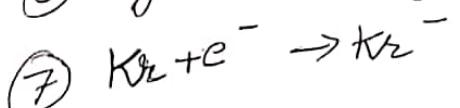
$$\Delta H = \oplus Ve \checkmark$$



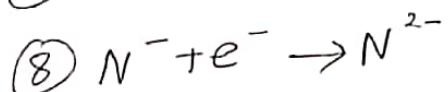
$$\Delta H = \Theta Ve \checkmark$$



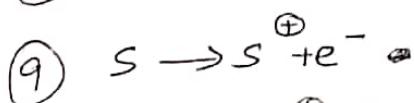
$$\Delta H = \Theta Ve \checkmark$$



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



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

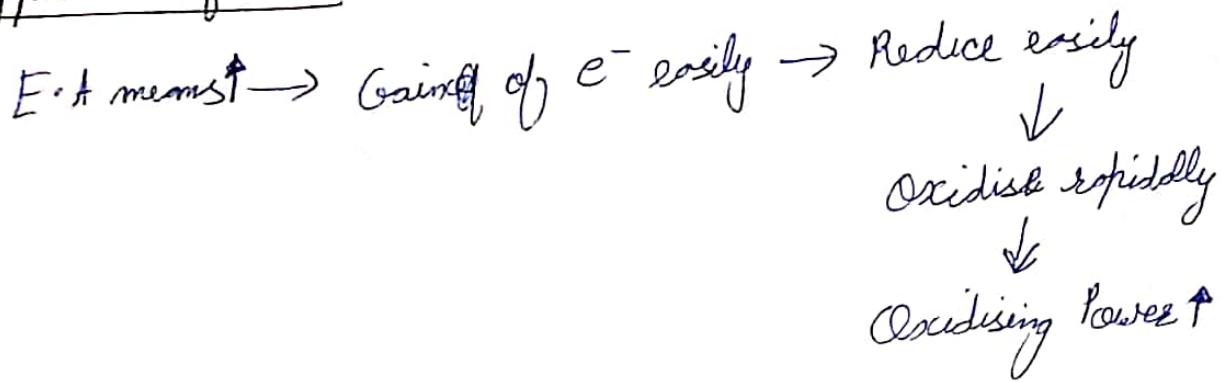


$$\Delta H = \Theta Ve \checkmark$$



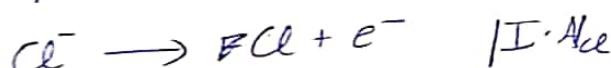
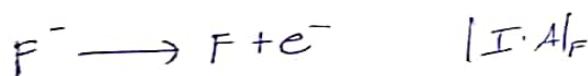
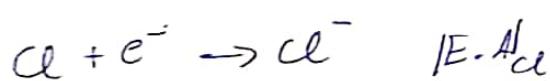
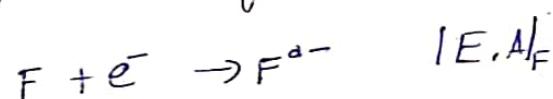
$$\Delta H = \Theta Ve \checkmark$$

Application of E.A.:



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

Q Compare I.E. of F^- and Cl^-

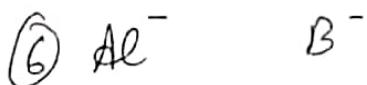
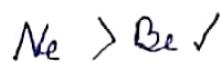
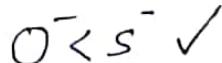
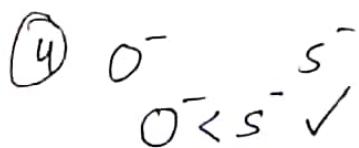
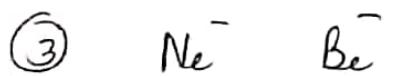
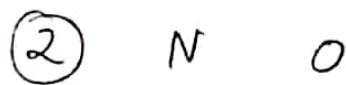
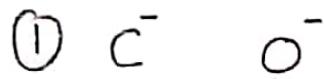


$$E.A = I.A$$

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

$$|I.E|_{F^-} < |I.E|_{Cl^-}$$

Q2. Compare I.E. order in following.



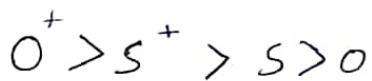
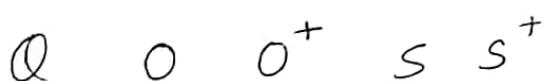
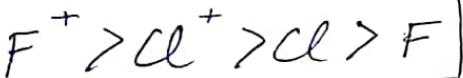
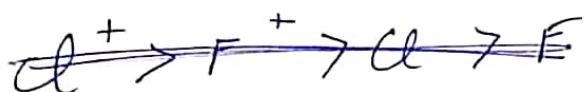
Q3. Compare I.E.



Q 34. IE.



Q S.E.A. order. ?



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, 7, 10, 11)

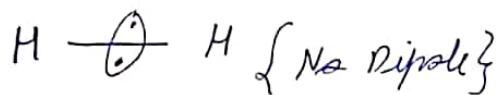
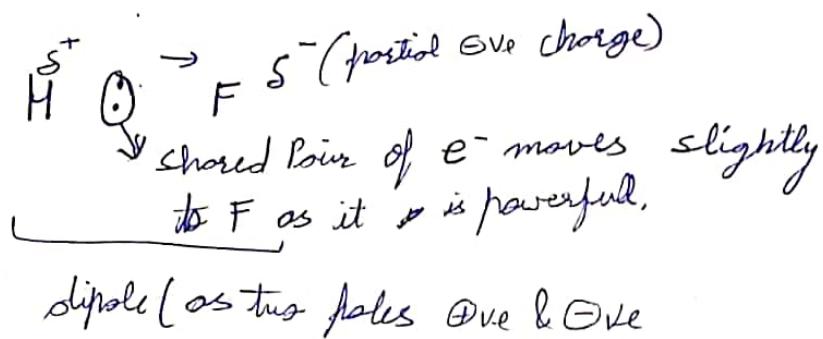
(~~1, 2, 3~~) (~~4, 5, 6~~)

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

J-M (Q 1, 4, 5, 8, 10, 11, 14, 17, 19, 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.



→ 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

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

$EN_A \Rightarrow$ Electron Negativity of A

$EN_B \Rightarrow$ Electron Negativity of B

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

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

~~for Kilo J/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

$$EN_B = 3$$

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

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

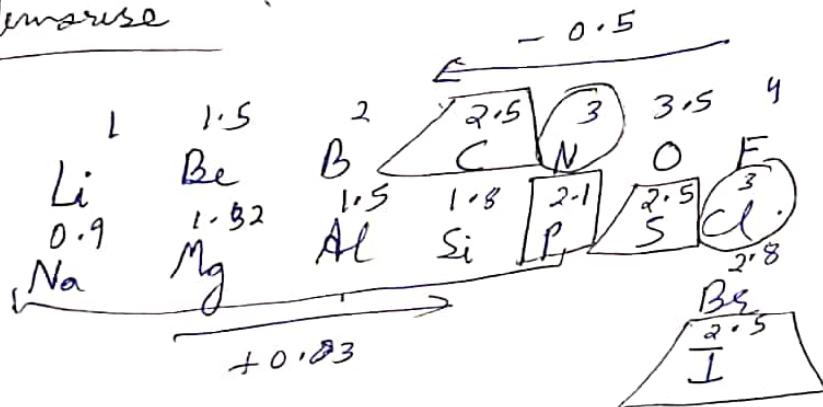
$$E_{B-B} = 64 \text{ kcal/mol}$$

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

$$= 3 + 0.624$$

$$\boxed{= 3.624}$$

Memorise



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

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

$$M \approx P = 2.1$$

$$N \approx Cl = 3$$

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

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

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

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

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

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

$$(E.N.)_P = \frac{f.E. \frac{17}{2}}{2.8}$$

$$\left[= \frac{17}{5.6} \right] = 3.03$$

③ Alfred Roschaw Scale :-

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

Z_{eff} → effective nuclear charge

r → covalent radius in \AA°

$$\begin{aligned} 1 \text{ \AA}^\circ &= 10^{-10} \text{ m} \\ 1 \text{ pm} &= 10^{-12} \text{ m} \end{aligned}$$

$$E.N_p = E.N_{AR} + 0.744$$

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

Factors Affecting Electron Negativity

① Z_{eff} :-

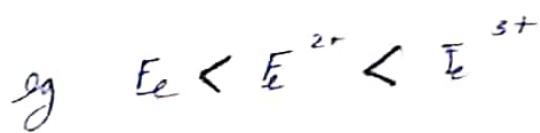
$Z_{\text{eff}} \uparrow$ $E.N \uparrow$

② Value of n :-

$n \uparrow$ $E.N \downarrow$

③ charge :- (+ve)

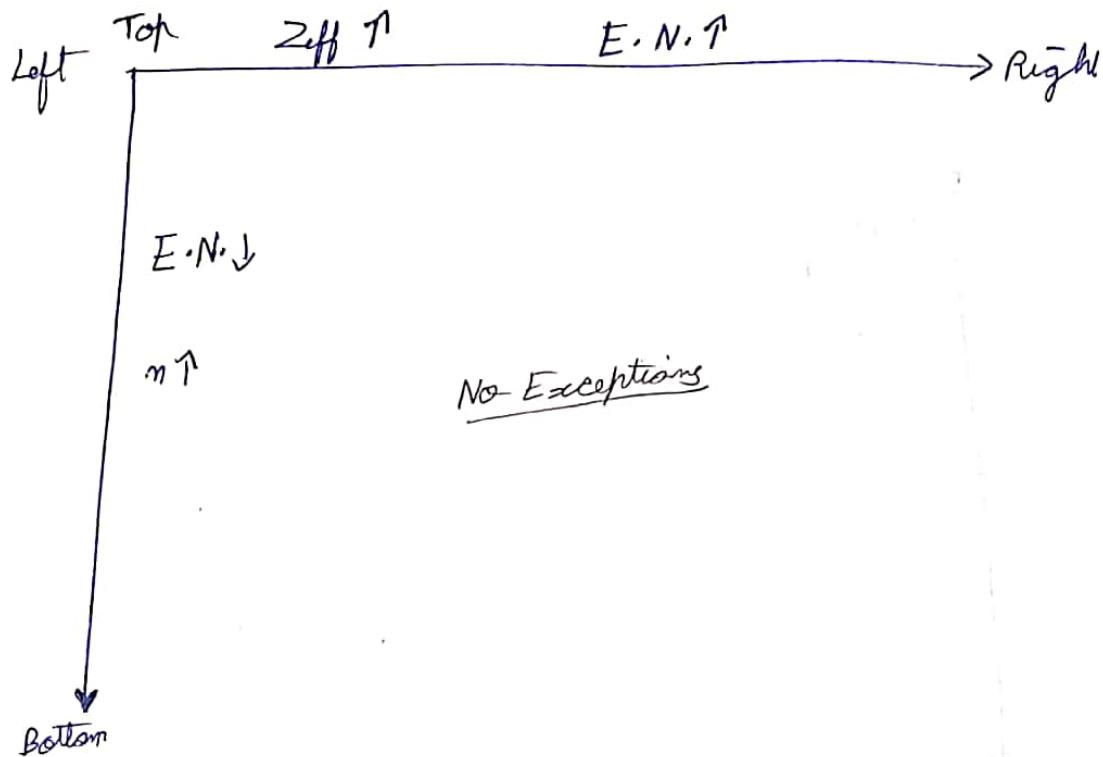
$E.N \propto$ oxidation state of element.



~~Note~~

Note - ① No Effect of half filled or fully filled e⁻ config.

Variation across Periodic Table



Q: Decide δ^+ & δ^- charge in following,

- ① $C-H$
 $H^{\delta^+} \quad C^{\delta^-}$
- ② $H-F$
 $H^{\delta^+} \quad F^{\delta^-}$
- ③ $O-H$
 $O^{\delta^-} \quad H^{\delta^+}$
- ④ $N-F$
 $N^{\delta^+} \quad F^{\delta^-}$

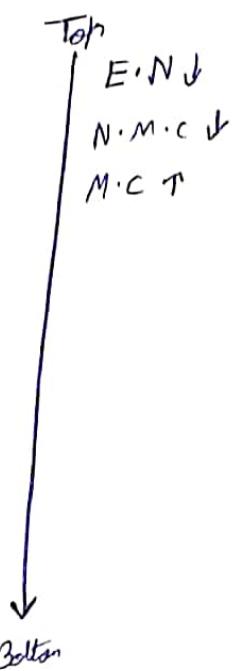
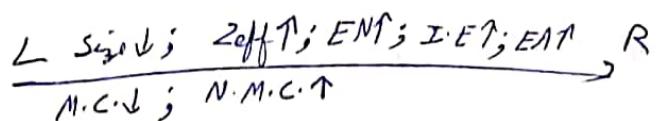
②

F - F

Non-Polar

Applications of Electron Negativity

→ ①



- ② If $\Delta \text{DEN} \neq 0$ {Polar} e.g. H-F
- $\Delta \text{EN} = 0$ {Non-Polar} e.g. F-F
- ③ Prediction of Bond Length of Heterodiatomic molecule.
- $$d_{AB} = r_A + r_B + 0.09 | \text{EN}_A - \text{EN}_B | (\text{in } \text{\AA})$$

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

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

ΔEN 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



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

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

$$I \cdot C = 16(0.9) + (0.9)^2 \\ = 14.4 + 0.81 \times 3.5$$

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

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

Q4. ΔEN for $I \cdot C = 50$

$$\Delta EN = x$$

$$50 = 16x + \frac{0.81(x^2)}{3.5}$$

$$7x^2 + 18x - 100$$

$$x = -14 \pm \sqrt{196 + 2800}$$

$$= -14 \pm \sqrt{2996}$$

$$= -14 \pm 54$$

~~x^2~~ .

$$x = -32 \pm \sqrt{1024 + 2800}$$

~~496~~
~~416~~

~~104~~

224

122

$$= -32 \pm 61$$

~~19~~

$$= -\frac{16 \pm 30.5}{7}$$

$$= \frac{14.5}{7}$$

$$\boxed{= 2.1}$$

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

$$\Delta EN < 2.1$$

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

covalent compound

$$\Delta EN > 2.1$$

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

ionic compound

Q1. If the value of $\sqrt{E_{A-B} - \frac{1}{4}(E_{AA} + E_{BB})}$ is termed as Δ , if Δ is given as 14.4 for elements A & B, and bond length of A-A bond is 1.1 \AA and bond length of B-B bond is 1.2 \AA

Calculate -

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

in kJ/mol

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

$$= 1.4688$$

$$\begin{array}{r} 14.4 \\ \times 10.2 \\ \hline 146.88 \end{array}$$

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

$$\begin{array}{r} 144.00 \\ + 1.4688 \\ \hline 146.88 \end{array}$$

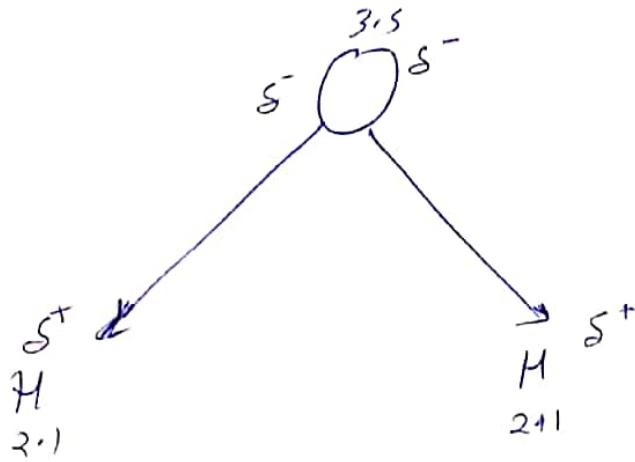
$$\therefore \text{I.C} = 23.05008 + 0.7556$$

$$\boxed{= 24.25\%}$$

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

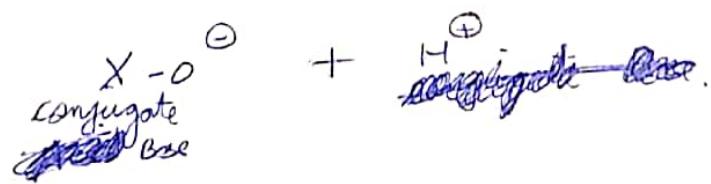
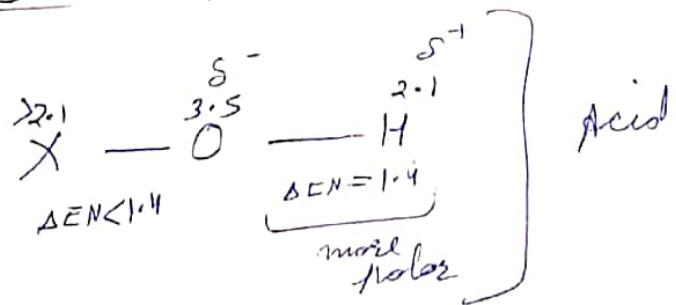
Nature of Hydroxide

→

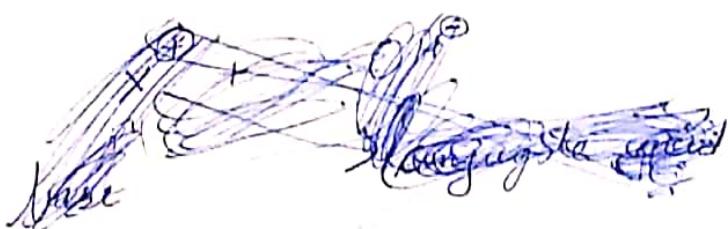
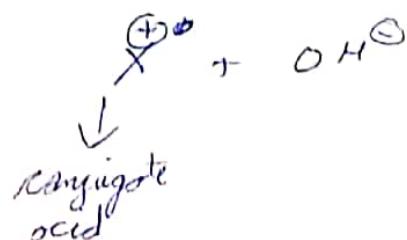
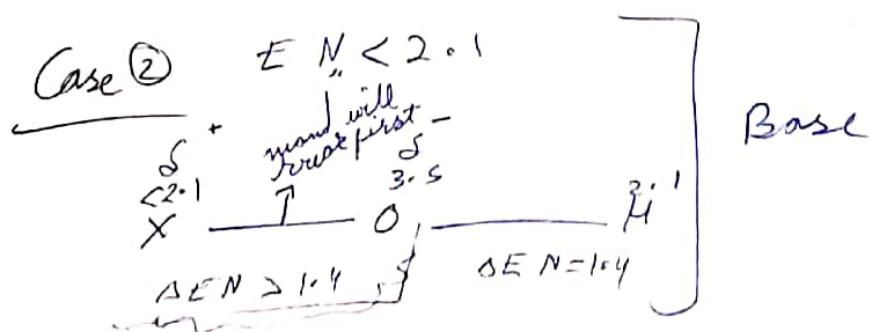


more polar bond will break in aqueous solution.

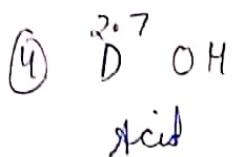
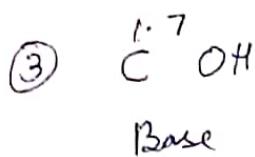
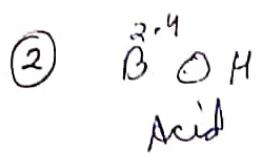
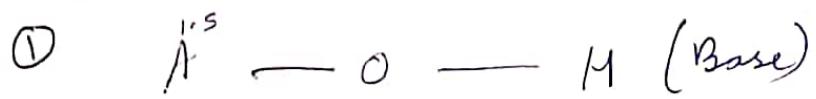
Case ① $EN_x > 2.1$



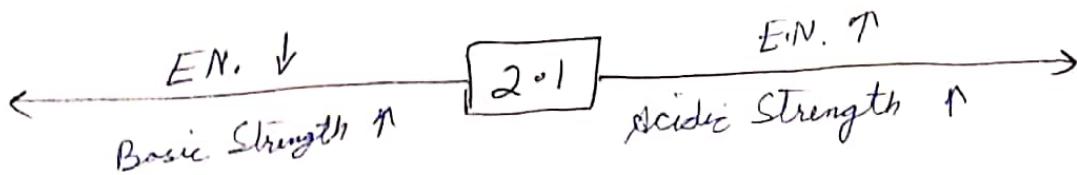
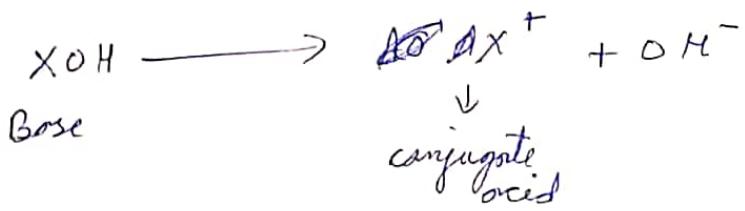
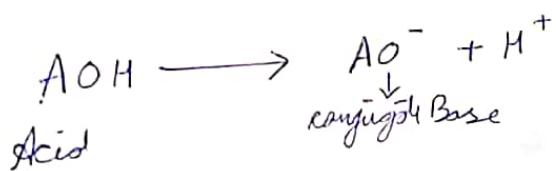
Case ② $EN_x < 2.1$



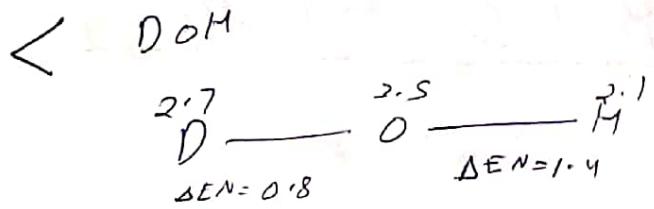
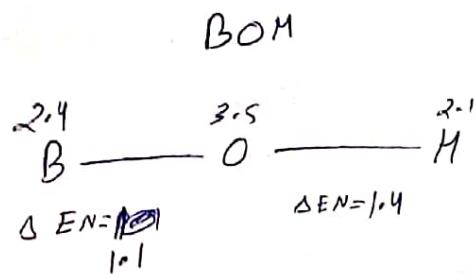
Q find Acid & Base.



Acidic And Basic Strength of Hydroxides.



Ex.: Acidic strength

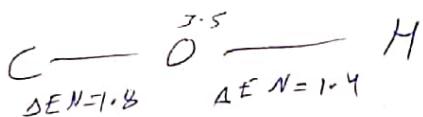
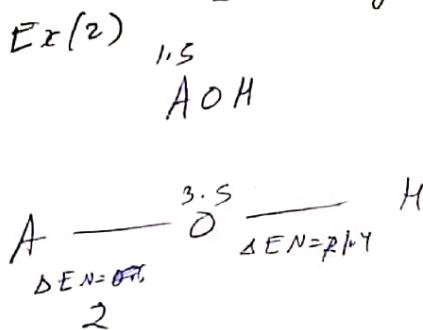


less ~~EN~~ \downarrow less strength in ~~acid~~ bond
break easily

conjugate Base more ~~stable~~ stable

\downarrow
Thus, Acid strength ↑

Basic strength



Break easily (because of high polarity)

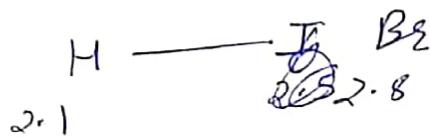
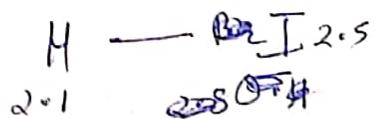
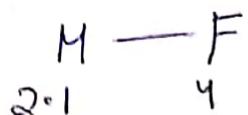
\downarrow
More Basic strength ↑

\downarrow
More stable Conjugate Acid.

Bond Strength/Bond Energy

Bond Strength $\propto \Delta EN$

Ex:-



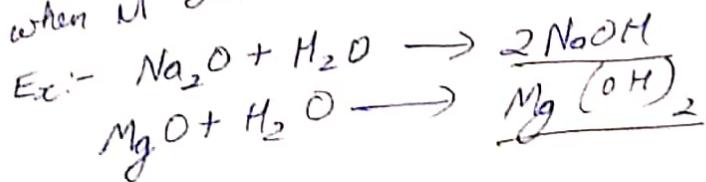
$\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$ (Bond strength)
 $\Delta EN \uparrow$, bond strength \uparrow

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

Types of Oxides

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

\rightarrow when it dissolve in water (H_2O) form base.



M.W. 10-05-2024

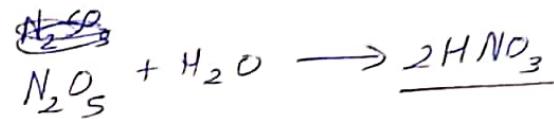
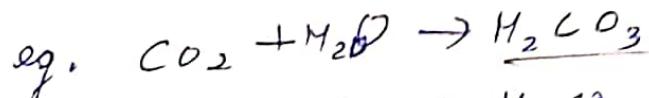
~~Das~~

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.

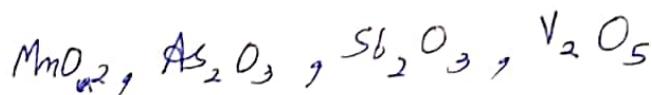
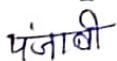
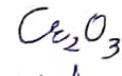
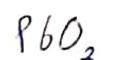
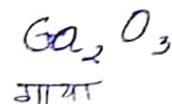
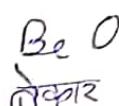
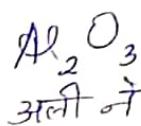
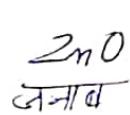
→ when it dissolves in water forms acids.



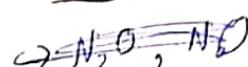
③ - Amphoteric Oxides -

→ They react with both acids and bases.

Ex. - ~~Ex.~~



④ - Neutral Oxides

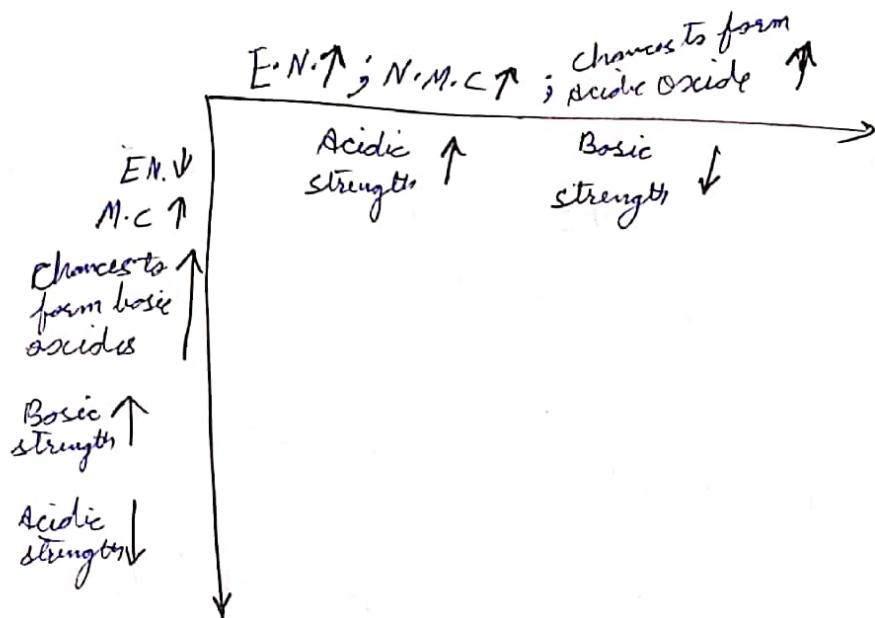


→ oxides which do not react with acid as well as base.

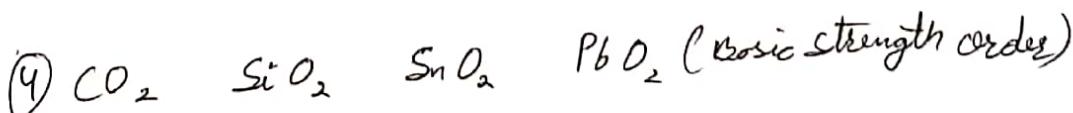
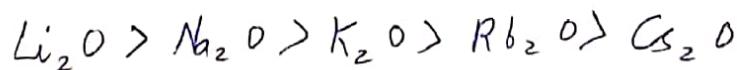
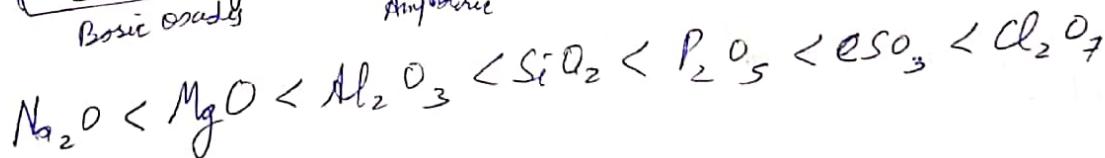
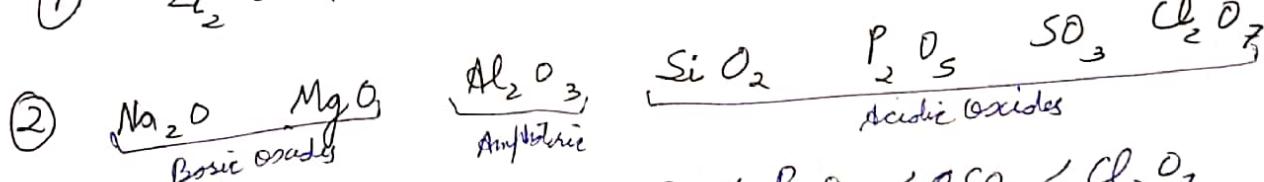
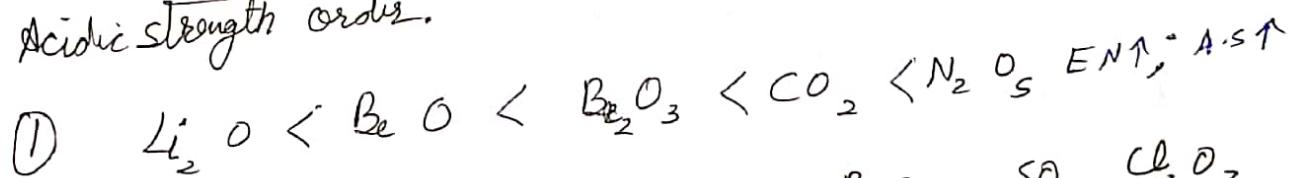
→ Ex. $\text{N}_2\text{O}, \text{NO}, \text{CO}, \text{H}_2\text{O}$ → (If treated as solvent, then considered neutral)

→ (If not used as a solvent, considered Amphoteric)

Periodicity of oxides



Q Acidic strength order.



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}

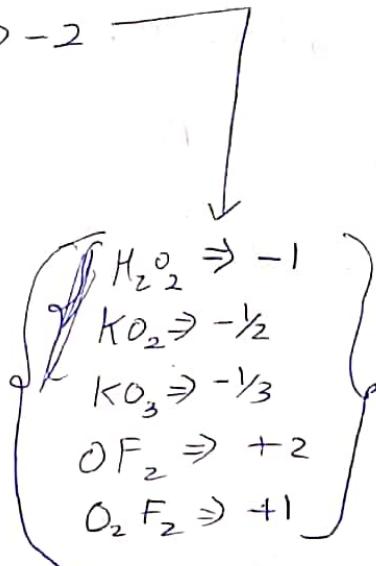
② Hydrogen ⇒ Hydride with metal ⇒ -1 {LiH, NaH, KH...}

→ Hydrides with non metals / other elements ⇒ +1 {NH₃, PH₃, CH₄}

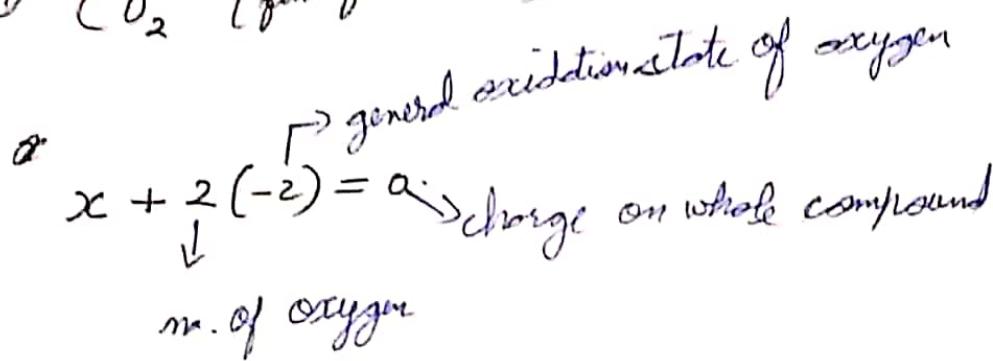
③ Oxygen general oxidation state ⇒ -2

④ Fluorine ⇒ -1 (always)

Acidic Strength & oxidation state



Q. ① CO_2 (find for carbon)



$$x - 4 = 0$$

$$\boxed{x = 4}$$

② SO_2

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

$$x - 4 = 0$$

$$\boxed{x = 4}$$

③ SO_4^{2-}

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

$$x - 8 = -2$$

$$\boxed{x = 6}$$

\rightarrow non metal

④ NH_3

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

$$x + 3 = 0$$

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

⑤ HNO_3

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

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

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

⑥ Na_2O_2

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

$$2x + 10 = 0$$

$$2x = 10$$

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

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

⑦ Fe_3^{3+}

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

$$x - 8 = -3$$

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

⑧ NH_4^+

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

$$x + 4 = 1$$

$$x = 1 - 4$$

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



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

$$x - 8 = -1$$

$$x = -1 + 8$$

$$\begin{array}{|l} x = 8 - 1 \\ \hline x = 7 \end{array} \checkmark$$

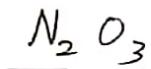
⑩



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

$$\begin{array}{|l} x = -4 \\ \hline \end{array} \checkmark$$

⑪

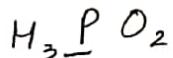


$$2x + 3(-2) = 0$$

$$2x - 6 = 0$$

$$\begin{array}{|l} 2x = 6 \\ \hline x = 3 \end{array} \checkmark$$

⑫

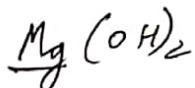


$$x + 3(+1) + 2(-2) = 0$$

$$x + 3 - 4 = 0$$

$$\begin{array}{|l} x = 4 - 3 \\ \hline x = 1 \end{array} \checkmark$$

⑬



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

$$\begin{array}{|l} x - 2 = 0 \\ \hline x = 2 \end{array} \checkmark$$

(15)

(14) Na(15) O₂

$$2x \neq 0$$

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

$$\boxed{\cancel{x=0}} \checkmark$$

(16) H₂O₂

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

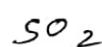
$$2x + 2 = 0$$

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

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

Q Compare Acidic Strength

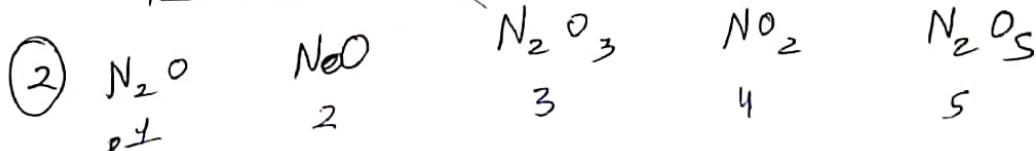
Ex ①



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

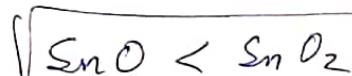
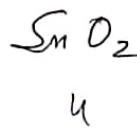
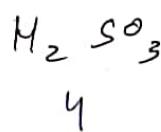
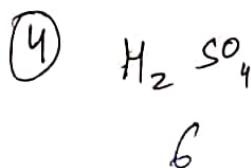
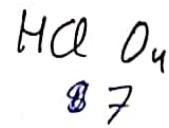
$$x = -4$$

$$\boxed{S O_2 < S O_3} \checkmark$$



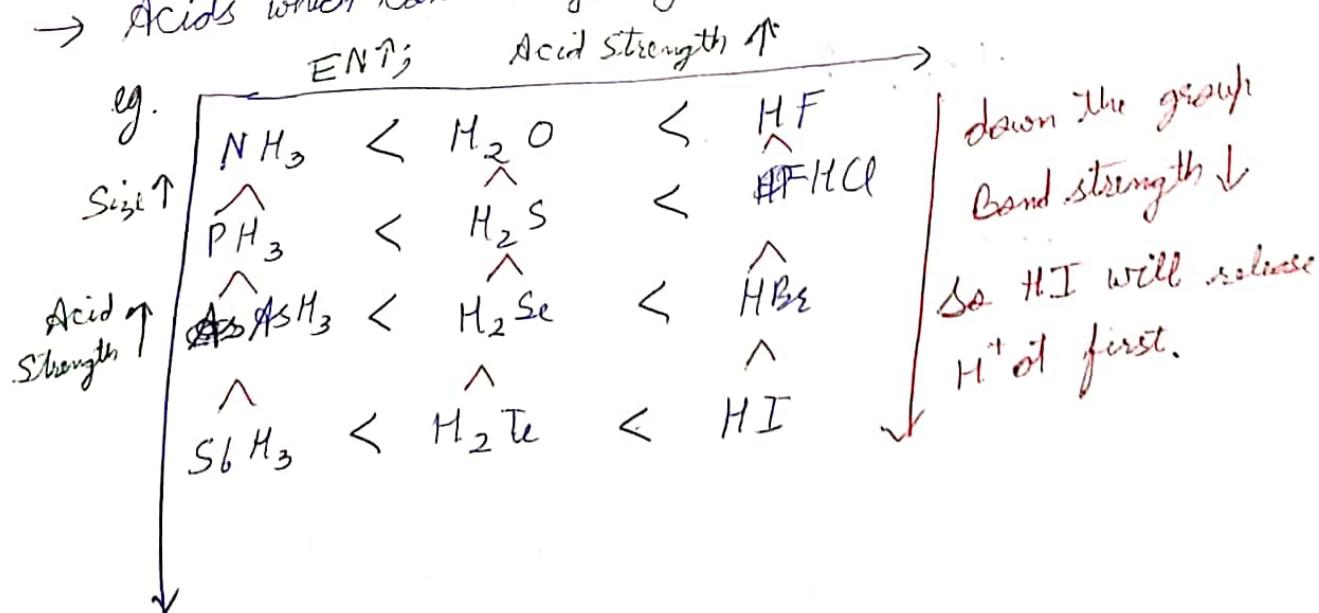
$$\boxed{N_2O < NO < N_2O_3 < NO_2 < N_2O_5} \checkmark$$

(152)



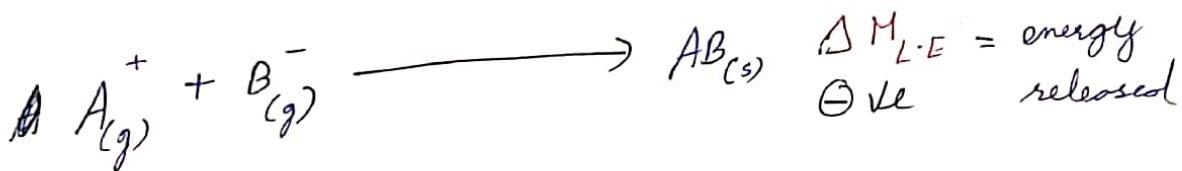
Hydro Acids

→ Acids which contains hydrogen with other non metal

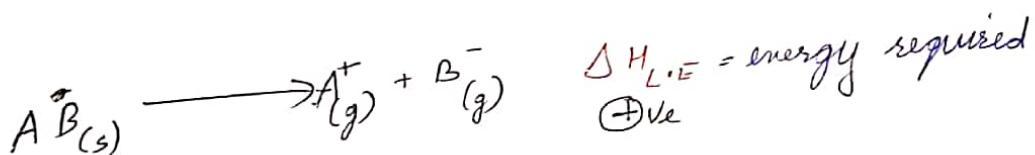


* Lattice Energy ($\Delta H_{L.E.}$)

→ 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 ~~into~~ into their constituent gaseous ions.



factors of L.E. :-

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

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

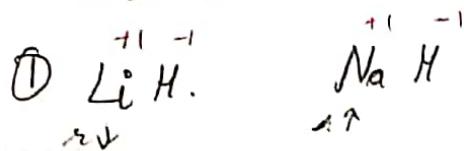
$r \approx r_A + r_C$ → product of cation
radius of
anion

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

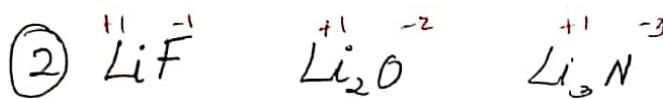
$r \uparrow$; $L.E. \downarrow$

(9, 9₂) P; r↑; L.E. ↑ { Phle charge & ka
decreas for radius ka }

Q1. L.E. order?



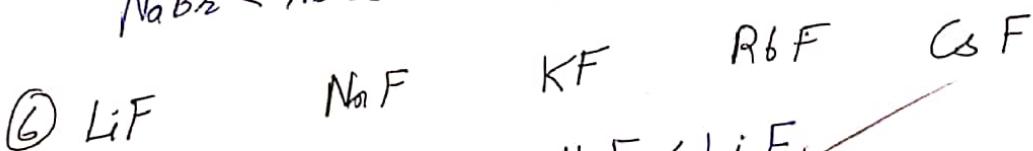
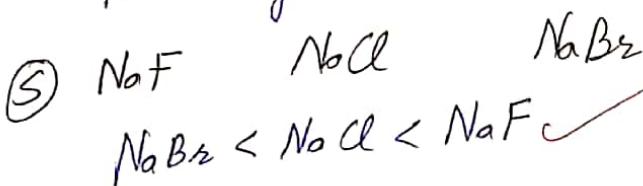
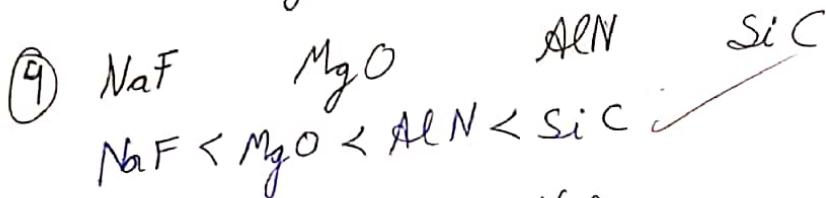
$$\text{LiH} > \text{NaH}$$



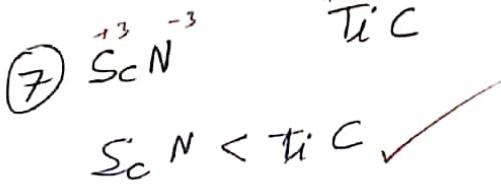
$$\text{LiF} < \text{Li}_2\text{O} < \text{Li}_3\text{N}$$



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



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



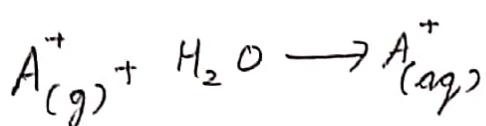
$$\text{ScN} < \text{TiC}$$

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

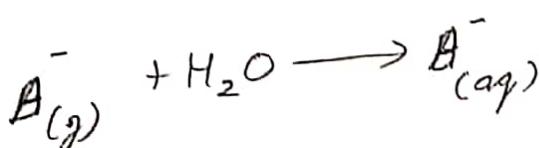
$\text{C}^{4-} \rightarrow \text{Carbide}$

Hydration Energy

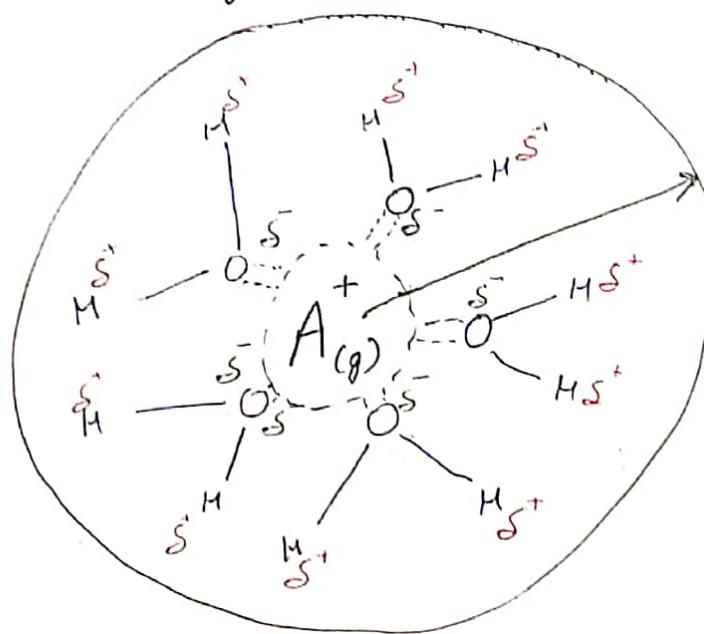
→ It is the amount of energy released when 1 mole of gaseous ions are interested with water (dissolve).



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



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

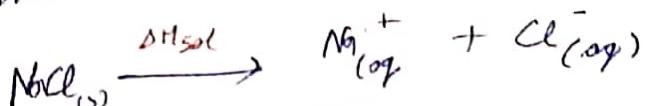


Hydration of Cation
radius of $A_{(aq)}^+$

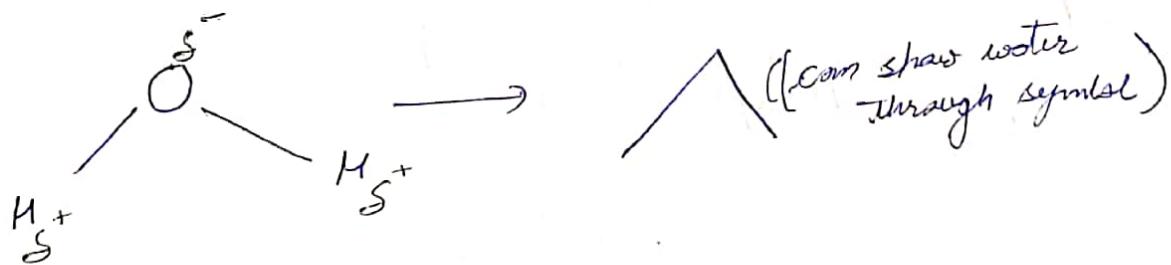
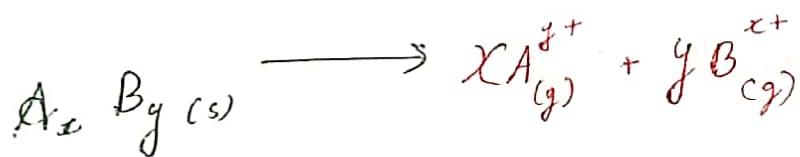
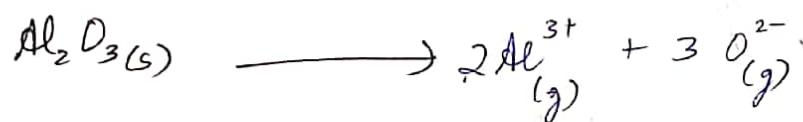
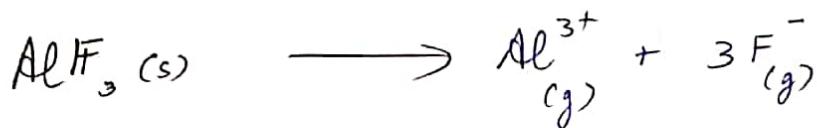
More water molecule interact ↑; ~~then~~ hydration energy ↑.

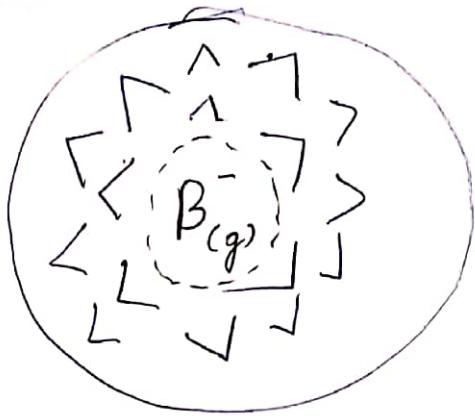
radius of aqueous ↑

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



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





Hydration of anion

Factors affecting Hydration Energy

$$H.E \propto q_1 q_2 \quad \{ \text{charge} \uparrow H.E \uparrow \}$$

$$H.E \propto \frac{1}{r} \quad \left\{ \begin{array}{l} r \uparrow H.E \downarrow \\ \text{L} \rightarrow \text{radius of ion} \end{array} \right\}$$

(charge is more dominating)

Q Compare Hydration Energy

$$\textcircled{1} \quad Li_{(aq)}^+ \quad Na_{(aq)}^+ \quad K_{(aq)}^+ \quad Rb_{(aq)}^+ \quad Cs_{(aq)}^+$$

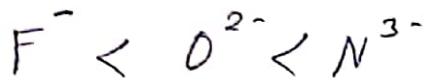
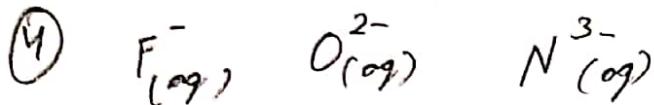
$$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$$

$$\textcircled{2} \quad F_{(aq)}^- \quad Cl_{(aq)}^- \quad Br_{(aq)}^- \quad I_{(aq)}^-$$

$$F^- > Cl^- > Br^- > I^-$$

$$\textcircled{3} \quad Na_{(aq)}^+ \quad Mg_{(aq)}^{2+} \quad Al_{(aq)}^{3+}$$

$$Na^+ < Mg^{2+} < Al^{3+}$$

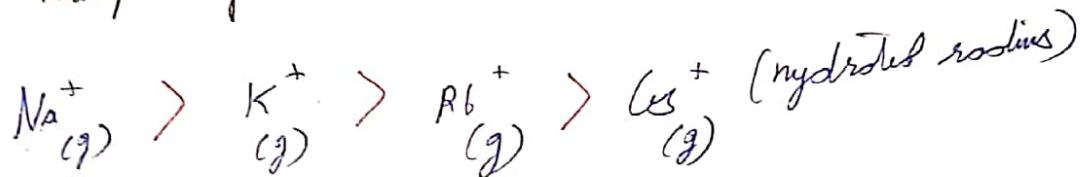


Application of hydration energy :-

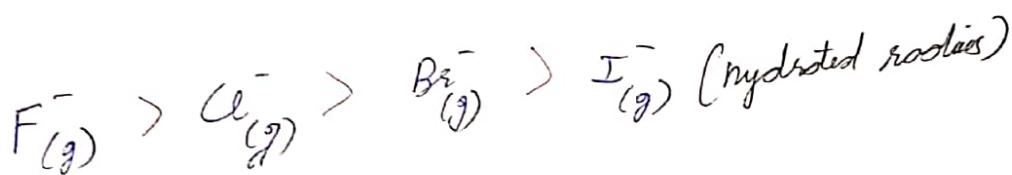
① Hydrated radius -

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

e.g.. Compare hydrated radius



e.g. ②.



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.~~ \uparrow 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.

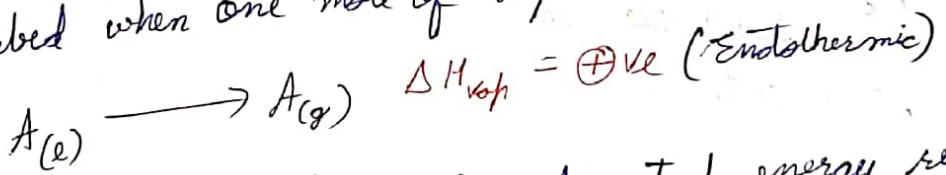
* Bond-Haber Cycle

Imp Terms -

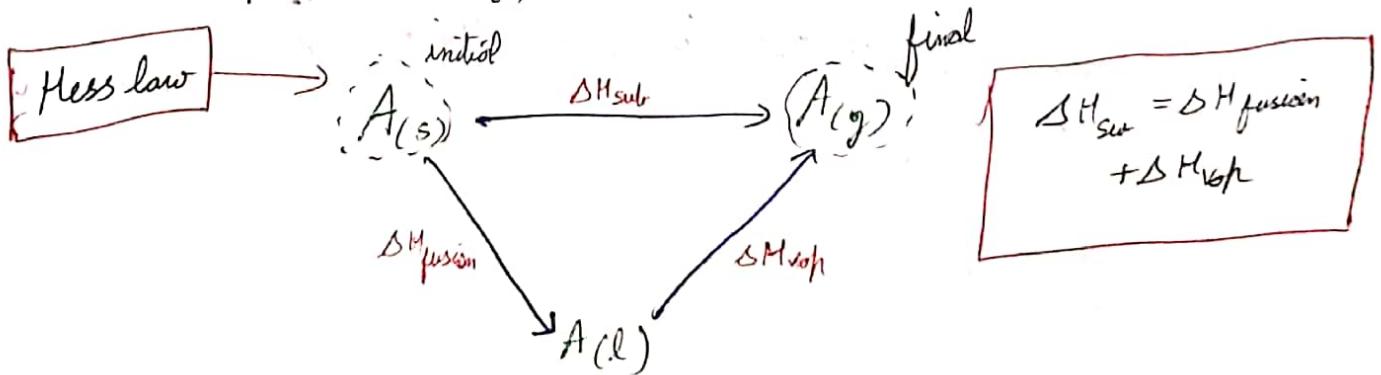
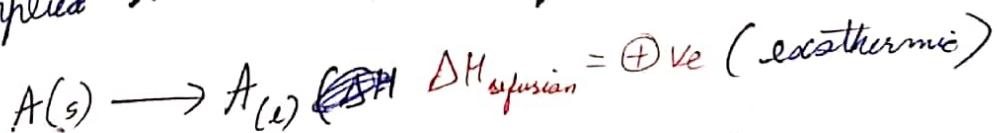
① Enthalpy of Sublimation (ΔH_{sub}) - Amount of energy required/ absorbed when 1 mole of solid is converted to gas.



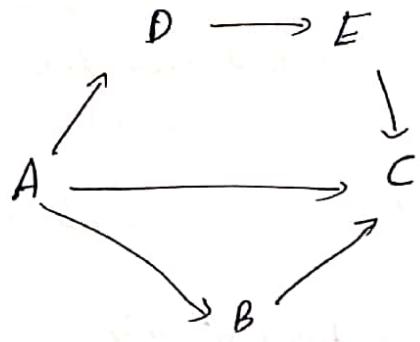
② Enthalpy of Vaporisation (ΔH_{vap}) - Amount of energy supplied/ absorbed when one mole of liquid is converted into gas.



③ Enthalpy of Fusion (ΔH_{fusion}) - Amount of energy required/ supplied to convert 1 mole of solid into liquid.



Hess Law-



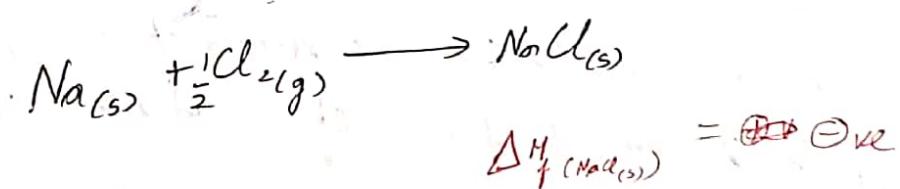
$$\Delta H_{AC} = \Delta H_{ADEC} = \Delta H_{ABC}$$

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

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

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

(4) Enthalpy of formation (ΔH_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 /molar 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)

$\text{Br}_2 \rightarrow \text{Liquid}$

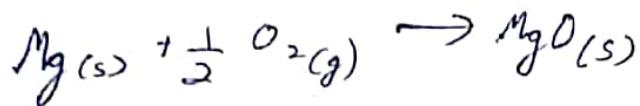
$\text{I}_2 \rightarrow \text{Solid}$

Carbon \rightarrow Solid (Graphite)

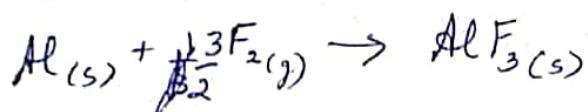
$S_8 \rightarrow \text{Solid}$

$P_4 \rightarrow \text{Solid}$

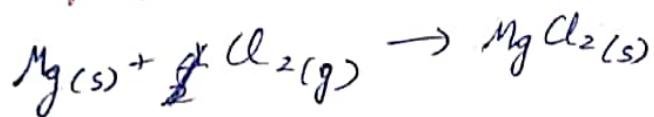
EgQ. ① $\Delta H_f (\text{MgO}_{(s)})$



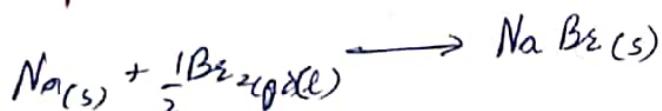
② $\Delta H_f (\text{AlF}_{3(s)})$



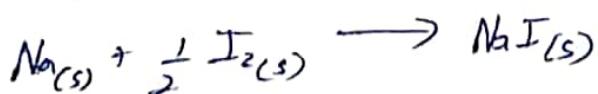
③ $\Delta H_f (\text{MgCl}_{2(s)})$



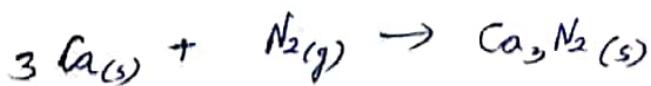
④ $\Delta H_f (\text{NaBr}_{(s)})$



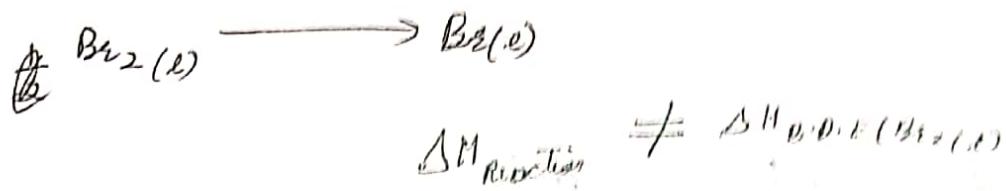
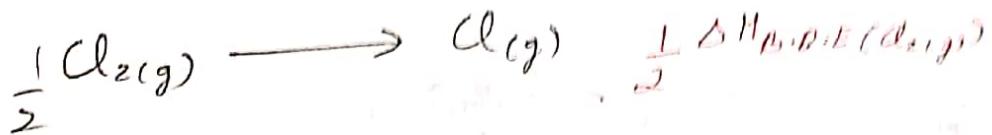
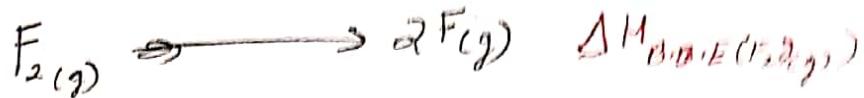
⑤ $\Delta H_f (\text{NaI}_{(s)})$



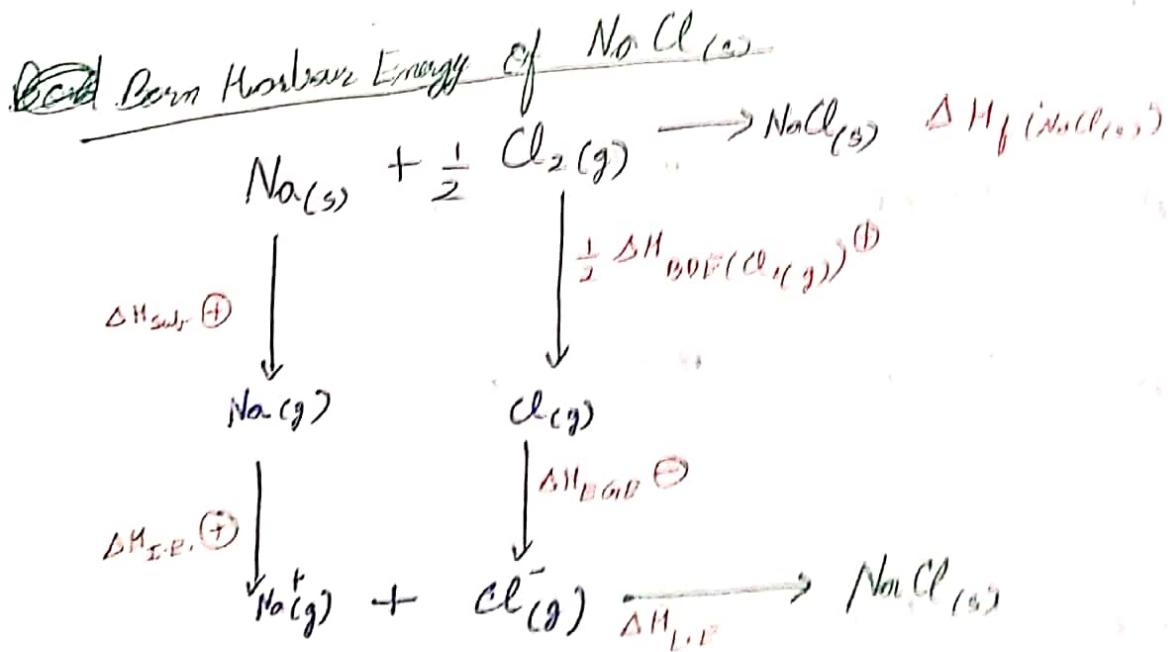
⑥ $\Delta H_f (\text{Ca}_3\text{N}_2_{(s)})$



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



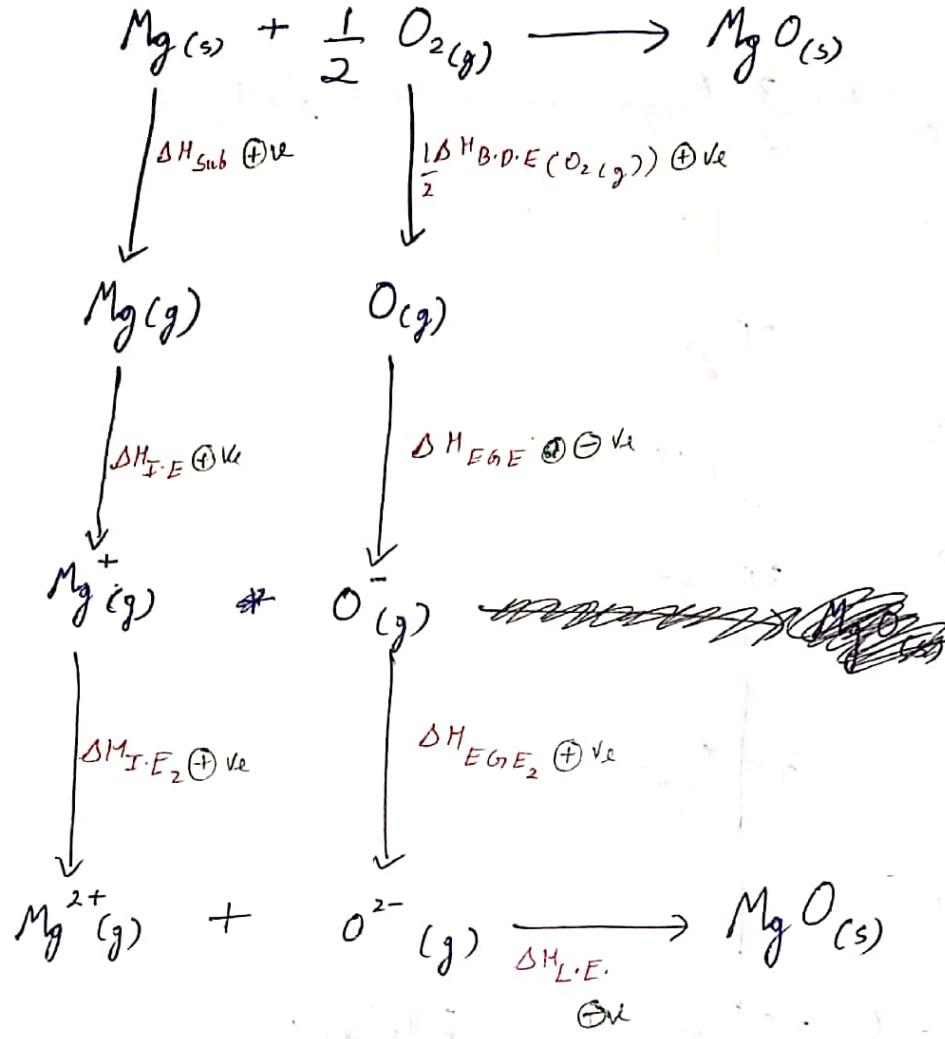
$$\Delta H_{\text{reaction}} = \Delta H_{B.D.E}(Br_2(g))$$



$$\Delta H_f(NaCl(s)) = \Delta H_{\text{sub}(Na(s))} + \Delta H_{I.P.}(Na(g)) - \frac{1}{2} \Delta H_{B.D.E}(Cl_2(g)) + \Delta H_{L.F.}(Cl^-(g))$$

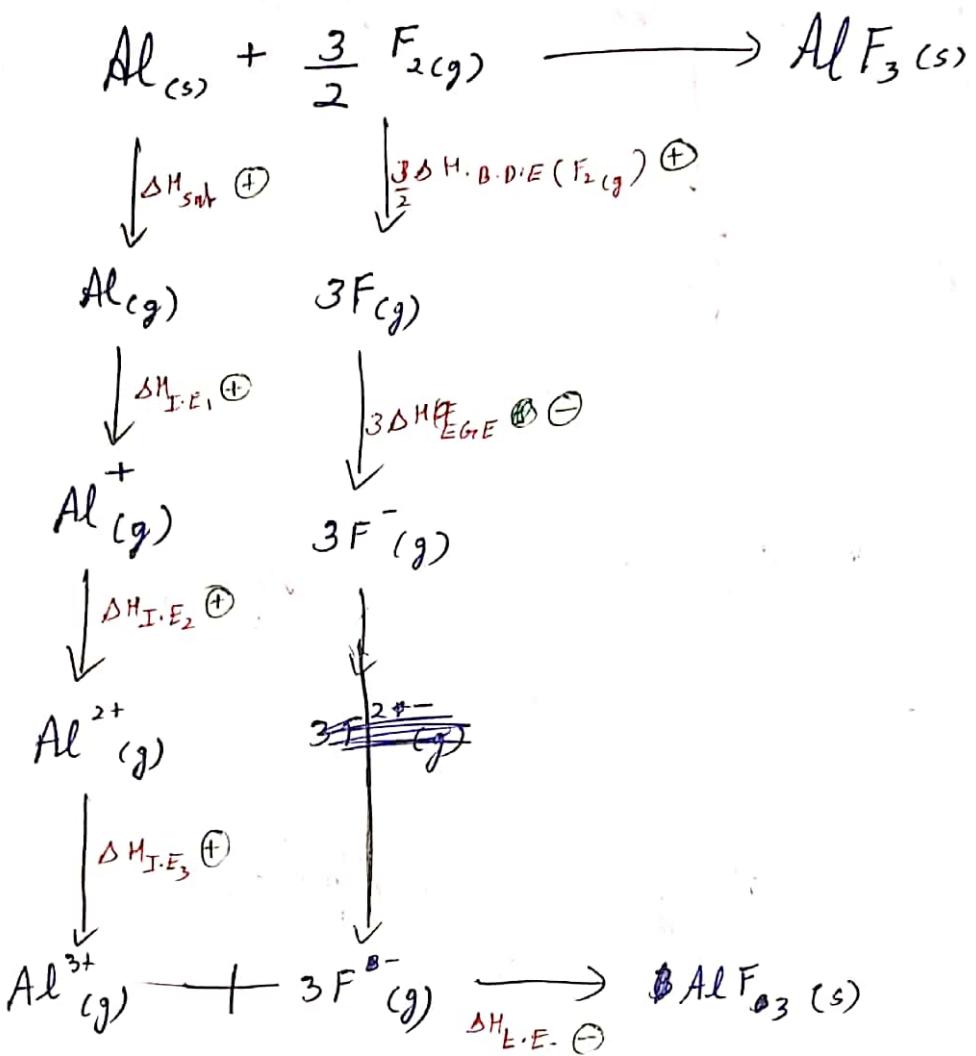
$$+ \Delta H_{B.G.B.}(Na^+(g))$$

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



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

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

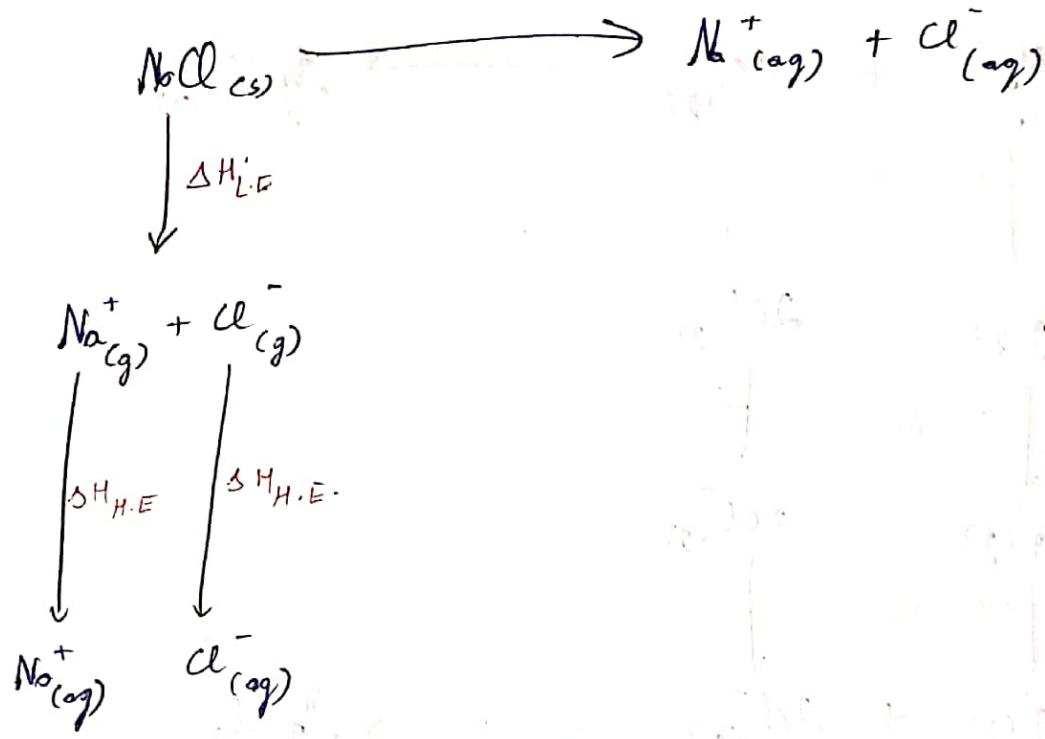


Q ④ $\text{MgCl}_2(s)$ H.W. 13-0 S-2024

⑤ $\text{AlN}(s)$ Race-till-It
S-2

⑥ $\text{Ca}_3\text{N}_2(s)$

Solubility of Ionic compound in (H₂O)

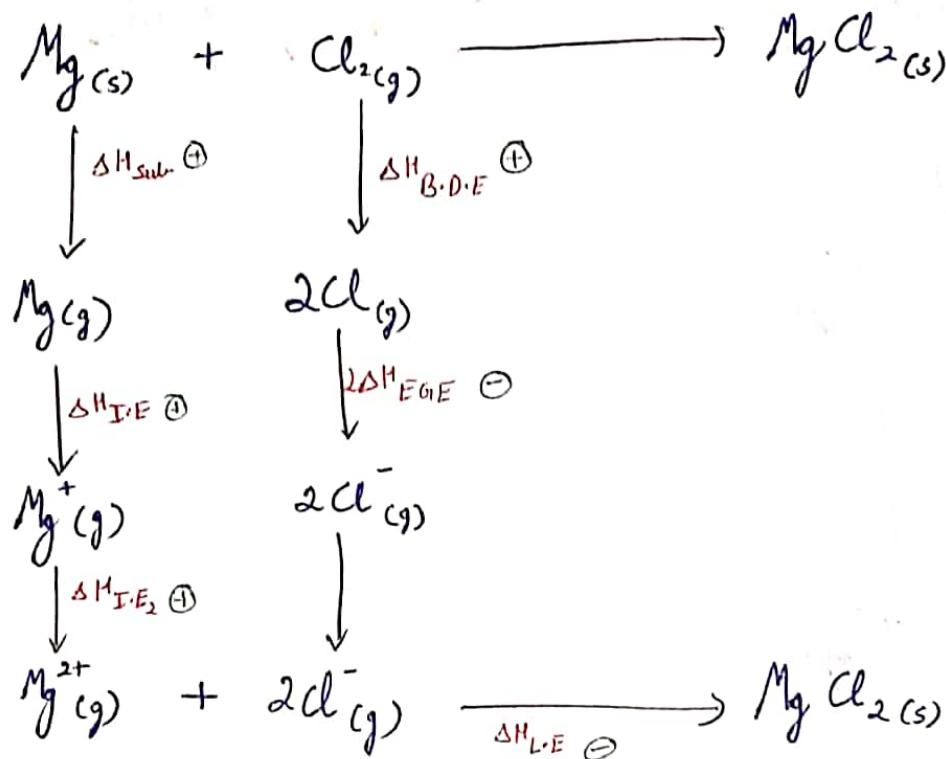


$$|\Delta H_{L.E.}| > |\Delta H_{H.E.}| \quad \text{Not Soluble}$$

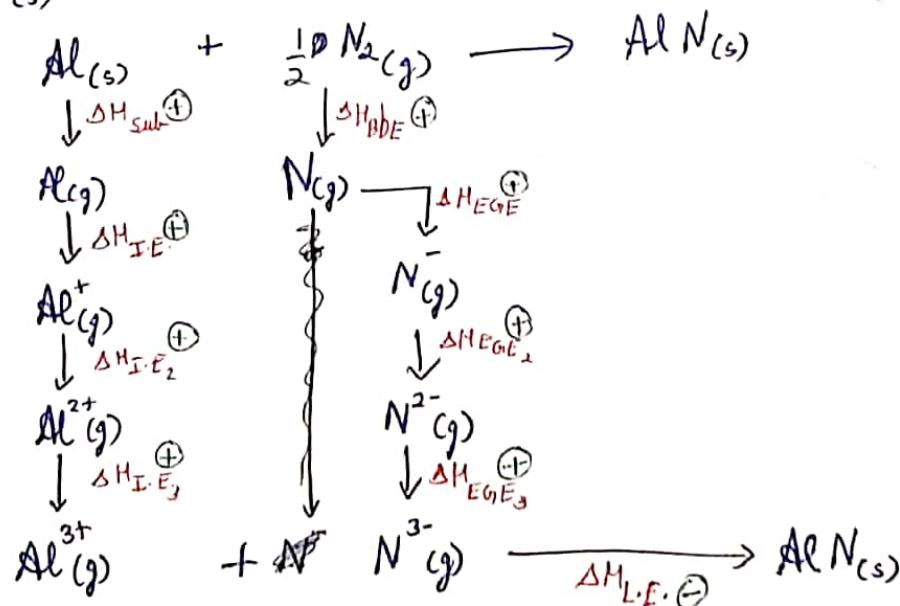
$$|\Delta H_{L.E.}| < |\Delta H_{H.E.}| \quad \text{Soluble in H}_2\text{O}$$

H.W.

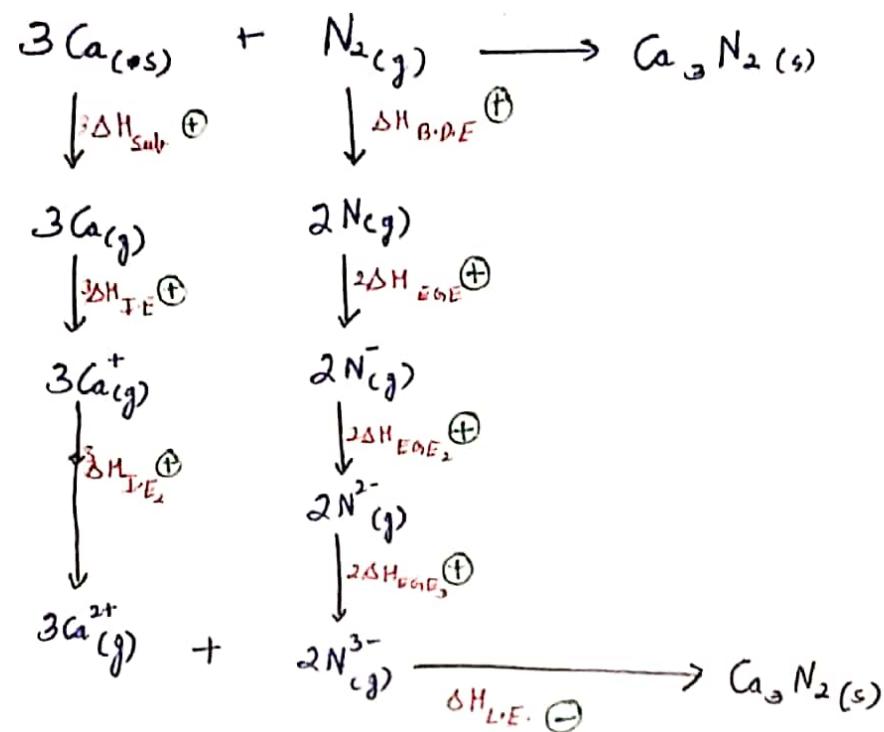
① $MgCl_2$



② $AlN_{(s)}$



③ Ca_3N_2



(169)

(17)

(172)

