TOPICS TO BE COVERED

1. Genesis Of Periodic Table

2. Effective Nuclear Charge

3 Atomic Size , Ionisation Energy , Electron Affinity , Electronegativity

4 Nature of Oxides

Genesis of Periodic Classification

Dobereiner's Traids

↓

Newland's Law of Octaves

↓

Mendeleev's Periodic Table

↓

Modern Periodic Table

Dobereiner's Traids

Dobereiner arranged certain elements with similar properties in groups of three in such a way that the atomic mass of the middle element was nearly the same the average atomic masses of the first and the third elements

Elements	Atomic weight	Element	Atomic weight	Element	Atomic weight
Li	7	Ca	40	Cl	35.5
Na	23	Sr	88	Br	80
K	39	Ba	137	I	127

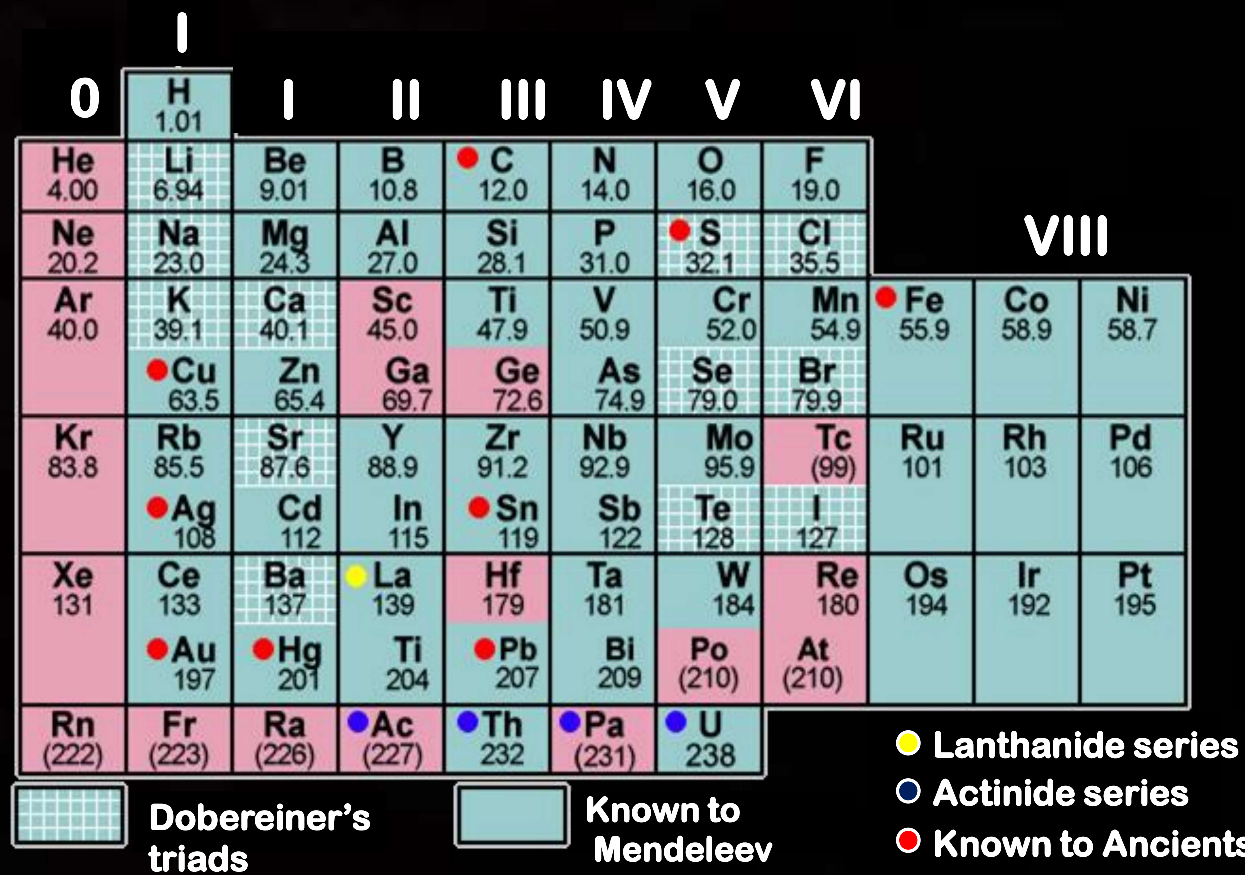
Newland's Law of Octaves

That when elements are arranged in order of increasing atomic masses, **every eighth element has properties similar to the first**. Newlands called it law of octaves because similar relationship exists in the musical notes also.

sa(do)	re(re)	ga(mi)	ma(fa)	pa(so)	da(la)	ni(ti)
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	–	–

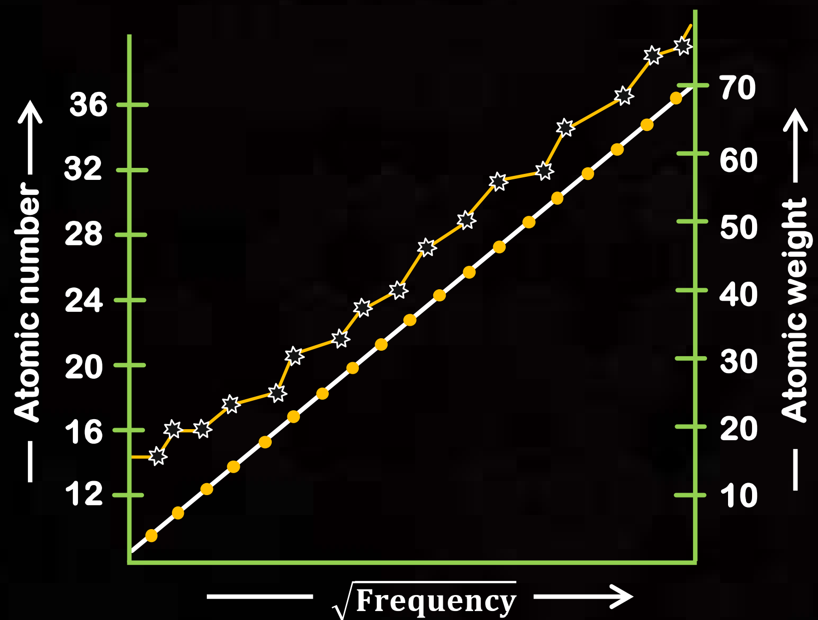
Mendeleev’s Periodic Law

The properties of the elements are a periodic function of their atomic weights.

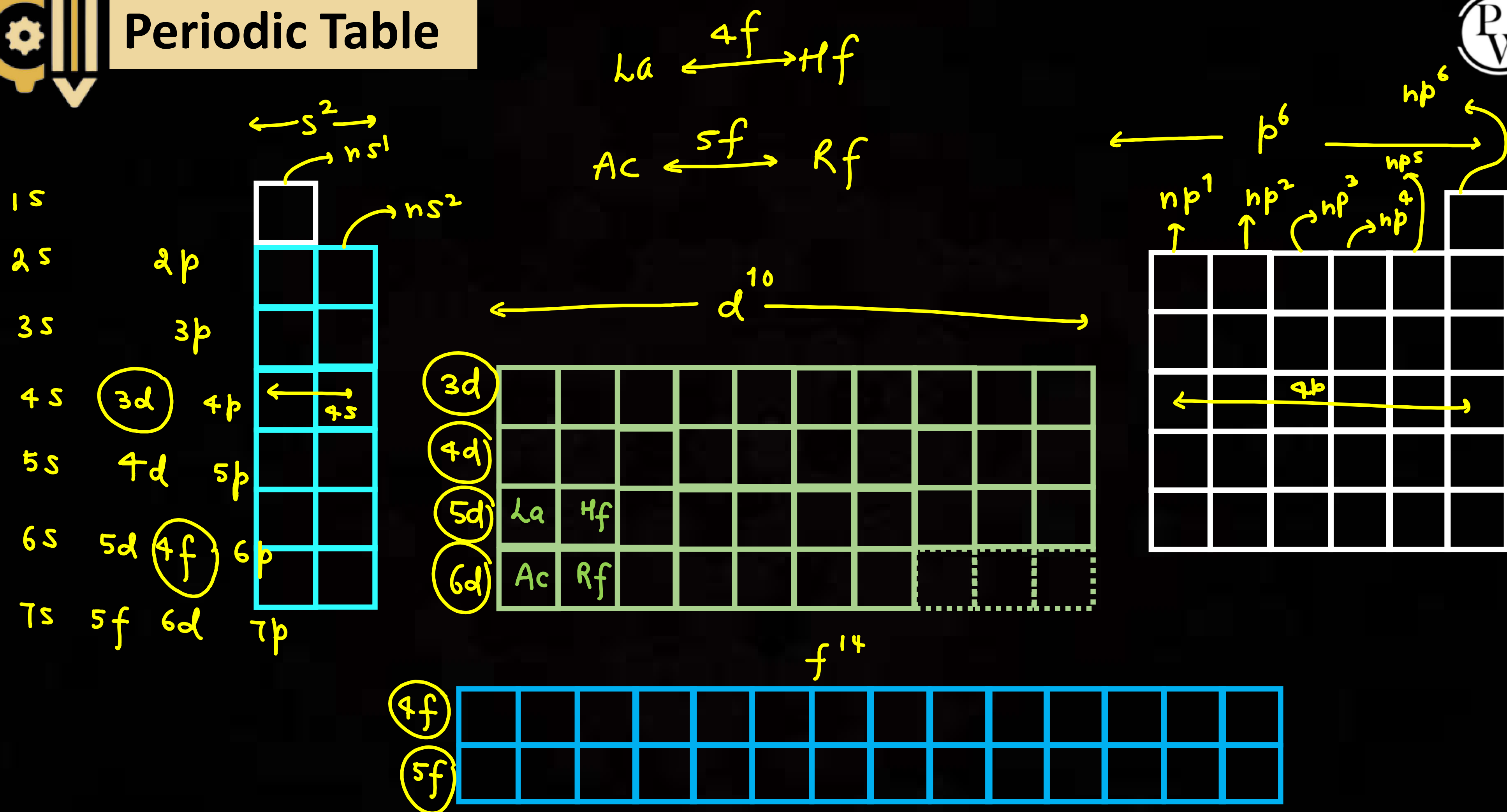


Modern Periodic Table

Henry Moseley observed regularities in the characteristic X-ray spectra of the elements. A plot of $\sqrt{v}$ (where v is frequency of X-rays emitted) against atomic number (Z) gave a straight line and not the plot of $\sqrt{v}$ vs atomic mass.



Periodic Table



Periodic Table

Groups and Periods

Atomic No.

Metal, Non-metal, Metalloids

$[Rn]\, 7s^2\, 6d^{10}\, 5f^{14}\, 7p^2$

La $\boxed{Ce \rightarrow Lu}$ Hf

Ac $\boxed{Th \rightarrow Lr}$ Rf

* 102 atomic No (Ac.)

↳ 3^{rd} group. halogen family

G-17

$ns^2\, np^6$

M (85)

$[Xe]\, 6s^2\, 4f^{14}\, 5d^{10}\, 6p^5$

X (114) → Group (14)

period → 7

Lanthanide / Actinide : 3^{rd} gro

H																	He	2
Li	Be											B	C	N	O	F	Ne	10
Na	Mg											Al	Si	P	S	Cl	Ar	18
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	36
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	54
Cs	Ba	57 La	72 Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	86
Fr	Ra	89 Ac	104 Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	Nh	Fl	Mc	Lv	Ts	Og	118
													114	115	116	117		

58	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	71
90	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	103

Electronic Configuration

H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca	Ga	Ge	As	Se	Br	Kr
Rb	Sr	In	Sn	Sb	Te	I	Xe
Cs	Ba	Tl	Pb	Bi	Po	At	Rn

Be: $[He]\ 2s^2$

Ga: $[Ar]\ 4s^2\ 3d^{10}\ 4p^1$

Q. The element $\boxed{Z = 114}$ has been discovered recently. It will belong to which of the following family/ group and electronic configuration?

Period

(A) Carbon family, $[Rn]\ 5f^{14}\ 6d^{10}\ 7s^2\ 7p^2$

(B) Oxygen family, $[Rn]\ 5f^{14}\ 6d^{10} 7s^2 7p^4$

(C) Nitrogen family, $[Rn]\ 5f^{14}\ 6d^{10}\ 7s^2 7p^6$

(D) Halogen family, $[Rn]\ 5f^{14}\ 6d^{10}\ 7s^2\ 7p^5$

Q. The element with atomic number 117, 119 , 120 , 91 will be

Halogen

s block

Alkali | Alkaline earth.

119 | 120

Act.

117 | 118

Period 7

A Alkali's

B Halogen , Alkali , Alkaline earth metal & Lanthanide

C Halogen , Alkali , Alkaline earth metal & Actinide

D Transition element , Halogen , Alkali , Alkaline earth metal

IUPAC name of 101 to 118

suffix : ium

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	enn	e

AEM

[ ] ns^2

101 : Unnilunium (Unu)

Unb

102 : Unnilbi __

119 : Uue

120 : Ubn

Name of Elements from 101 to 118

101 Mendeleev *ko mila* 102 Nobel *in* 103 Lowrence

104 Rutherford 105 Dube 106 Sea *me* 107 Bohr 108 Hass 109 Meit 110 Dar *se* 111 Roe 112 Coper

113 Niho 114 Fle *to* 115 Mosco *to* 116 Live 117 Ten 118 Ogan

Atomic No.	Name
101	Mendelevium
102	Nobelium
103	Lawrencium
104	Rutherfordium
105	Dubnium
106	Seaborgium

Atomic No.	Name
107	Bohrium
108	Hassium
109	Meitnerium
110	Darmstadtium
111	Roentgenium
112	Copernicium

Niho Fle *to* Mosco *to* Live Ten Ogan

Atomic No.	Name
113	Nihonium
114	Flerovium
115	Moscovium
116	Livermorium
117	Tennessine
118	Oganesson

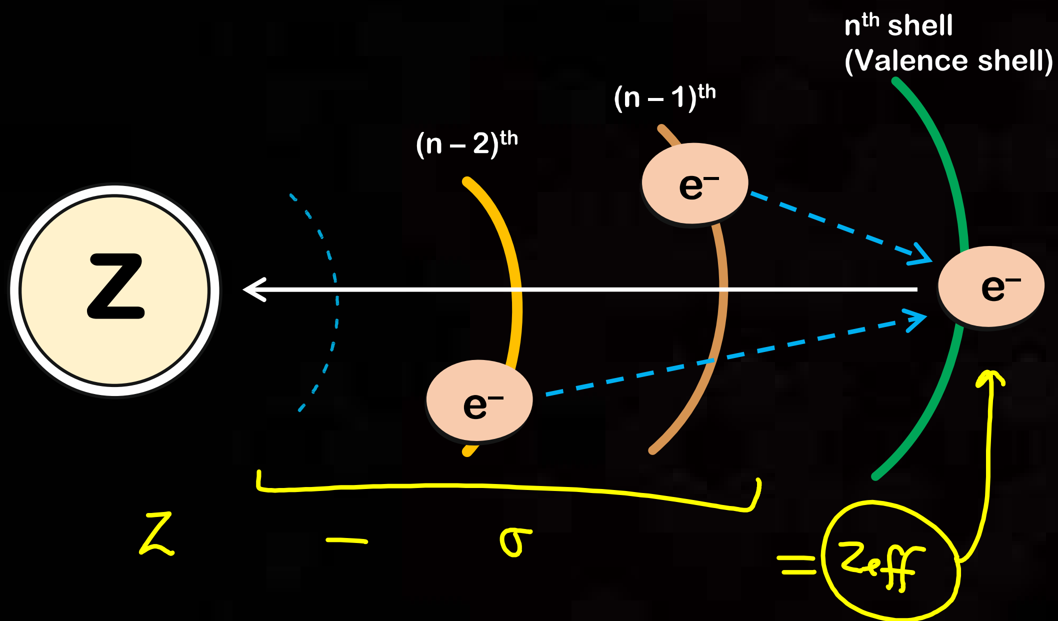
Identify the incorrect match.

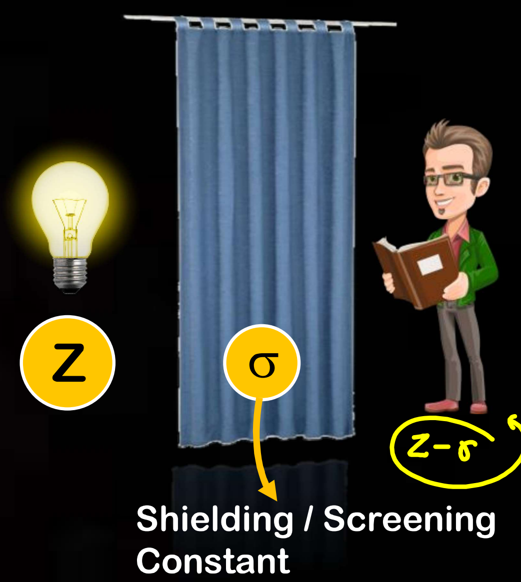
Name		IUPAC Official Name
(a) Unnilunium	101 $\longrightarrow$	(i) Mendelevium
(b) Unniltrium	103 $\longrightarrow$	(ii) Lawrencium
(c) Unnilhexium	106 $\longrightarrow$	(iii) Seaborgium
(d) Unununnium	111 $\not\longrightarrow$	(iv) Darmstadtium

(A) (a), (i)　　(B) (b), (ii)

(C) (c), (iii)　　(D) (d), (iv)

Effective Nuclear Charge

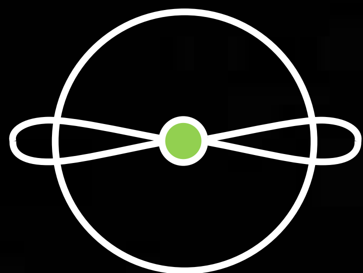




Screening Effect

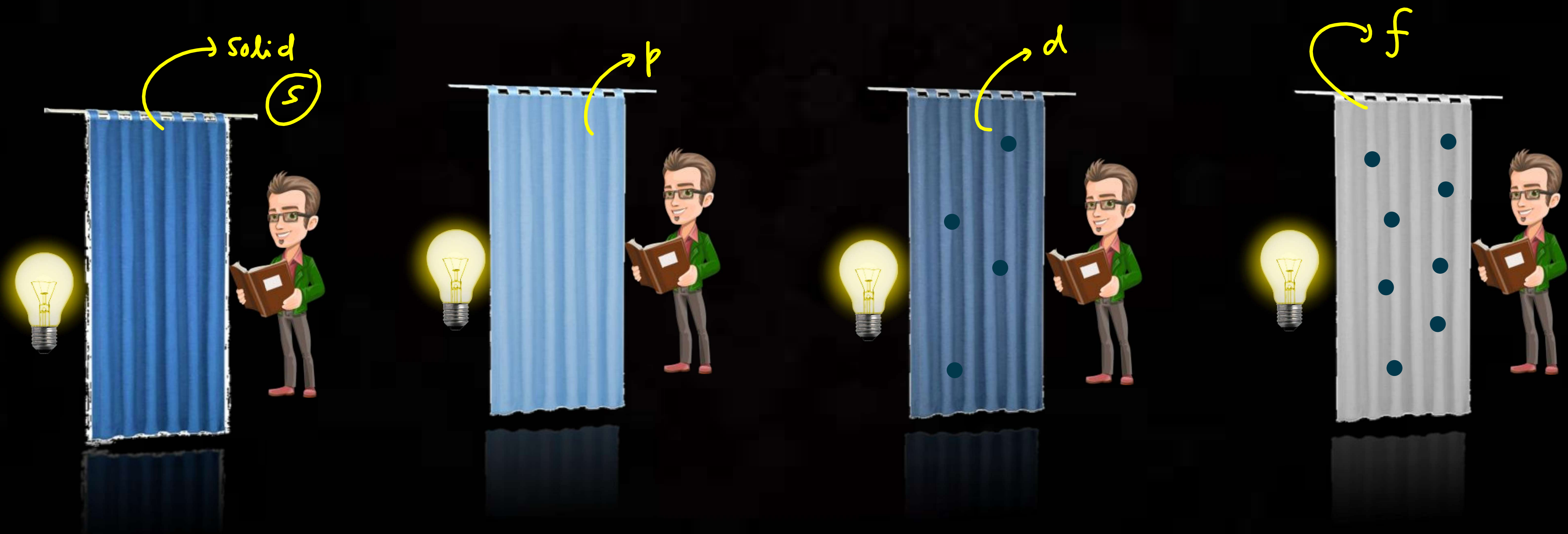
There is a reduction in nuclear charge due to presence of screen b/w test electron and nucleus.

Penetration effect



$s > p > d > f$: Penetration power

$s > p > d > f$: Shielding effect



Q. Screening effect is not observed in :

$+$ e^-

$n=1$

(A) He^+

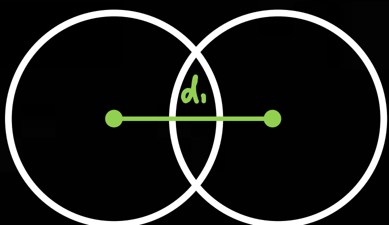
(B) Li^{2+}

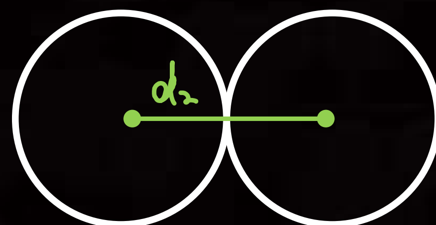
(C) Be^{3+}

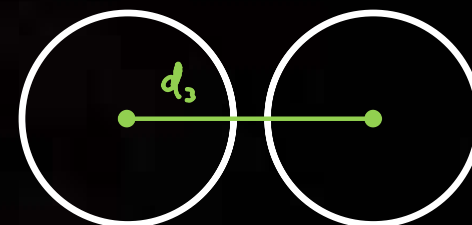
(D) In all cases

Atomic radius

Covalent radius < Metallic radius < Vander Waal radius



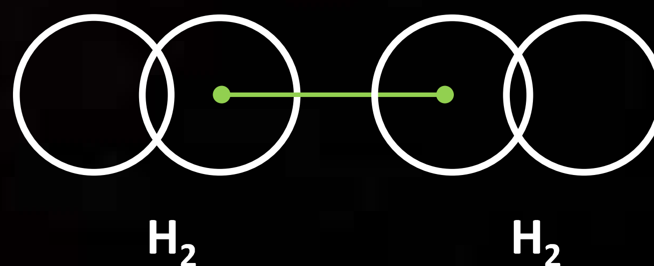




$MR = \frac{d_2}{2}$

$VWR = \frac{d_3}{2}$

Radius = $\frac{d_1}{2}$

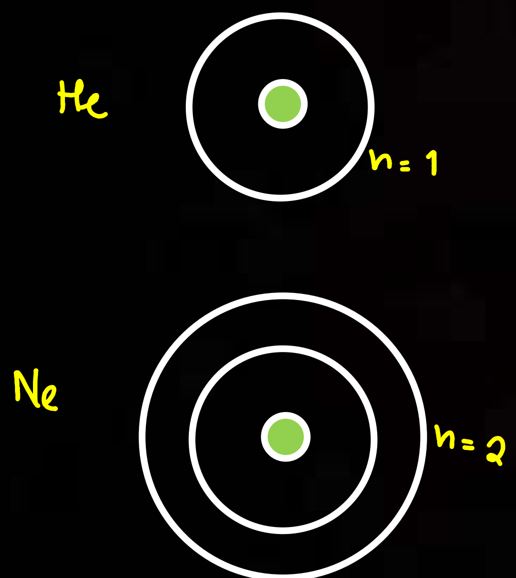


Atomic radius

Variation in Group : Top $\downarrow$ Bottom AR $\uparrow$

(Left to right)

Variation in Period $\longrightarrow$ $Z_{eff} \uparrow$: AR $\downarrow$



Practice

shell (valence) no. ↑ : AR ↑
Period no ↑

- B $\underset{n=2}{}$ < P > S > Cl < Br

$$\underbrace{P \quad S \quad Cl}_{n=3} \qquad \underbrace{Br}_{n=4}$$

- C S Al Cs

Atomic radius

* सावधानी

							He
							^
Li	Be	B	C	N	O	F	Ne
^	^	^	^	^	^	^	^
Na	Mg	Al	Si	P	S	Cl	Ar
^	^	v	^	^	^	^	^
K	Ca	Ga	Ge	As	Se	Br	Kr
^	^	^	^	^	^	^	^
Rb	Sr	In	Sn	Sb	Te	I	Xe
^	^	^	^	^	^		
Cs	Ba	Tl	Pb	Bi	Po		

3d Series

Lanthanide Contraction

Ce $\longrightarrow$ Lu

Poor shielding of f orbital

Electronic Configuration of La, Hf, Ac, Rf, Ce, Lu, Th, Lr ?

$[Xe]6s^2 5d^1$ $\boxed{La}$ Ce $\longrightarrow$ Lu $\boxed{Hf}$

$\boxed{Ac}$ Th $\longrightarrow$ Lr $\boxed{Rf}$

4f Series :

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

D-block

n											
4	Sc		Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
	∧		∧	∧	∧	∧	∧	∧	∧	∧	∧
5	$_{39}Y$		$_{40}Zr$	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
	∧		≈	≈	≈	≈	≈	≈	≈	≈	≈
6	$_{57}La$	$_{58}Ce \rightarrow {}_{71}Lu$	$_{72}Hf$	Ta	W	Re	Os	Ir	Pt	Au	Hg

Ionic Radius

$Z_{eff} \uparrow$: IR $\downarrow$ $\left(Z_{eff} \simeq \frac{Z}{e} \right)$

Cation

$Be \xrightarrow{-e^-} Be^+ \xrightarrow{-e^-} Be^{2+}$

$\frac{4}{4}$ $\frac{4}{3}$ $\frac{4}{2}$

IR : $Be^{2+} < Be^+ < Be$

Anion

$O \xrightarrow{+e^-} O^- \xrightarrow{+e^-} O^{2-}$

$\frac{8}{8}$ $\frac{8}{9}$ $\frac{8}{10}$

I.R. : $O^{2-} > O^- > O$

Isoelectronic species

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

No. of electrons: $(7+3)$ $(8+2)$ $(9+1)$ $(11-1)$ $(12-2)$ $(13-3)$

Q. The ionic radii (in Å) of N^{3-}, O^{2-} and F^{-} are respectively :

$N^{3-} > O^{2-} > F^{-}$

7 8 9

(A) 1.36, 1.40 and 1.71

(B) 1.71, 1.40 and 1.71

(C) 1.71, 1.40 and 1.36

(D) 1.71, 1.36 and 1.40

Q. Zr and Hf have almost equal atomic and ionic radii because of

A Lanthanoid contraction

B Diagonal relationship

C Actinoid contraction

D Belonging to the same group

4d
॥
5d

Ag
॥
Au

Sc
^
Y
^
La

Q. The correct order of atomic radii in group 13 elements is

(A) B < Al < In < Ga < Tl

(B) B < Al < Ga < In < Tl

(C) B < Ga < Al < In < Tl

(D) B < Ga < Al < Tl < In

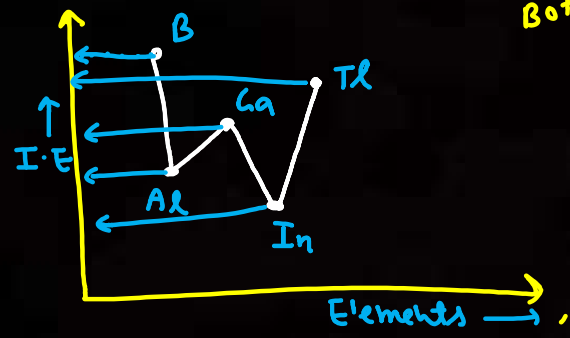
B < Ga < Al < In < Tl

Ionisation Energy

L → R : Zeff ↑ : I.E. ↑

Top ↓ Bottom : AR ↑ : I.E. ↓

$\boxed{B > Tl > Ga > Al > In}$



s^1 s^2

$\boxed{Li < Be}$

I.E.

s^1	s^2							
								He
								∨
Li	Be		B	C	N	O	F	Ne
∨	∨		∨	∨	∨	∨	∨	∨
Na	Mg		Al	Si	P	S	Cl	Ar
∨	∨		∧	∨	∨	∨	∨	∨
K	Ca	3d	Ga	Ge	As	Se	Br	Kr
∨	∨		∨	∨	∨	∨	∨	∨
Rb	Sr		In	Sn	Sb	Te	I	Xe
∨	∨		∧	∧	∨	∨		
Cs	Ba	4f	Tl	Pb	Bi	Po		

Highest I.E. : He

Lowest I.E. : Cs

Ionisation Energy

Li < B < Be < C < O < N < F << Ne

❖	Li	Be (s^2)	B (s^2p^1)	C	N (s^2p^3)	O	F <<	Ne (s^2p^3)
❖	Na	Mg	Al	Si	P	S	Cl <<	Ar

$\boxed{n} \downarrow$

I.E.

4	Sc		Ti
	V		V
5	$_{39}Y$		$_{40}Zr$
	V		Λ
6	$_{57}La$	$\boxed{_{58}Ce \longrightarrow {_{71}Lu}}$	$_{72}Hf$

❖ Be > B

Mg > Al

Ca > Ga

Q. Consider the following ionization enthalpies of two elements 'A' and 'B' Which of the following statements is correct ?

G-2

$A \xrightarrow{899} A^{+} \xrightarrow{1757} A^{2+} \xrightarrow{14847} A^{3+}$

$B \xrightarrow{737} B^{+} \xrightarrow{1450} B^{2+} \xrightarrow{7731} B^{3+}$

Group -2

A
B

Element	Ionization enthalpy (kJ/mol)		
	1^{st}	2^{nd}	3^{rd}
A	899	1757	14847
B	737	1450	7731

A Both 'A' and 'B' belong to group-1 where 'B' comes below 'A'

B Both 'A' and 'B' belong to group-2 where 'A' comes below 'B'.

C Both 'A' and 'B' belong to group-2 where 'B' comes below 'A'

D Both 'A' and 'B' belong to group-1 where 'A' comes below 'B'

Q. Amongst the elements with following electronic configurations, which one of them may have the highest ionization energy ?

→ IGC

→ half / fully

A $[Ne]3s^23p^1$

B $[Ne]3s^23p^3$

C $[Ne]3s^23p^2$

D $[Ar]3d^{10}4s^24p^3$

Q. The 1st Ionisation enthalpy of Na, Mg and Si are 496, 737, 776 $kJmol^{-1}$ respectively then what will be the 1st ionisation enthalpy of Al in $kJmol^{-1}$

Na Mg Al Si

Na < Al < Mg < Si

(A) > 766 $kJmol^{-1}$

(B) > 496 and < 737 $kJmol^{-1}$

(C) > 737 and < 766 $kJmol^{-1}$

(D) > 496 $kJmol^{-1}$

Q. The correct order of decreasing $\boxed{\text{second ionisation}}$ enthalpy of Ti(22), V(23), Cr(24) and Mn(25) is :

A Mn > Cr > Ti > V

B Ti > V > Cr > Mn

C Cr > Mn > V > Ti ✓

D V > Mn > Cr > Ti

$Ti \longrightarrow Ti^{+} \longrightarrow Ti^{+2}$

$V \longrightarrow V^{+} \longrightarrow V^{2+}$

$4s^1 3d^5$ $Cr \longrightarrow Cr^{+} \longrightarrow Cr^{2+}$

$3d^5$

$Mn \longrightarrow Mn^{+} \longrightarrow Mn^{2+}$

Diagonal Relationship

n = 2	Li	Be	B	C	N
n = 3	Na	Mg	Al	Si	P

Size :

Li
||
Mg

Li^{+}
∨
Mg^{2+}

Inert Pair Effect

Stability of oxidation ~~state~~

$2s^2 2p^1$

B $(B^{3+} \gg B^{+1})$	C $C^{4+} > C^{2+}$	N
Al $Sn^{4+} > Sn^{+2}$	Si $PbCl_4 < PbCl_2$, $PbO_2 < PbO$	P
Ga	Ge	As
In	Sn	Sb
Tl $\rightarrow 6s^2 4f^{14} 5d^{10} 6p^1$	Pb $\rightarrow 6p^2$	Bi $\rightarrow 6p^3$
$Tl^{+1} > Tl^{+3}$	$Pb^{4+} < Pb^{+2}$	$Bi^{+3} > Bi^{+5}$

$Bi^{+5} \rightarrow$ BiF_5

Tl^{+3} $3F^{\ominus}$ $\rightarrow$ TlF_3

TlF

TlCl

$Tl^{\oplus}$ $I_3^{\ominus}$

TlI_3

PbO$_2$

PbCl$_2$

Reaction $\rightarrow$

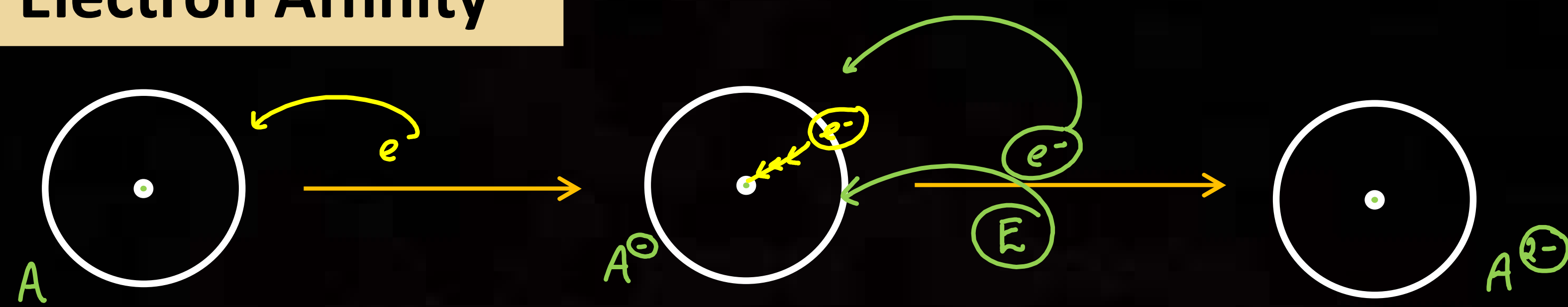
$Pb^{+4} \rightarrow Pb^{+2}$

OA

$Sn^{+2} \rightarrow Sn^{+4}$

RA

Electron Affinity



E.A. = ⊕ve

ΔH_{eg} = ⊖ve

E.A. = ⊖ve

$(\Delta H_{eg} = \oplus ve)_{second}$

❖ **Stable electronic configuration**

stable
e⁻
E

ΔH = ⊕ve

Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar

Be: ΔH = ⊕ve

N: ΔH = ⊕ve

P: ΔH = ⊖ve

Ne, Ar: ΔH = +ve

Electron Affinity

$Z_{eff} \uparrow$: E.A $\uparrow$

Variation in Group

T ↓ B — size ↑ EA ↓

Variation in Period

F Vs. Cl

Electron density ↑

$2s^2 2p^5$

$F \longrightarrow F^{\ominus}$ (+ e^-) $\Delta H = -x$

$y > x$

$3s^2 3p^5$

$Cl \longrightarrow Cl^-$ (+ e^-) $\Delta H = -y$

- B ∧ Al
- C ∧ Si
- N ∧ P
- O ∧ S
- F ∧ Cl

❖	B	C	N	O	F
	∧	∧	∧	∧	∧
❖	Al	Si	P	S	Cl

$Cl > F > Br > I$

$S > Se > Te > O$

$\boxed{I > S}$

$ns^2np^5 \xrightarrow{e^-} ns^2np^6$

$\Delta H = +ve$

					He
B	C	N	O	F	Ne
∧	∧	∧	∧	∧	
Al	Si	P	S	Cl	Ar
∨	∨	∨	∨	∨	
Ga	Ge	As	Se	Br	Kr
∨	∨	∨	∨	∨	
In	Sn	Sb	Te	I	Xe
∨	∨	∨	∨		
Tl	Pb	Bi	Po		

Note : (1) Oxygen has min. EGE in family.

(2) Halogen family has max. EGE in periodic table.

(3) Any element from G-17 has higher EGE wrt other element in PT.

Q. The formation of the oxide ion $O^{2-}(g)$, from oxygen atom requires first an exothermic and then an endothermic step as shown below :

$\overset{\ominus}{O} \xrightarrow[e^-]{} O^{2-}$

$[Ne]$

$$O(g) + e^- \rightarrow O^-(g); \Delta_f H = -141\ kJ\ mol^{-1}$$

$$O^-(g) + e^- \rightarrow O^{2-}(g); \Delta_f H = +780\ kJ\ mol^{-1}$$

Thus process of formation of O^{2-} in gas phase is unfavorable even though O^{2-} is isoelectronic with neon. It is due to the fact that

A Electron repulsion outweighs the stability gained by achieving noble gas configuration

B O^- ion has comparatively smaller size than oxygen atom

C Oxygen is more electronegative

D Addition of electron in oxygen results in larger size of the ion.

❖ Cl > Br > S > O

❖ I > S > Se > O

s^1 s^2p^1

❖ Li > B : EGE

$A \xrightarrow{e^-} A^{\ominus}$

E

E↑ : Stability ↓

Q. Identify the least stable ion amongst the following :

(A) Li–

(B) B–

(C) Be–

$\left(Be \xrightarrow{e} Be^- \right)$ E

(D) C–

Metallic Character

I.E.↓↓

$M \longrightarrow M^+ + e^-$

Metallic character ↑

Reactivity of M

Li	Be
∧	∧
Na	Mg
∧	∧
K	Ca
∧	∧
Rb	Sr
∧	∧
Cs	Ba

Non Metallic Character

$M + e^- \longrightarrow M^{\ominus}$

EA ↑

					He
B	C	N	O	F	Ne
Al	Si	P	S	Cl	Ar
Ga	Ge	As	Se	Br	Kr
In	Sn	Sb	Te	I	Xe
Tl	Pb	Bi	Po		

Metalloids : आज सबसे तेजी

Electronegativity

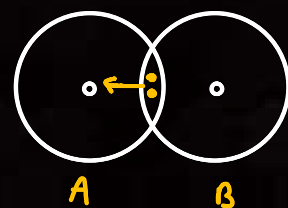
Tendency of an atom to attract shared pair of electrons from a covalent bond.

$\overset{-\delta}{A} \; \ominus\!\!-\!\!-\!\!-\; \overset{+\delta}{B}$ (EN : A > B)

Left → Right

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

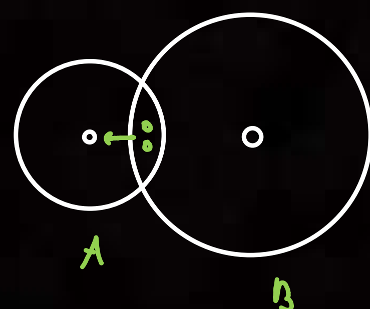
1. $(Z_{eff})_A > (Z_{eff})_B$



Group

$\text{Size} \uparrow \longrightarrow$ E.N. $\downarrow$

2. $(\text{Size})_A < (\text{Size})_B$



Pauling Scale

A— B

B-B

A-A

It is based on an empirical relation between energy of a bond & electronegativity.

$$\chi_A - \chi_B = 0.208\sqrt{\Delta}\ \text{k cal mol}^{-1}$$

$$\Delta = E_{A-B} - \sqrt{E_{A-A} \times E_{B-B}}$$

M.S.

$$\chi = \frac{\text{I.E.} + \text{E.A.}}{2}$$

$$\chi_M = 2.8\chi_P$$

Electronegativity

Li 1	Be 1.5	B 2	C 2.5	N (3.0)	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl (3.0)
K	Ca					Br 2.8
Rb	Sr					I 2.5
Cs	Ba					

$Na \xrightarrow{0.3} Mg \xrightarrow{0.3} Al \xrightarrow{0.3} Si \xrightarrow{0.3} P \xleftarrow{0.4} S \xleftarrow{2.5} Cl$

Most electronegative element : F

Q. The electronegativity of aluminium is similar to :

A Lithium

B Carbon

C Boron

D Beryllium

Li Be B

Mg Al

OXIDE

Amphoteric Oxides

As^{3+} Fe^{3+} Sb^{3+} Cr^{3+} V^{+5} Te^{+4}

Zn Sn Be Al Pb Ga Cd

As_2O_3	Fe_2O_3	Sb_2O_3	Cr_2O_3	V_2O_5	TeO_2
ZnO	BeO	Al_2O_3	Ga_2O_3	SnO	SnO_2
PbO	PbO_2	Pb_3O_4	Pb_3O_2	CdO	

Acidic Oxides

Non – metal oxides

B_2O_3 CO_2 N_2O_5 P_2O_5 Cl_2O_7

Metalloid oxides

As_2O_5 Sb_2O_5

SeO_2 TeO_3

GeO_2

As

Sb

Se

Te

Ge

Neutral Oxides

CO NO N_2O

Basic Oxides

Metals

+1/+2/+3 → Basic Oxides

+4 → Amphoteric Oxides

+5/+6/+7 → Acidic Oxides

Basic Oxides	Amphoteric Oxides	Acidic Oxides
Li_2O	MnO_2	FeO_3
CaO	TiO_2	CrO_3
MgO	ZrO_2	Mn_2O_7

Q. Which of the following is the most basic oxide?

(A) SeO_2

(B) Al_2O_3

(C) Sb_2O_3

(D) Bi_2O_3 ✓

Bi^{3+}

Q.

Match the following :

Oxide	Nature
(a) CO	(i) Basic
(b) BaO	(ii) Neutral
(c) Al_2O_3	(iii) Acidic
(d) Cl_2O_7	(iv) Amphoteric

Which of the following is correct option?

	(a)	(b)	(c)	(d)
A	(ii)	(i)	(iv)	(iii)
B	(iii)	(iv)	(i)	(ii)
C	(iv)	(iii)	(ii)	(i)
D	(i)	(ii)	(iii)	(iv)