COMPARISON OF IONISATION ENERGY

PERIODIC TABLE

Q- Compare 4th IE of P S Cl

P	S	Cl
$[Ne], 3s^2, 3p^3$	$[Ne], 3s^2, 3p^4$	$[Ne], 3s^2, 3p^5$
$-3e$	$-3e$	$-3e$
$[\ ], 3s^2$	$[\cdot], 3s^2, 3p^1$	$[\ ], 3s^2, 3p^2$

$Cl > P > S \quad [IE_4]$

COMPARISON OF IONISATION ENERGY

PERIODIC TABLE

Q. Compare 3rd IE of . Be B. C

✓

Be

$1s^2, 2s^2,$

$-2e$ ↓

He ← $1s^2$

=

B

$1s^2, 2s^2, 2p^1$

$-2e$ ↓

$1s^2, 2s^1$

C

$1s^2, 2s^2, 2p^2$

$-2e$ ↓

$1s^2, 2s^2$

Be > C > B [IE_3]

HW

COMPARISON OF IONISATION ENERGY

PERIODIC TABLE

Q- Compare 5^{th} IE of N O F ?

N

$[He], 2s^2, 2p^3$

$-4e^-$

$[He], 2s^1$

O

$[He], 2s^2, 2p^4$

$-4e^-$

$[He], 2s^2$

F

$[He], 2s^2, 2p^5$

$-4e^-$

$[He], 2s^2, 2p^1$

$O > F > N$ [IEs]

APLICATION OF IONISATION ENERGY

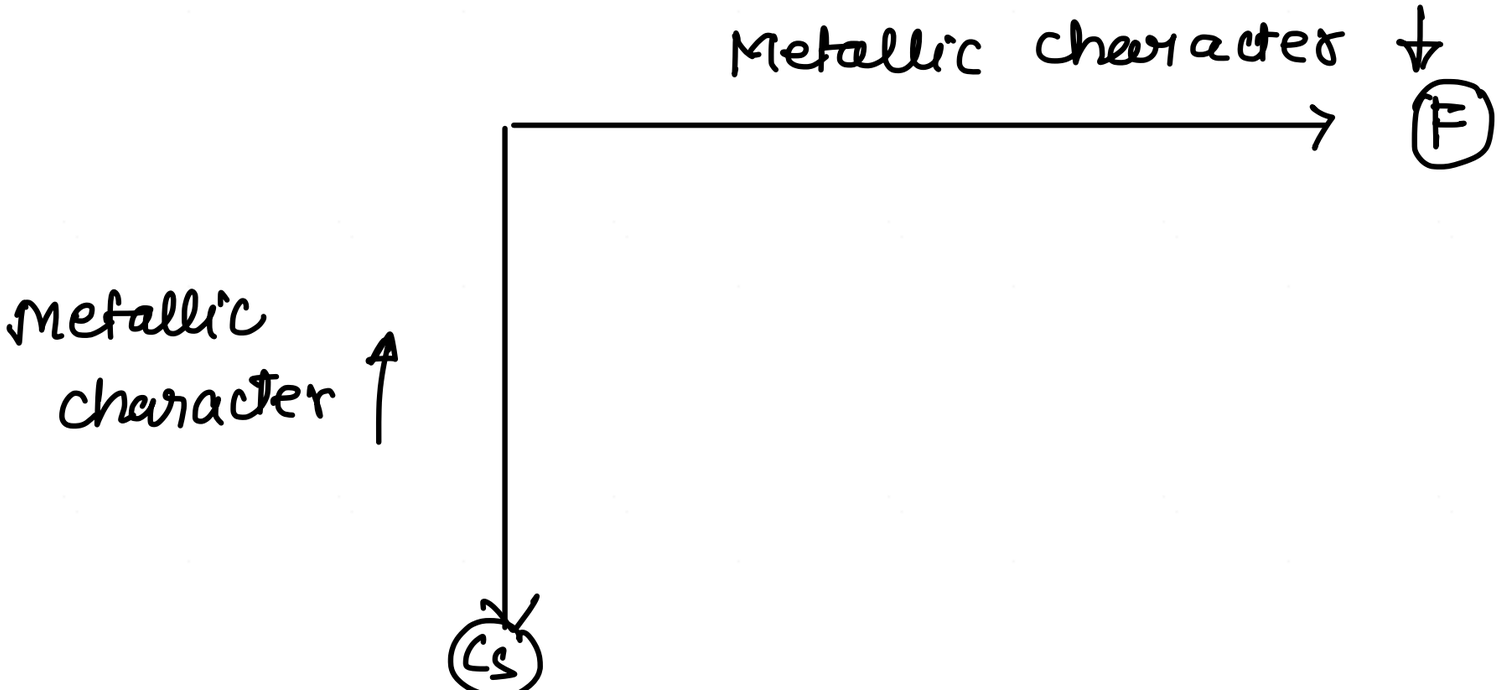
Metallic character (Reactivity of metals) :

Generally for metals Ionisation Energy is low.

For Non-metals Ionisation Energy is high.

Metallic character (Reactivity of metals) $\propto \frac{1}{IE}$

Reactivity of metals increases down the group as ionisation energy decreases.



STABILITY OF OXIDATION STATE OF AN ELEMENT

(a) If the difference between two successive ionisation energy of an element ≥16eV, then its lower oxidation state is stable.

Ex. $\left.\begin{aligned} Na_{(g)} &\longrightarrow Na^{+}_{(g)} \\ Na^{+}_{(g)} &\longrightarrow Na^{2+}_{(g)} \end{aligned}\right] \Delta IE = 42.7eV$

Difference between ionisation energy > 16 eV. So Na^{+} is more stable.

(b) If the difference between two successive ionisation energy of an element ≤ 11 eV, then its higher oxidation state is stable.

Ex. $\left.\begin{aligned} Mg_{(g)} &\longrightarrow Mg^{+}_{(g)} \\ Mg^{+}_{(g)} &\longrightarrow Mg^{2+}_{(g)} \end{aligned}\right] \Delta IE = 7.4eV$

Ex. Difference of ionisation energy < 11 eV. So Mg^{+2} is more stable.

STABILITY OF OXIDATION STATE OF AN ELEMENT

TABLE

(C) If difference is between both of these values than also lower oxidation state is stable.

Ex.

$$\left.\begin{aligned} Al_{(g)} &\longrightarrow Al^{+}_{(g)} \\ Al^{+}_{(g)} &\longrightarrow Al^{2+}_{(g)} \end{aligned}\right] \Delta IE = 12.8eV \text{ . So } Al^{+} \text{ is more stable}$$

$$\left.\begin{aligned} Al^{+}_{(g)} &\longrightarrow Al^{2+}_{(g)} \\ Al^{2+}_{(g)} &\longrightarrow Al^{3+}_{(g)} \end{aligned}\right] \Delta IE = 6.0\ eV \text{ . So } Al^{+3} \text{ is more stable.}$$

Overall order of stability is $\boxed{Al^{+3} > Al^{+} > Al^{+2}}$

* If there is sudden large increase in IE shows that give electronic configuration is stable.

Ex. X, Y, Z are element of 3rd period. and their IE_1, IE_2 & IE_3 is given in (KJ/mol)?

		IE_1	IE_2	IE_3
	v.e=1			
X	[Na]	500	5521	9827
	v.e=2			
Y	[Mg]	600	1400	16231
Z		4823	9227	18243

P, Cl, Ar

Q- A = $1s^2, 2s^2, 2p^3$ B = $1s^2, 2s^2, 2p^2$

C = $1s^2, 2s^2, 2p^4$ D = $1s^2, 2s^2, 2p^6$

(i) Order of IE_1 D > A > C > B

ii) order of IE_2 D > C > A > B

iii) Which element has large diff. of IE_1 and IE_2

Ans (C)

iv) Large difference in 2nd and 3rd IE

Ans (B)

Ex. for existance of Fe^{+2} and Fe^{+3} which of the following is/are true.

(a) $IE_1 < IE_2$

(b) $IE_3 << IE_4$

(c) $IE_2 < IE_3$

(d) $IE_1 <<< IE_2$

(e) $IE_3 < IE_2$ (Never)

QUESTIONS

TABLE

Number of valence electrons = number of lower values of IP before 1st highest jump.

Q. Match the column.

Column-I	**Column-II**
Valence electronic configuration	**Successive ionisation energies**
(a) ns^1	(p) 19, 27, 36, 48,270
(b) ns^2	(q) 16, 28, 34, 260
(c) $ns^2\ np^1$	(r) 18, 26, 230, 250
(d) $ns^2\ np^2$	(s) 14, 200, 220, 240

Ans. (a) s, (b) r, (c) q, (d) p

Q. Values of first four ionisation potential of an elements are 68, 370, 400, 485. It belongs to which of the following electronic configuration:-

(1) $1s^2, 2s^1$ (2) $1s^2, 2s^2\ 2p^1$

(3) $1s^2, 2s^2\ 2p^6, 3s^1$ (4) (1) and (3) both

Ans. (3)

QUESTIONS

TABLE

Q. Arrange the following into correct order of IE

(i) O, F, Cl, S

(ii) F, Cl, Br, I

(iii) Be, B, C, N

(iv) N^{-3}, O^{-2}, F^{-}

(v) Li^{+}, He, Be^{+2}

(vi) Mn^{+2}, Mn^{+3}, Mn^{+4}

$1s^2$ $1s^2$ $1s^2$

vi) IE $\propto$ +ve charge

$Mn^{+4} > Mn^{+3} > Mn^{+2}$

(i) $F > O > Cl > S$

ii) $F > Cl > Br > I$

iii) Be, B, C N ⟶ order $N > C > Be > B$

ns^2 np^1 np^2 np^3

iv) N^{-3} O^{-2} F^{-}

np^6 np^6 np^6

IE $\propto \frac{+ve}{-ve}$, $F^{-} > O^{-2} > N^{-3}$

v) $Be^{+2} > Li^{+2} > He$ (IE $\propto$ +ve charge)

QUESTIONS

PERIODIC TABLE

Q. If the I.P. of Na, Mg & Si are 496, 737 & 786 kJ/mole respectively then I.P. of Al is

(A) 760 kJ/mole (B) 756 kJ/mole

(C) 577 kJ/mole (D) 986 kJ/mole

Ans. (C)

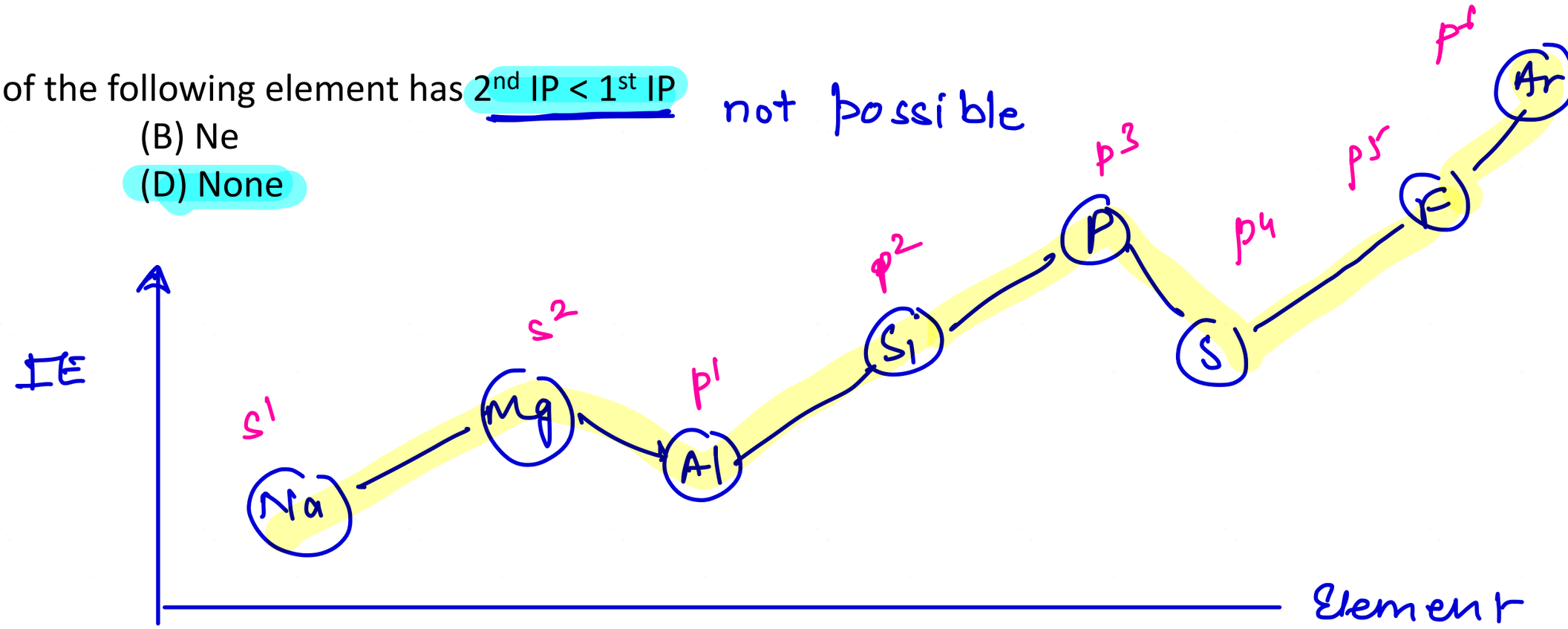
Q. Which of the following element has 2^{nd} IP < 1^{st} IP

(A) Mg (B) Ne

(C) C (D) None

Ans. (D)

not possible



*** VIMP IE →

i) Along period increases [L → R]

ii) Along group decreases [T - B]

iii) same period then check point

EC : $s^1 < p^1 < s^2 < p^2 < p^4 < p^3 < p^5 < p^6$

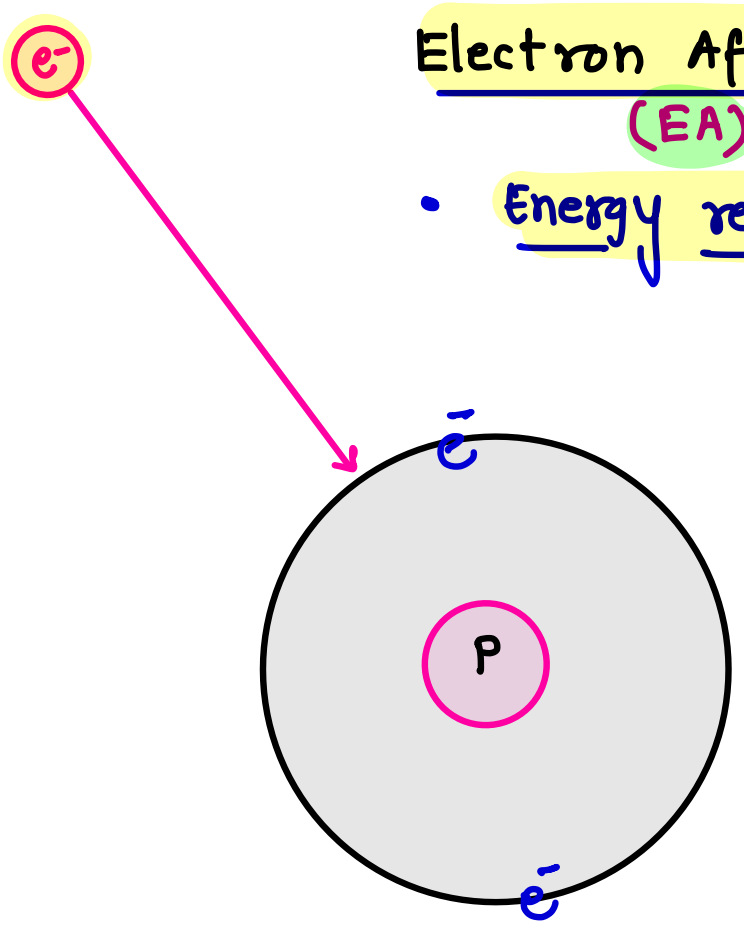
iv) 4th ⟶ 12th [$6^{th} > 4th > 5^{th}$]
period elements

v) group - 13 [DUDU Effect]

vi) group - 14 [Pb > Sn]

vii) For same element $IE \propto \frac{+ve\ charge}{-ve\ charge}$

viii) for different element check EC.



Electron Affinity (EA)

- Energy released.

Electron gain Enthalpy (ΔH_{eg})

- Energy represented with sign

Released = -ve

absorbed = +ve

Force Experienced

(i) Attraction from Nucleus

ii) repulsion for electrons

Case-1 Attraction dominates Addition of electron Release energy or process will exothermic

$\Delta H_{eg} < 0$ $EA > 0$

→

Case-2 : Repulsion dominates for Addition of electron we must give energy. process will be endothermic / energy absorbed.

✓ $\Delta H_{eg} > 0$, $EA < 0$ [Mathematical]

**

Ex. IIA (s^2). N (p^3). inert gases (p^6), Anion

Q. Identify the process Exothermic and endothermic

Exothermic: $\Delta H_{eg} < 0$

Endothermic: $\Delta H_{eg} > 0$

(a) $Be + e \longrightarrow Be^-$ Endo.

(b) $Na + e^- \longrightarrow Na^-$ Exo.

(c) $Cl + e^- \longrightarrow Cl^-$ Exo.

(d) $N + e^- \longrightarrow N^-$ Endo.

(e) $P + e^- \longrightarrow P^-$ Exo

(f) $O^- + e^- \longrightarrow O^{-2}$ Endo.

(g) $Ar + e^- \longrightarrow Ar^-$ Endo.

Higher Electron gain Enthalpy :-

$$X(g) + e^- \longrightarrow X^-(g) \qquad \Delta H_{eg_1}$$

ΔH_{eg_1} can be +ve or -ve depending upon element X.

$$X^{\ominus} + e^- \longrightarrow X^{-2}(g) \qquad \Delta H_{eg_2} > 0$$

$$X^{-2} + e^- \longrightarrow X^{-3}(g) \qquad \Delta H_{eg_3} > 0$$

$$|\Delta H_{eg_3}| > |\Delta H_{eg_2}| > |\Delta H_{eg_1}|$$

$$\Delta H_{eg}(X^{-3}) = \Delta H_{eg_1} + \Delta H_{eg_2} + \Delta H_{eg_3}$$

which always endothermic

Note → formation of polyvalent Anions (X^{-n}) will always endothermic. ($n > 1$)

"Variation of Electron Affinity (EA)"

i) EA $\propto$ Z_{eff}.

on going Left to right in a period EA ↑

[check point Electronic configuration]

ii) $EA \propto \frac{1}{\text{Period No}}$

on going top to bottom EA decreases.

Exception

i) Li > B Na > Al

$2s^1$ $2p^1$ $3s^1$ $3p^1$

On Addition of 1 electron

Lithium will be more stablised

ii) Ne ← e^- Be ← e^- N ← e^-

$\underline{p^6}$ $\underline{s^2}$ $\underline{p^3}$

EA N > Be > Ne

(iii)

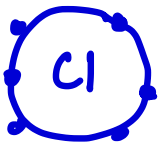
(EA)

EA (2nd) < EA (3rd) period

group

2P < 3P

U > F > Br > I



Halogen

S > Se > Te > O

O < S

oxygen

N < P < As < Sb < Bi

N < P

Nitrogen

Si > C > Ge > Sn < Pb

C < Si

Carbon

B < Al

Boron

Ga > Al > B > Tl > In

Max EA (Cl) , (Min EA) → (He)