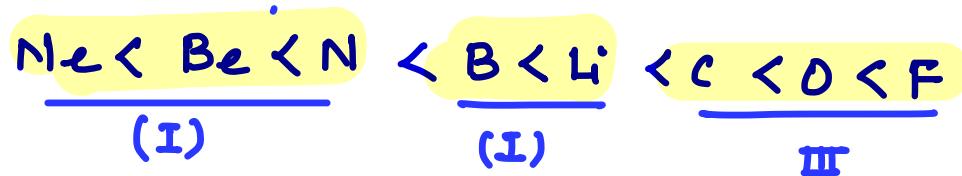


1st period



2nd period



3rd period



→ it will be very less
- ve as it has np³

Configuration

Q. Arrange the following in increasing order of EA.

				p^1	s^1
(a)	Li	Be	B		
(b)	C	N	O		
(c)	Cl	P	Si		
(d)	N	P	As		

$$Be < B < Li$$

$$N < C < O$$

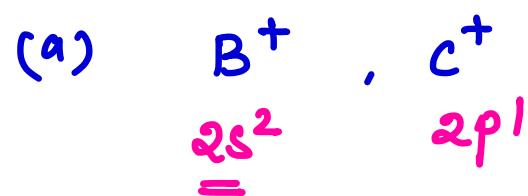
$$P < Si < Cl$$

$$N < P < As$$

• For different element EA see electronic configuration

• for same element $EA \propto \frac{+ve\ charge}{-ve\ charge}$

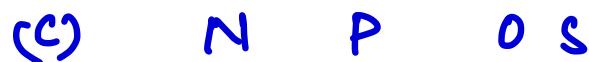
Q. Arrange the following in increasing order of IP and EA.



$$\begin{array}{ll} \text{IP} & B^+ > C^+ \\ \text{EA} & C^+ > B^+ \end{array}$$



$$\begin{cases} \text{IP} & O^{-2} < O < O^+ \\ \text{EA} & O^{-2} < O < O^+ \end{cases}$$



$$N > O > P > S$$

IP

$$\begin{array}{cc} p^3 & p^4 \\ N & O \\ \hline P & S \end{array}$$

p^3	p^4
N	O
P	S

(2P) (3P)

$S > O > P > N$ (EA)

④ N P C Si

p^2
C
 p^3
N

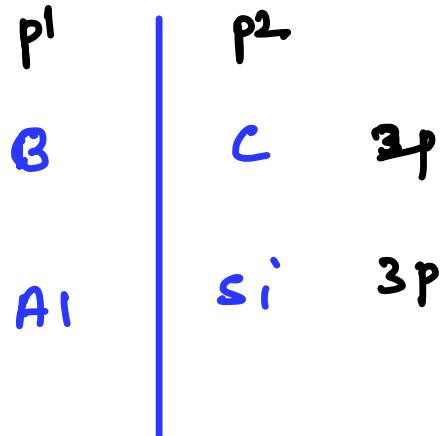
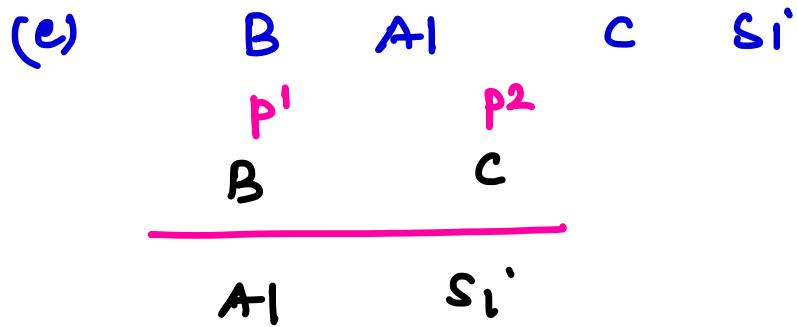
Si P

N > C > P > Si (IE)

p^2	p^3
C	N
Si	P

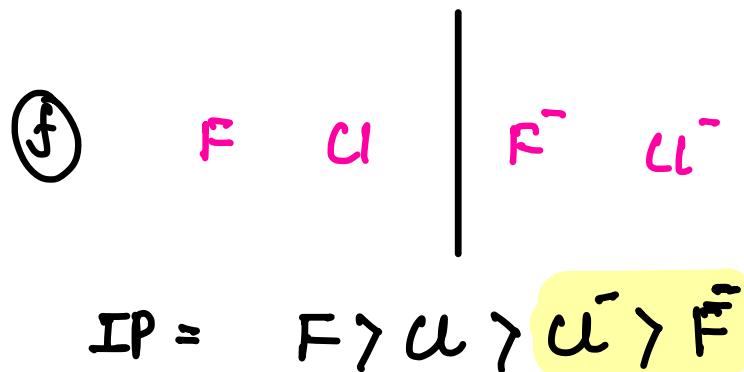
2P
3P

Si > C > P > N (EA)



(IE) C > B > Si > Al

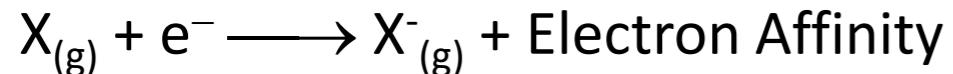
Si > C > Al > B



(EA) Cl > F > Cl⁻ > F⁻

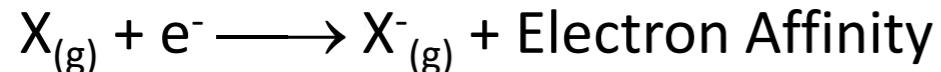
ELECTRON AFFINITY/ELECTRON GAIN ENTHALPY (EA/ ΔH)_{eg})

(1) The amount of energy released when an electron is added to the valence shell of an isolated gaseous atom known as Electron affinity.

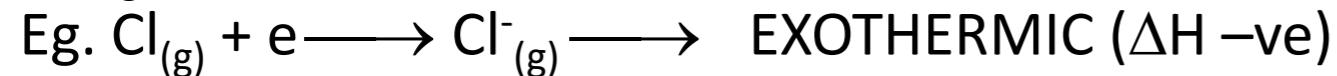


Some Important Points :-

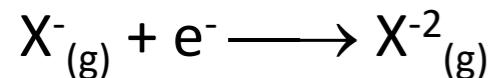
(1) Generally first electron addition in an isolated gaseous atom is an exothermic process (except stable electronic configuration)



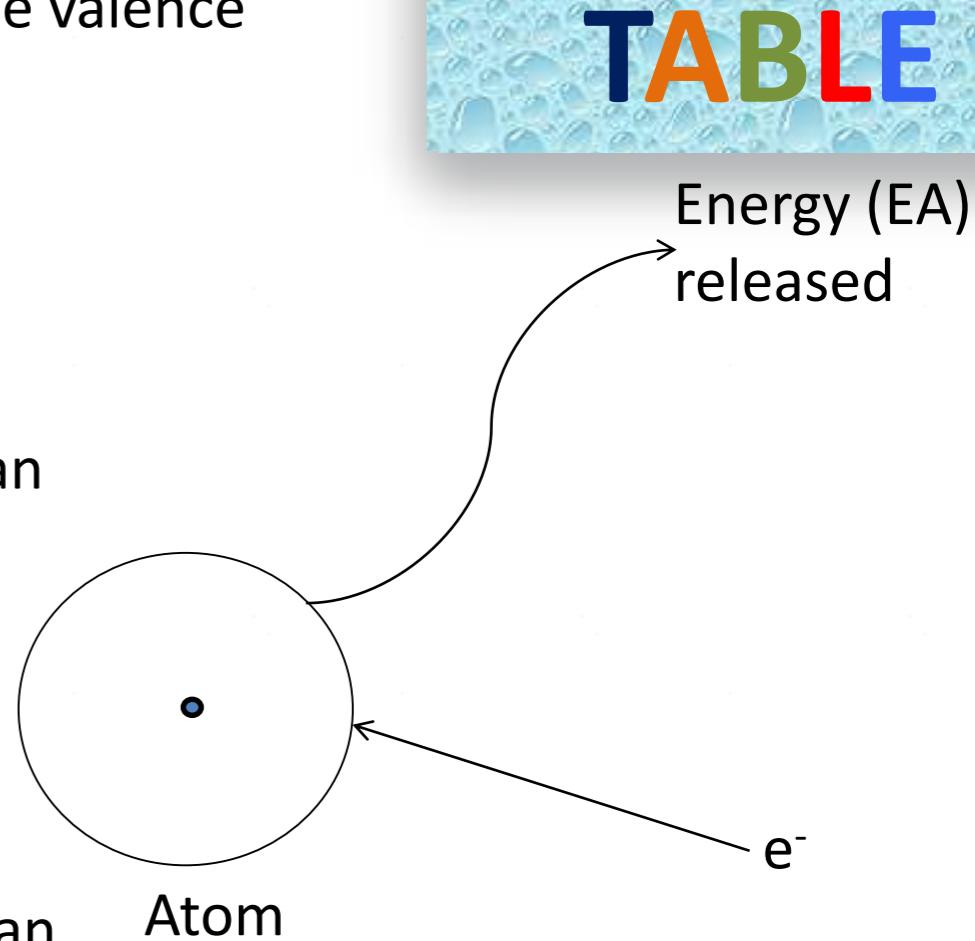
ΔH_{egI} (first electron gain enthalpy) = -ve (negative)



(2) Second electron addition in an isolated gaseous atom is always an endothermic process due to inter electronic repulsion.

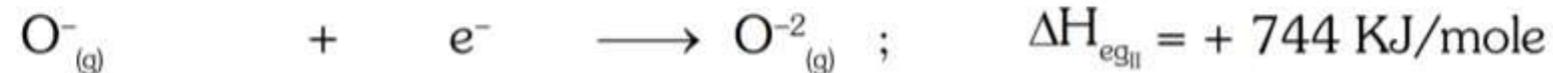


ΔH_{egII} (second electron gain enthalpy) = +ve (positive)



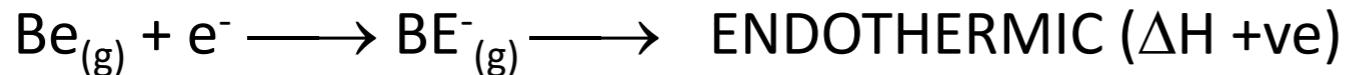
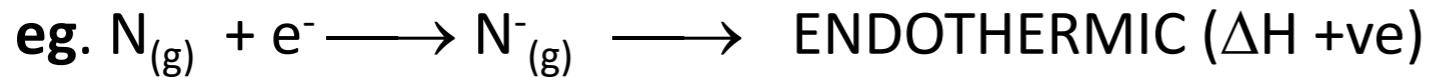
ELECTRON AFFINITY/ELECTRON GAIN ENTHALPY ($\text{EA}/\Delta\text{H}$)_{eg})

Ex.



(3) Formation of poly negative anion like O^{-2} , N^{-3} , C^{-4} etc. is always an endothermic process.

For Stable e- configuration like Half filled & full filled, process is Endothermic.



Q. Identify endo / exo process

- | | |
|---|---|
| (A) $\text{S} \rightarrow \text{S}^{-2}$ | (B) $\text{Na}^+_{(g)} \rightarrow \text{Na}_{(g)}$ |
| (C) $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$ | (D) $\text{N}_{(g)} \rightarrow \text{N}^-_{(g)}$ |
| (E) $\text{F}_{(g)} \rightarrow \text{F}^-_{(g)}$ | |

TABLE

FACTORS AFFECTING ELECTRON AFFINITY

(A) Effective nuclear charge (Z_{eff}) :

$$\text{Electron Affinity} \propto Z_{\text{eff}}$$

(B) Atomic size :

$$\text{Electron Affinity} \propto \frac{1}{\text{Atomic size}}$$

(C) For ions :

$$\text{Electron Affinity} \propto \frac{\text{positive charge}}{\text{negative charge}}$$

(D) Penetration Power :

$$\text{EA} : - \text{ns}^1 > \text{np}^1$$

$$\text{eg} : - \text{Li} > \text{B} \longrightarrow 2^{\text{nd}} \text{ Pd}$$

$$\text{eg} : - \text{Na} > \text{Al} \longrightarrow 3^{\text{rd}} \text{ Pd}$$

TABLE

FACTORS AFFECTING ELECTRON AFFINITY

(e) **Stability of completely filled or half filled orbitals** : Electron affinity of elements having full-filled or half filled configuration is very less or zero so for these elements electron gain enthalpy ΔH_{egII} will be positive.

Ex. (i) EA :- $ns^1 > ns^2$ (ii) EA :- $np^2 > np^3$

TABLE

VARIATION OF ELECTRON AFFINITY

In 2nd period -

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

$\underbrace{\text{Ne} < \text{Be} < \text{N}}_{\text{endothermic}} < \text{B} < \text{Li} < \text{C} < \text{O} < \text{F}$

Note :- Halogens have higher EA as compared to other elements.

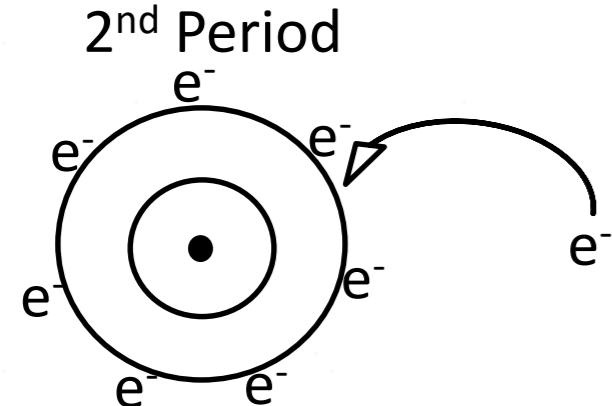
TABLE

VARIATION OF ELECTRON AFFINITY

(ii) In Group :

F

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



Small size

High e⁻ density

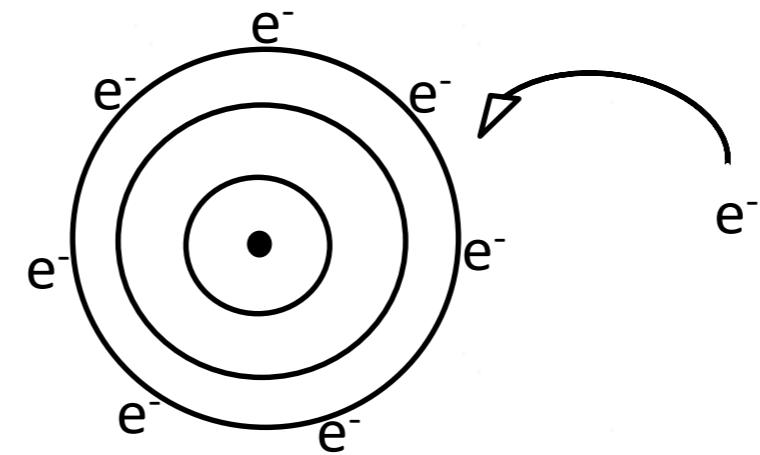
Incoming e- face more repulsion

EA ↓

Cl

[Ne] $3s^2 3p^5$

3rd Period



Large size

Low e⁻ density

Incoming e- face less repulsion

EA ↑

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

TABLE

VARIATION OF ELECTRON AFFINITY

Group 17th overall order : F < Cl > Br > I → Cl > F > Br > I

TABLE

Group 16th overall order : O < S > Se > Te

Group 15th overall order : N < P > As > Sb

Cl > F > Br > I	S > O > P > N	Si > C > P > N
-----------------	---------------	----------------

Q. Compare the order increasing electron gain enthalpy with negative sign for the following elements :

(1) O, F, S, Cl

VARIATION OF ELECTRON AFFINITY

(2) N, P, O, S



TABLE

(3) C, Si, N, P

Relation between IE and EA



$$|IE(X)| = |EA(X^+)|$$

$$|IE(X^+)| = |EA(X^{+2})| \checkmark$$

$$|IE(X^-)| = |EA(X)| \checkmark$$

Q - which of the following is/are incorrect

(a) $|EA(x)| = |IE(x)|$

(b) $|EA(x^+)| = |IE(x_-)|$

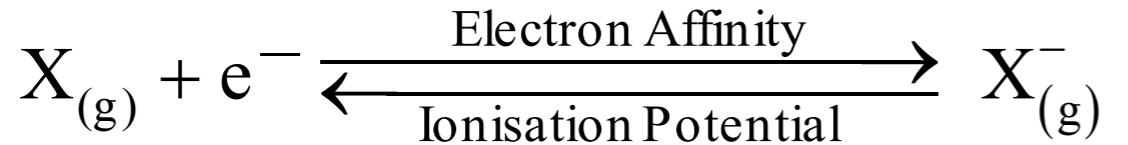
(c) $|EA(x)| = |IE(x^-)|$

(d) $|EA(x^{+2})| = |IE(x^+)|$

(e) $|EA(x^{-2})| = |IE(x^{-3})|$

RELATION BETWEEN IE AND EA

✓ Electron affinity of neutral atom is equal to ionisation energy of its anion.

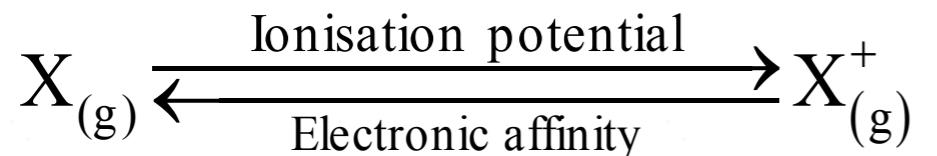


$$(EA \text{ of } X_{(g)}) = (IE \text{ of } X_{(g)}^-)$$



$$EA \text{ of } Cl = IP \text{ of } Cl^-$$

IE of neutral atom is equal to electron affinity of its cation



$$(IE \text{ of } X_{(g)}) = (EA \text{ of } X_{(g)}^+)$$



$$IP \text{ of } Na = EA \text{ of } Na^+$$

TABLE

QUESTIONS

Q. What is the value of electron gain enthalpy of Na^+ if IE1 of Na = 5.1 eV:-

- (1) +0.2 eV
- (2) -5.1 eV
- (3) -10.2 eV
- (4) +2.55 eV

Ans. (2)

Q. Compare IE of F^- , F , Cl^- , Cl

$$|\text{IE}(\text{Na})| = |\text{EA}(\text{Na}^+)|$$

$$5.1 = |\text{EA}(\text{Na}^+)|$$

$$-5.1 = \underline{\text{EA}(\text{Na}^+)}$$

TABLE

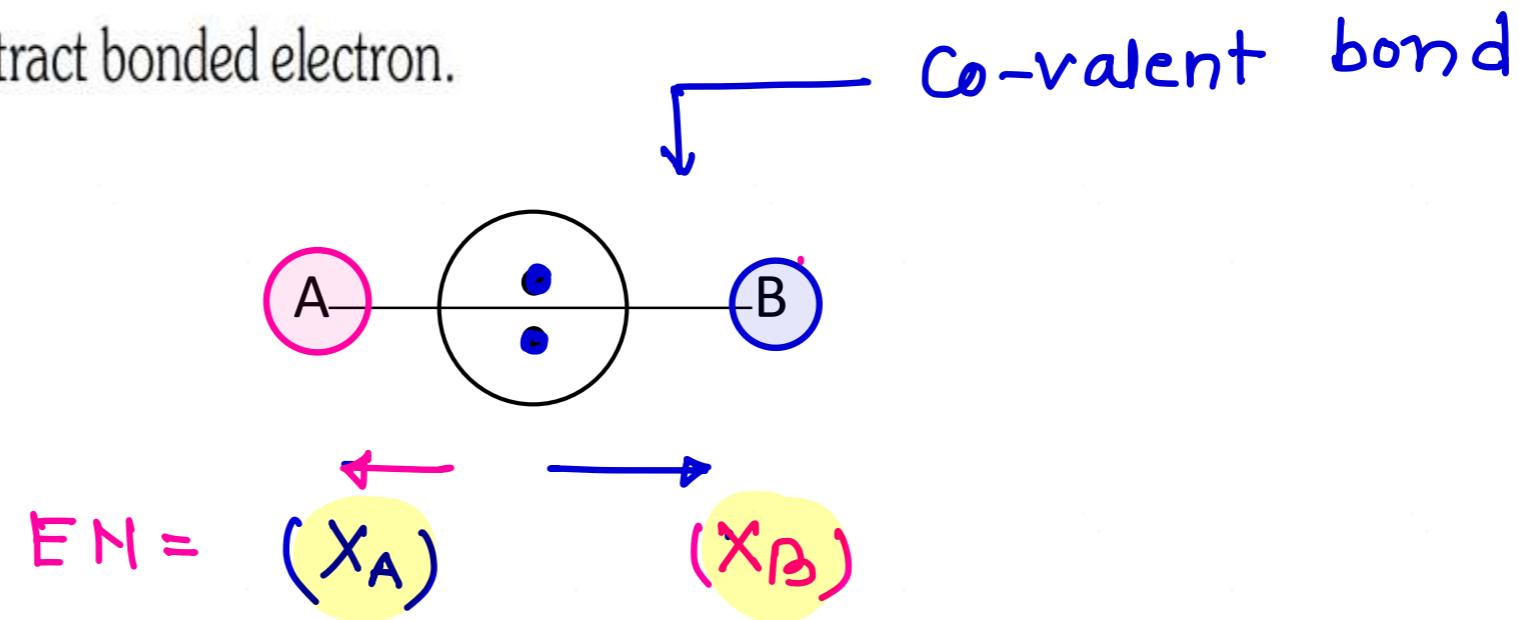
ELECTRONEGATIVITY (EN)

The tendency of a covalently bonded atom to attract shared pair of electrons towards itself is called electronegativity.

A polar covalent or ionic bond of A - B may be broken as

- (a) $A - B \rightarrow A^- : + B^+$ (Electronegativity A > Electronegativity B)
- (b) $A - B \rightarrow A^+ + :B^-$ (Electronegativity A < Electronegativity B)

depending on their tendency to attract bonded electron.



• Tendency to pull shared electron pair towards it self called Electronegativity.

DIFFERENCE BETWEEN EN AND EA

Electronegativity

- Tendency of an atom in a molecule to attract the bonded electrons
- It is not an energetic terms.
- It regularly increases in a period because not depend on stable electronic configuration
- It has no unit

Electron Affinity

- Energy released when an electron is added to neutral isolated gaseous atom
- It is an energetic terms.
- It does not increases regularly in a period because depend on stable electronic configuration
- It is measured in eV/atom or KJ mol⁻¹ or K cal mole⁻¹



ALLEN
CAREER INSTITUTE
KOTA (RAJASTHAN)

TABLE

ELECTRONEGATIVITY SCALE

(i) Pauling scale : Based on bond energy

increased

approx.

Li	Be	B	C	N	O	F	H
1.0	1.5	2.0	2.5	3.0	3.5	4.0	2.1
Na	Mg	Al	Si	P	S	Cl	
0.9	1.2	1.5	1.8	2.1	2.5	3.0	
K					Br		
0.8					2.8		
Rb					I		
0.8					2.5		
Cs							
0.7							
Fr							
0.7							

EN decrease

In Pauling's scale, elements having almost same electronegativity are-

$$\begin{aligned} N &= Cl = 3.0 \\ C &= S = I = 2.5 \\ P &= H = 2.1 \\ Be &= Al = 1.5 \\ K &= Rb = 0.8 \\ Cs &= Fr = 0.7 \end{aligned}$$

✓ EN (Al) > EN (Be)

✓ P > B > H

✓ Cl > N

✓ S > C > I

* Calculation of Electronegativity *

1) Pauling Scale



if ($x_B > x_A$)

$$RE = \Delta \dot{A}_{AB} = E_{A-B} - \sqrt{E_{A-A} \cdot E_{B-B}}$$

↳ Resonance energy. $(E_{AB})_{obs} - (E_{A-B})_{calculated}$.

$$|x_B - x_A| = 0.1017 \sqrt{\Delta_{AB}}$$

(all energies
are in
 kJ/mol)

$E_{A-A} \rightarrow$ Bond dissociation energy of $A-A$

$E_{B-B} \rightarrow$ Bond dissociation energy of $B-B$

Ex. find the electronegativity of fluorine if $E_{H-H} = 100 \text{ kJ/mol}$, $E_{F-F} = 36 \text{ kJ/mol}$ and $E_{H-F} = 141 \text{ kJ/mol}$ and Electronegativity of hydrogen is 2.1.



$$\Delta_{HF} = E_{H-F} - \sqrt{E_{H-H} \cdot E_{F-F}}$$

$$\Delta_{HF} = 141 - \sqrt{100 \times 36}$$

$$\Delta_{HF} = 141 - 60 = 81$$

$$x_F - x_H = 0.1017 \sqrt{81}$$

$$x_F - x_H = 0.9153$$

$$x_F = 0.9153 + 2.1 = 3.0153$$

ELECTRONEGATIVITY SCALE

(ii) Mulliken scale : According to Mulliken electronegativity is average value of ionisation potential and electron affinity of an element

$$X_m = \frac{\text{Ionisation Potential} + \text{Electron Affinity}}{2}$$

Q. If the ionisation potential is IP, electron affinity is EA and electronegativity is X then which of the following relation is correct :-

- (1) $2X - EA - IP = 0$
- (2) $2EA - X - IP = 0$
- (3) $2IP - X - EA = 0$
- (4) All of the above

Ans. (1)

$$EN = \frac{IP + EA}{2}$$

$$\underline{IP + EA - 2EN = 0}$$

If ionisation potential and electron affinity are given in eV, then electronegativity by Mulliken on Pauling scale will be

$$X_p = \frac{X_m}{2.8}$$

where X_p is electronegativity on the basis of Pauling scale.

TABLE

Higher EN = F
min EN = Cs



$$(EN)_m = \frac{IE + EA}{2}$$

IE & EA are given
ev / atom



$$(EN)_m = \frac{IE + EA}{2 \times 96.4}$$

IE and EA are
in KJ/mol.



$$(EN)_m = \frac{IE + EA}{2 \times 23.1}$$

when IE and EA
are given Kcal/mol.

Ex. 1 Find the electronegativity of an element for which.

(a) IE = 330 Kcal/mol EA = 210 Kcal/mol.

$$x_m = \frac{330 + 210}{2 \times 23.1} = 11.6 \Rightarrow x_p = \frac{11.6}{2.8} = \underline{\underline{4.1}}$$

(b) IE = 330 kJ/mol EA = 210 kJ/mol

$$x_m = \frac{330 + 210}{2 \times 96.4} = 2.80 \quad x_p = 1$$

(c) IE = 12 eV/atom EA = 6 eV/atom

$$x_m = \frac{12 + 6}{2} = 9 \quad x_p = \frac{9}{2.8} = \underline{\underline{3.21}}$$

Allered Roschow scale :

$$x_{AR} = \frac{0.359 Z_{eff} \cdot e^2}{r_{cov.}^2}$$

($x \rightarrow Z_{eff.}$
 $x \rightarrow r_{cov.}$
given)

$$x_p = 0.744 + x_{AR}$$

$$e = 1.6 \times 10^{-19} C.$$

$r_{cov.}$ = Covalent
radius

ELECTRONEGATIVITY SCALE

$$X_p = \frac{\text{Ionisation Potential} + \text{Electron Affinity}}{5.6}$$

If ionisation potential and electron affinity are given in K.cal/mole then

$$X_p = \frac{\text{Ionisation Potential} + \text{Electron Affinity}}{2 \times 62.5}$$

FACTORS AFFECTING ELECTRONEGATIVITY

(A) Effective nuclear charge (Z_{eff})

$$\text{Electronegativity} \propto Z_{\text{eff}}$$

→ on going left to right
 Z_{eff} . increases.

Ex. N < O < F

(B) Atomic size

$$E_N \propto \frac{1}{\text{period} \wedge 10}$$

Ex. F > Cl > Br > I

(C) For ions

✓

$$\text{Electronegativity} \propto Z_{\text{eff}} \propto \frac{\text{positive charge}}{\text{negative charge}}$$

Ex. $\text{Mn}^{+2} < \text{Mn}^{+4} < \text{Mn}^{+7}$

$\text{O}^{-2} < \text{O}^{-1} < \text{O} < \text{O}^{+1} < \text{O}^{+2}$

$\text{Fe} < \text{Fe}^{+2} < \text{Fe}^{+3}$

on going top to EN decreases

- ✓ Exception
- ✓ 4th - 14th

$E_N (\text{Ga}) > E_N (\text{Al})$

$E_N (\text{6th}) > E_N (\text{5th})$

↓
Period

↓
Period

TABLE

DESCRIPTION OF PERIOD SUBSHELL

(C)

% s - character

Electronegativity \propto %s - Character of Hybridised atom

TABLE

EN \propto % s-character.

Hybridisation

• SN (Steric No.) = No of σ -bond + Lone pair

S.N	Hybridisation	% s character
2	SP	$= \frac{1}{2} \times 100 = 50\%$.
3	SP ²	$= \frac{1}{3} \times 100 = 33.3\%$.
4	SP ³	$= \frac{1}{4} \times 100 = 25\%$.
5	SP ³ d	$= \frac{1}{5} \times 100 = 20\%$.
6	SP ³ d ²	$= \frac{1}{6} \times 100 = 16.6\%$.