

18-1-29

Periodic Properties

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- Periodic table gives the complete information regarding all elements.

7 period (row)

18 group (column)

	s	d	p	
1	H			
2	Li			He
3	Na	Mg		Ne
4	K	Ca		Ar
5			... 1st row	
6			2nd row	
7			Lanthanoid Actinoid	

(4)

lanthanoid

(4)

actinoid

f

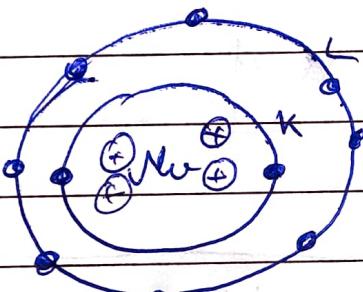
Periodic properties :-

- Ionic size
- Ionization energy
- Electron affinity
- Electronegativity

Effective nuclear charge (Z_{eff}) :-

$$Z_{eff} = [\text{Attraction between nuclear & } e^-] - [\text{Repulsion between } e^-]$$

$\Rightarrow Z_{eff} = \text{Nuclear charge} - \text{screening effect.}$



$Nu \leftarrow e^- \leftarrow e^-$

$\Rightarrow Nu \leftarrow e^- \rightarrow e^- e^-$



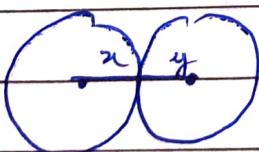
Atomic radius

metallic radius

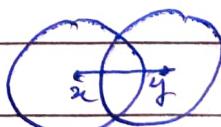
covalent radius

Vanderwaal's radius

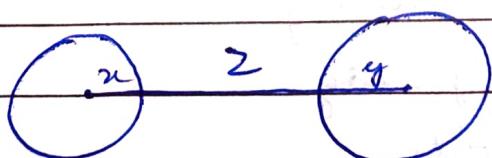
Example of screening/shielding effect.



$x+y = \text{metallic radius}$



$x+y = \text{covalent radius}$



$x+y+z = \text{vanderwaal's radius}$

$R_N > R_M > R_C$

Stability order



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→ Atomic size

- decrease along period
- increase along group
- It depends on following factors
- 1- Effective nuclear charge (Z_{eff})

decrease

increase

$$\text{Atomic size} \propto \frac{1}{Z_{eff}}$$

- 2- Electronic configuration:-

Atomic size depends on half filled & full filled configuration.

$$\begin{array}{c} \text{Ex - } N > C > O \\ \quad \quad \quad 2p^3 \quad 2p^2 \quad 2p^4 \end{array}$$

Similarly, $C_N \approx Mn$ (size)
 $\& Co \approx Zn$ (size)

- 3- Inners transition elements -

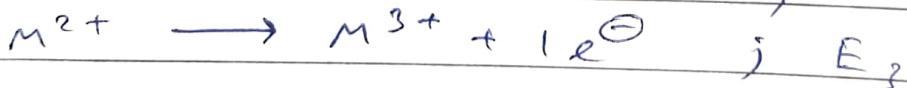
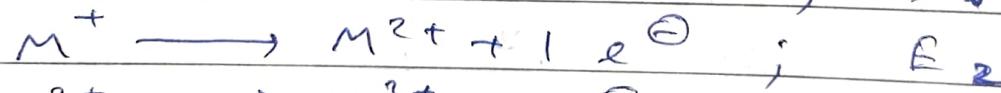
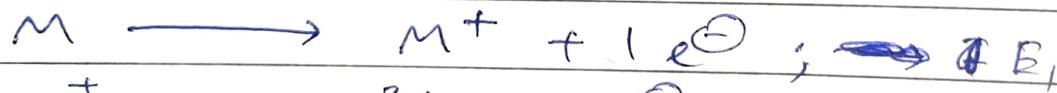
In lanthanoid & actinoid series, the size

progressively increases from La to Ce & Ac to Es.

This is called lanthanoid contraction & actinoid contraction.

→ Ionization energy/enthalpy :-

- It is the amount of energy required to remove an electron from the outermost shell of a neutral-isolated atom.
- It is always an endothermic process.
- When heat is measured at a constant pressure, it is called enthalpy.



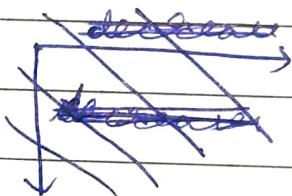
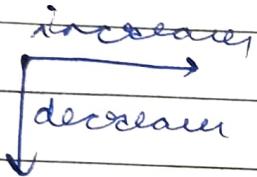
$$E_3 > E_2 > E_1$$

↳ bcz M^{2+} is more e^- deficient than M^+ .

- general trend :-

along the period \rightarrow I.E. increases

" " group I.E. decreases



- different factors impacting I.E. :-

- (i) effective nuclear charge \propto I.E. & Z_{eff}
- ~~(ii)~~ electronic configuration
- ~~(iii)~~ size of atom \rightarrow I.E. $\propto \frac{1}{\text{size}}$

$$\hookrightarrow s > p > d > f \rightarrow (\text{I.E.})$$

- (iv) Principal quantum number
- ~~(v)~~ $\hookrightarrow K > L > M > N$ (size increases)

(v) screening / shielding effect

$$\hookrightarrow \text{screening effect of size} \propto \frac{1}{\text{I.E.}}$$

(vi) energy of orbital $gsm e^\ominus$

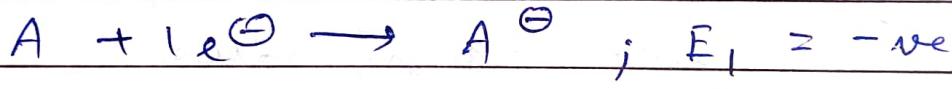
$$\hookrightarrow s > p > d > f$$

(vi) half filled & fully filled orbital stability

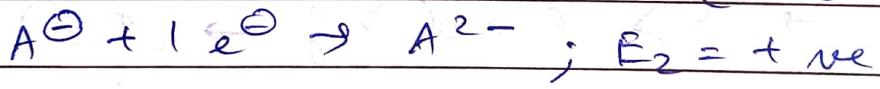
~~IE & stability~~

DE & stability of e^- configuration

→ electron affinity :-



(exothermic)



(endothermic)

Energy required to add an extra e^- to the neutral atom.

factors :-

← ~~size~~

1 - size \rightarrow ~~EA~~ $\propto \frac{1}{\text{size}}$

2 - ~~size~~ \rightarrow EA \propto nuclear charge (Z_{eff})

~~size~~

3 - Electronic configuration - stability

~~Stability~~

- important observations along group: -

Alkalimetale \rightarrow down the group \rightarrow decrease
 II A & II B \rightarrow zero EA value (Be & Zn)
 IIIA ~~& IVB~~ IVA \rightarrow EA value is not as expected
 on the decreasing trend down the group.

V A \rightarrow very low EA

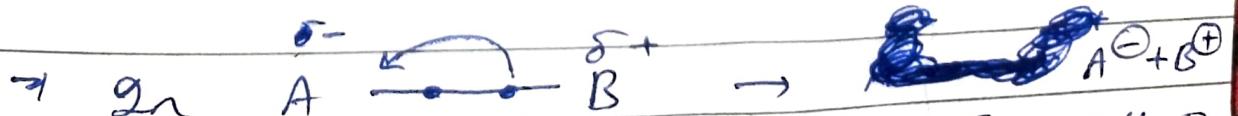
VI A \rightarrow S > 0

(Because oxygen has less size, no repulsion)

\rightarrow Electronegativity:-

~~Definition~~ The tendency of an atom to attract a shared pair of e^- .

Σ - let $\bullet EN(A) > EN(B)$



most electronegative \rightarrow Fluorine $\rightarrow EN = 4.0$
 least \rightarrow Francium $\rightarrow EN = 0.7$.

Pauling scale \rightarrow X
for EN value

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* factors :-

(i) $E_N \propto \frac{1}{\text{size}}$

(ii) IE (ionization energy)

$E_N \propto IE$

(iii) EA (electron affinity)

$E_N \propto EA$

(iv) % s-character.

$s > p > d > f$ & $sp^3 < sp^2 < sp$

$E_N \propto (\% s)$

(v) $E_N \propto$ oxidation state

(vi) $E_N \propto$ effective nuclear charge (Z_{eff})
 $\uparrow E_N \propto Z_{eff}$

(vii) $E_N \xrightarrow{\text{increase}}$ observation
↓ decrease

radius \rightarrow max \rightarrow van der waal

min \rightarrow cationic

(Fajan's rule)

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1 - Lanthanide scale :-

① types of radius

atomic radius, ionic, covalent, metallic, van der waal & radius.

E_{A-A} , $E_{B-B} \rightarrow$ intermolecular energy

$E_{A-B} \rightarrow$ denocation energy.

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

$\Delta_{A-B} \rightarrow$ ionic resonance energy

$$(\Delta_{A-B})^{\frac{1}{2}} = [E_{A-B} + (E_{A-A} \times E_{B-B})^{\frac{1}{2}}]^{\frac{1}{2}}$$

$$\therefore X_A - X_B \propto (\Delta_{A-B})^{\frac{1}{2}}$$

$$\therefore (X_A - X_B) = K \cdot (\Delta_{A-B})^{\frac{1}{2}}$$

mostly, $K = 0.182$

$$\therefore (X_A - X_B) = 0.182 \left[E_{A-B} + (E_{AA} \times E_{BB})^{\frac{1}{2}} \right]^{\frac{1}{2}}$$

2-(b)

Allred & Rochow's scale

$$(X_A)_{AR} = 0.359 \times \frac{Z_{eff}}{Z} + 0.744$$

↓
Allred & Rochow

Rochow's scale :-

$$Z_{eff} = Z - \sigma$$

↓
Attraction

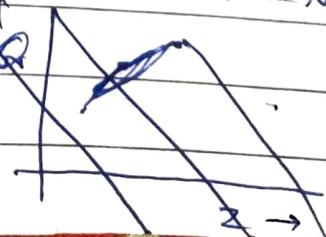
$$Z_{eff} = Z - \sigma \rightarrow \text{eff nuclear charge at periphery}$$

Z = Atomic no., σ = screening effect.

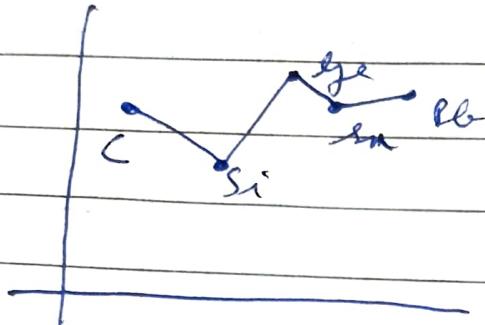
Patterns of E_n in periodic table :-

(i) E_n (group III A) > E_n (group II A)
 ↳ due to smaller atomic size
 E_n decrease down the group

(ii) group IA → alkali metal → lowest E_n
 (iii) group IV A



IVA \rightarrow $s^2 p^2$



$Ge > Pb > C > Sn > Si$

these abnormal

descendents

in $Ge \rightarrow$ d orbital starts filling

in $Pb \rightarrow$ f orbital "

hence Ge has higher EN & Pb has such abnormal size.

~~Bond angle :-~~

(i) variation

in bond angle :-

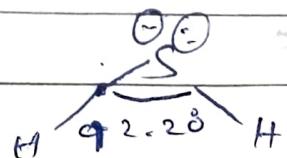
H_2O bond angle (H_2O) = ~~104.50~~

" " (H_2S) = 92.20

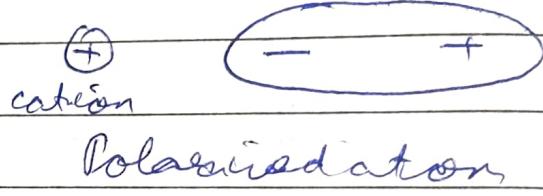
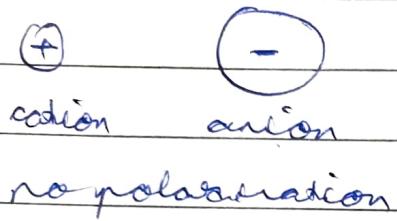
This is due to $X_O = 3.5$ & $X_S = 2.5$.
(& size of sulphur)

also due to VSEPR \rightarrow LP-LP > LP-BP > BP-BP

$CH_4 \rightarrow 109.28^\circ$ (BP-BP \rightarrow no repulsion)



→ Fajan's Rule → Polarising Power :-



In the presence of a cation, the anion polarises.

Based on polarising power, covalent character changes.

• Conclusion :-

(i) Polarising power $\rightarrow A^{3+} > B^{2+} > C^+$
with increase in power

Polarisation & positive charge

(ii) Polarisation & ~~size~~ /

size of cation

↳ smaller cation, bigger anion

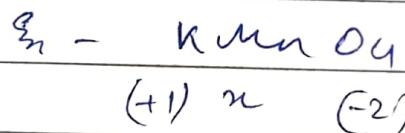
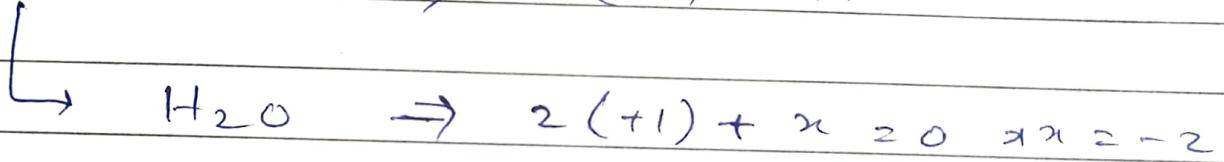
(iii)

~~• •~~ Polarization & I

noble gas configuration

→ oxidation state :-

$$\text{OS}(\text{O}) = -2, \text{ OS}(\text{H}) = +1$$



$$+1 + x + 4(-2) = 0$$

$$x = 8 - 1 = +7 \quad \text{so } \text{OS}(\text{Mn}) = +7$$

- ~~OS~~ increases down the group :-