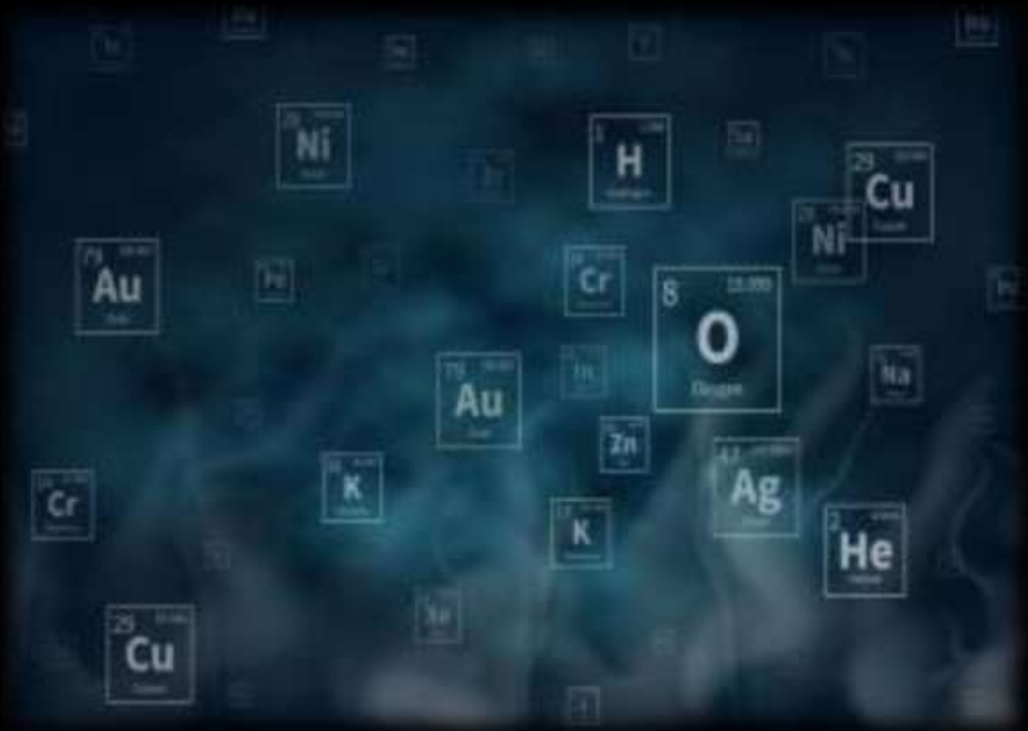
ARJUNA NEET BATCH

Classification of Elements & Periodicity in Properties



LECTURE-06

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Quick Revision:

(1) Ionic Radius

Cationic

$r_{atom} > r_{cation}$

Anionic

$r_{anion} > r_{atom}$

$$\text{size} \propto \frac{-\text{ve charge}}{+\text{ve charge}}$$

$$\boxed{r_{anion} > r_{atom} > r_{cation}}$$

② Ionisation Energy

$$\boxed{I.E \propto Z_{eff.} \propto \frac{1}{size}}$$

$$X(g) \longrightarrow X^+(g) + e^-$$

$\Delta H_{ionisation}$ ↓ +ve (endothermic)

→ size ↓, $Z_{eff.}$ ↑, I.E ↑

↓ size ↑, I.E ↓

Objective of today's class

Periodic Trends: Electron Gain Enthalpy

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Electron Gain Enthalpy

- **Electron Gain Enthalpy:** (E.G.E) It is the enthalpy change when an e^- is added to an isolated (non-bonded) neutral gaseous atom to convert it into anion.

$$X(g) + e^- \longrightarrow X^-(g)$$

[ΔH_{eg} = endothermic (+ve) or exothermic (−ve)]

- **Electron Affinity:** (E.A.) It is the amount of energy released when an e^- is added to the outermost shell in an isolated neutral gaseous atom.

E.A. = −ve (exothermic)

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Successive Electron Gain Enthalpy:

$[\Delta H_{eg_1} = -ve]$ $X(g) + e^- \longrightarrow X^-(g)$

addition of 1^{st} e^- → is generally exothermic (except stable E.C.)

$[\Delta H_{eg_2} = +ve]$ $X^-(g) + e^- \longrightarrow X^{2-}(g)$

addition of 2^{nd} e^- is always an endothermic process.

because when an e^- is added in an anion; inter-e^- repulsion ↑

Example:

^8O : 2, 6 $\qquad O^{2-}$: 2, 8 → Ne config^n

[Inter e$^-$ rep^n outweighs the stability of noble gas config^n]

Step 1: $O(g) + e^- \longrightarrow \cancel{O^-}(g)$ → $\Delta H_{eg(1)} = -141$ kJ/mol (exothermic)

+

Step 2: $\cancel{O^-}(g) + e^- \longrightarrow O^{2-}(g)$ $\quad \Delta H_{eg(2)} = +744$ kJ/mol (endothermic)

Overall rx^n: $O(g) + 2e^- \longrightarrow O^{2-}(g)$ $\quad \Delta H_{eg}(\text{overall}) = +603$ kJ/mol

→ Endothermic

O : size : very small

Add^n of 2nd e$^-$ increases inter-electronic repulsion.

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Important Points

- Formation of polynegative anion like O^{2-}, N^{3-}, C^{4-} etc. is always an endothermic process. → inter e⁻ repulsion : high

  oxide nitride carbide

  $[\Delta H_{eg} = +ve]$

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

$$X(g) + e^- \underset{\text{Ionisation energy}}{\overset{\text{Electron Affinity}}{\rightleftharpoons}} X^-(g)$$

{E.A. of X = I.E. of X^-}

- I.E. of neutral atom is equal to electron affinity of its cation.

$$X(g) \underset{\text{Electron Affinity}}{\overset{\text{Ionisation Energy}}{\rightleftharpoons}} X^+(g) + e^-$$

{I.E. of X = E.A. of X^+}

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❖ Factors affecting the Electron gain enthalpy:

(i) **Atomic size :** Electron gain enthalpy is inversely proportional to the atomic size. Generally smaller the size higher will be the electron gain enthalpy.

$$\uparrow \boxed{E.A \propto \frac{1}{\text{size}}} \downarrow$$

(ii) Effective Nuclear charge : Higher the effective nuclear charge, higher will be negative electron gain enthalpy.

$$\boxed{E.A \propto Z_{eff.}}$$

(iii) Screening Effect : Higher the screening effect, lower will be effective nuclear charge and hence lower will be negative electron gain enthalpy.

$$\downarrow \boxed{E.A \propto \frac{1}{\text{Screening effect}}} \uparrow$$

(iv) Electronic configuration : Half filled and fully filled electronic configuration is extra stable, so addition of an electron to that system is difficult and electron gain enthalpy is zero or positive.

[Extra Stable] Half-filled E.C. $\rightarrow p^3/d^5/f^7$ } fully-filled E.C. $\rightarrow p^6/d^{10}/f^{14}$

e.g. 1 $\boxed{E.A.}$ $\boxed{np^2 > np^3}$

$np^2 \xrightarrow{+1e^-} np^3$; $np^3 \xrightarrow{+1e^-} np^4$

{for noble gases; E.A. = 0}

2 $\boxed{E.A.}$ $\boxed{ns^1 > ns^2}$

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❖ Trend of electron affinity in group & period:

In a period, as size ↓ses & Z_{eff} ↑ses, E.A. generally ↑ses

2nd period :	$_3Li$	$_4Be$	$_5B$	$_6C$	$_7N$	$_8O$	$_9F$	$_{10}Ne$
	$1s^2 2s^1$	$2s^2$	$2s^2 2p^1$	$2s^2 2p^2$	$2s^2 2p^3$	$2s^2 2p^4$	$2s^2 2p^5$	$2s^2 2p^6$
E.G.E	−ve	+ve	−ve	−ve	+ve	−ve	−ve	+ve
(KJ/mol)	−60	+66	−15	−122	+31	−141	−328	+116

Imp. $\boxed{\underbrace{Ne < Be < N}_{\text{endothermic}} < B < Li < C < O < F}$ −ve E.G.E

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In a group,

E.A. generally ↓ses

$O + e^- \longrightarrow O^-$ ($\Delta H_{eg} = -141$ kJ/mol)

$S + e^- \longrightarrow S^-$ ($\Delta H_{eg} = -200$ kJ/mol)

(Small size) → inter e⁻ repⁿ ↑

$\boxed{-\text{ve sign}}$ → shows that process is exothermic (i.e. energy is released)

Group →

1	2	13	14	15	16	17	18
H −73							He +48
Li −60	Be +66	B −15	C −122	N +31	O −141	F −328	Ne +116
Na −53	Values of $\Delta_{eg}H$ in kJ/mol				S −200	Cl −349	Ar +96
K −48					Se −195	Br −325	Kr +96
Rb −47					Te −190	I −295	Xe +77
Cs −46					Po −174	At −270	Rn +68

Q1. Why electron gain enthalpy of chlorine is more negative than Fluorine?

(Imp)

$_9F + e^- \longrightarrow F^-$ $\quad \Delta H_{eg}$ $(-328\ KJ/mol)$

$1s^2 2s^2 2p^5$

$\boxed{Cl : \text{max. E.A.}}$

$_{17}Cl + e^- \longrightarrow Cl^-$ $(-349\ KJ/mol)$

$1s^2 2s^2 2p^6 3s^2 3p^5$

Due to small size of fluorine, the incoming e^- faces higher inter e^- repulsion than Cl & $\therefore$ energy released is less in case of F^-.

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Q2. Explain why?

$O + e^- \rightarrow O^- + \text{Energy}$; $\Delta H = -ve$ (exothermic)

$O^- + e^- \rightarrow O^{-2}$; $\Delta H = +ve$ (endothermic)

Due to small size of 'O', when 2^{nd} e^- is added inter e^- repulsion $\uparrow$ses & the process becomes endothermic.

Exceptions:

1. E.A of Cl > F > Br > I

F : small size
: inter e^- rep^n ↑

2. E.A of S > O > P > N

3. E.A of Si > C > P > N

C : $1s^2 2s^2 2p^2$
✓ Si : $1s^2 2s^2 2p^6 3s^2 3p^2$

Note : N & P have low E.A. due to stable half-filled E.C.

Questions

Q3. Which of the following element has highest electron affinity?

(1) O
(2) S
(3) Se
(4) Te

Q4. Which of the following is correct about Noble gas?

(1) Low electron affinity

(2) Only small atomic number

(3) Small atomic radius in the period

(4) Low ionisation potential in the period

→ High

Q5. Which of the following has highest electron affinity?

(1) Na (2) Li

(3) K (4) Rb

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(endo)

Q6. Electron gain enthalpy will be positive, when

(1) O^{-2} is formed from O^{-1}

(2) O^{-1} is formed from O

(3) S^{-1} is formed from S

(4) Na^{-} is formed from Na

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

$O + e^- \longrightarrow O^-$

$S + e^- \longrightarrow S^-$

$Na + e^- \longrightarrow Na^-$

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Q7. Element of which atomic number has highest electron affinity:-

(1) 35 : Br

(2) 17 : Cl

(3) 9 : F

(4) 53 : I

Thank You