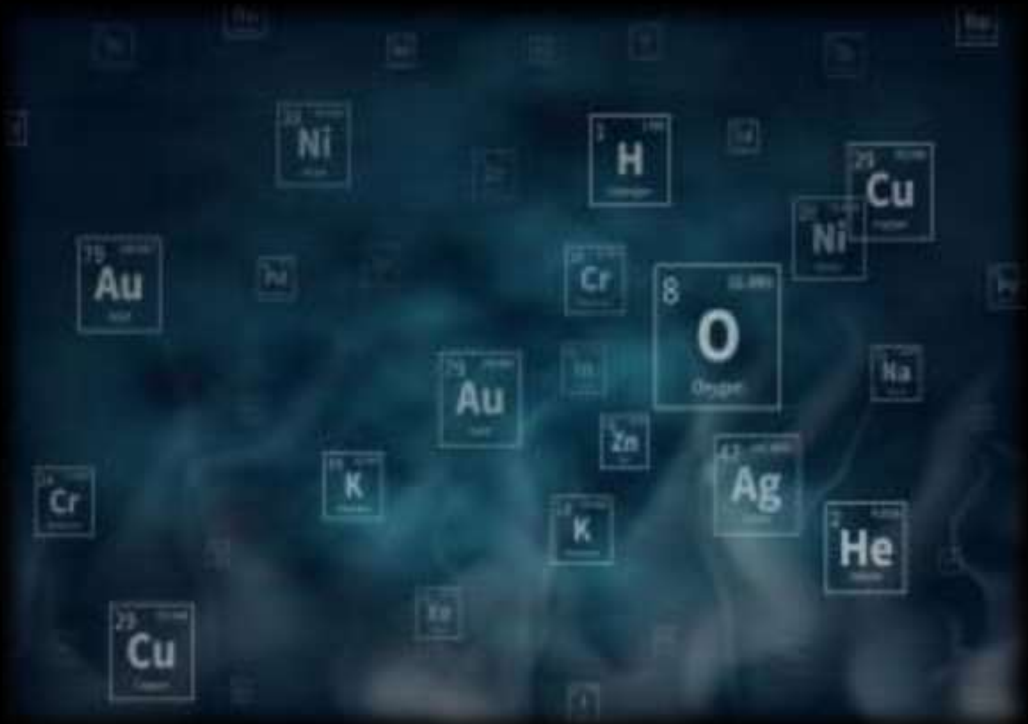
ARJUNA NEET BATCH

Classification of Elements & Periodicity in Properties



LECTURE-07

By:- Ashima Gupta

Quick Revision:

E.G.E : ΔH_{eg} = +ve / −ve

+ve → (endothermic)

−ve → (exothermic)

$1^{st}\ e^-$ → −ve (add)

$2^{nd}\ e^-$ → +ve (endo) (add)

E.A. −ve → exothermic

$O + 2e^- \longrightarrow O^{2-}$ (overall endothermic)

PERIOD → E.A. ↑ (generally)

GROUP ↓ E.A. ↓

Exceptions :

O < S (E.A.)

F < Cl

N < P

C < Si

2nd P : Li Be B C N O F Ne

E.G.E : +ve (Be) +ve (N) +ve (Ne)

Objective of today's class

Periodic Trends: Electronegativity

Electronegativity

- **Electronegativity:** It is the tendency of an atom to attract the shared pair of electrons towards itself in a covalently bonded molecule.

e.g. (1) $A \rightarrow B$ [B is more electro-ve than A]

$\overset{\delta+}{A} \quad B^{\delta-}$

A : B ($\delta \rightarrow$ delta)

A :B ($\downarrow$ partial)

(2) $H \rightarrow F$

2.1 4.0

$\Rightarrow \overset{\delta+}{H} - F^{\delta-}$ $\rightarrow$ (Polar Covalent Bond)

(3) $F \times F$ $\rightarrow$ (non-polar covalent bond)

4.0 4.0

ARJUN

❖ Factors affecting the Electronegativity:

(i) Atomic size :

$$\boxed{\text{Electro-vity} \propto \frac{1}{\text{size}}}$$

(ii) Effective Nuclear charge :

$$\boxed{\text{Electro-vity} \propto Z_{eff}}$$

(iii) Hybridisation :

↳ mixing of orbitals with slightly diff. energies to give a new set of orbitals with equal energy.

e.g.

Carbon : (Hybridisation)	sp^3	sp^2	sp
% s-character :	25%	33.33%	50%

Electro-vity : $sp^3 < sp^2 < sp$

$$\boxed{\text{Electro-vity} \propto \%\ \text{s-char.}}$$

Pauling Scale:

H 2.1						
Li 1.0	Be 1.5	B 2.0	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

$$\boxed{\underset{4.0}{F} > \underset{3.5}{O} > \underset{3.0}{N} = \underset{3.0}{Cl}}$$

ARJUN

Important Points:

Down the group, electronegativity ↓ses

Across the period, electro-vity ↑ses

Li
Na
K
Rb
Cs
Fr

- ❖ Electronegativity of Cs & Fr are equal. [Effect of nuclear charge balance the increase in shell]

V. Imp.

- ❖ Electronegativity of F > Cl but electron affinity of Cl > F. → (FAQ)

  4.0 3.0

- ❖ Electronegativity of Ga > Al (Due to Transition contraction)

Size Al > Ga

Electro-vity <

ARJUN

(for school)

Q. Differentiate between electron gain enthalpy and electronegativity.

Electronegativity	Electron Gain Enthalpy
(1) Tendency of an atom to attract the shared pair of e's towards itself.	Amount of enthalpy change when an e^- is added to an isolated neutral gaseous atom.
(2) Not an energetic term	Energetic term
(3) Unit: No unit	KJ/mol or Kcal/mol or eV/atom
(4) Bonded atoms	Non-bonded atom
(5) Group: Electro-vity $\downarrow$, Period: Electro-vity $\uparrow$	Irregular trend due to stability of Electronic config^n.

Electronegativity Scales:

1. Mulliken Scale:

$$\boxed{\text{Electronegativity} = \frac{I.P. + E.A.}{2}}$$

$\{1\,eV = 1.6 \times 10^{-19}\,J\}$

Both I.P (Ionisation Potential) & E.A (Electron Affinity) should be in eV unit

2. Pauling Scale:

Linus Pauling developed a method to calculate the relative electro-vity of an element.

$$\boxed{\chi_A - \chi_B = 0.101\sqrt{\Delta E}}$$

$\chi_A \rightarrow$ electro-vity of element A

$\chi_B \rightarrow$ " " " B

ΔE : Change in bond enthalpy (KJ/mol)

$$\Delta E = \left| \text{Bond energy of } A-B - \sqrt{\text{B.E of } A-A \times \text{B.E. of } B-B} \right|$$

Relation between Pauling Scale & Mulliken Scale:

The value of electro-vity in Mulliken Scale is 2.8 times higher than the value of Pauling Scale.

$$\boxed{M.S. = 2.8 \text{ times of value of } P.S.}$$

3. Allred Rochow's Electronegativity:

effective nuclear charge

$$\boxed{\text{Electronegativity} = \frac{0.359 \times Z_{eff}}{r^2} + 0.744}$$

distance.

Questions

Q1. What is the correct order of electronegativity?

(i.) $Cl > S > P > Si$

(ii.) $Si > Al > Mg > Na$

(iii.) $F > Cl > Br > I$

(iv.) All of these

Q2. Electronegativity scale of Pauling is based on

(i) Bond length

(ii) Bond energy

(iii.) Atomic radius

(iv) Covalent radius

${}_9F : 1s^2 2s^2 2p^5$

Q3. Outermost electronic Configuration of the most electro-ve element is

(i.) ns^2np^3 (ii) ns^2np^4 (iii) ns^2 (iv.) ns^2np^5

Q4. Arrange the following elements in ↑sing order of electro-vity:

(i.) F, Cl, Br, I : I < Br < Cl < F

(ii) Cl, O, F, I, Cs : Cs < I < Cl < O < F

(iii.) Mg, P, S, Al : Mg < Al < P < S

Applications of Electronegativity:

1. Metallic & Non-Metallic character

$$\uparrow \boxed{\text{Non-metallic char} \propto \text{Electro-vity} \uparrow}$$

2. Bond energy

$$\boxed{\text{Bond Energy} \propto \text{Electro-vity difference}}$$

eg. HF, HCl, HBr, HI $\downarrow$ B.E. $\downarrow$

3. Bond polarity

$$\boxed{\text{Bond Polarity} \propto \text{Electro-vity difference}}$$

e.g. HF > HCl > HBr > HI

4. Stevenson-Schomaker equation

$$\boxed{d_{A-B} = r_A + r_B - 0.09\,(x_A - x_B)}$$

x_B → Electro-vity (B)

x_A → Electro-vity (A)

Valency:

→ It is the combining capacity of an element.

Valency w.r.t. Hydrogen

	NaH	MgH_2	AlH_3	SiH_4	PH_3	H_2S	HCl
Valency =	1	2	3	4	3	2	1

PH_3 → phosphine

Valency w.r.t. Oxygen

	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl_2O_7
Valency :	1	2	3	4	5		

$2 \times x - 10 = 0$

$2x = 10$

$x = 5$

$x - 2 \times 3 = 6$

$x = 6$

$x \times 2 - 2 \times 7 = 0$

$2x - 14 = 0$

$x = 7$

Anomalous properties of second period elements:

The first element of each of the groups 1 (lithium) and 2 (beryllium) and group 13–17 (boron to fluorine) differs in many respect from the other members of their respective groups.

Period 2: Li ($1s^2 2s^1$) Be ($1s^2 2s^2$) B ($1s^2 2s^2 2p^1$) C ($2p^2$) N ($2p^3$) O ($2p^4$) F ($2p^5$)

Reason: of anomalous behaviour

1. due to small size
2. due to high I.E.
3. due to high electro-vity
4. absence of vacant d-orbitals.

2nd period : Li Be B C

3rd period : Na Mg Al Si

$Li \rightarrow Mg$ $Be \rightarrow Al$ $B \rightarrow Si$ { diagonal relationship }

$\Downarrow$

due to similar

$\text{Ionic potential } (\phi) = \dfrac{\text{Charge}}{\text{Size}}$

KNOWLEDGE CLOUD

1. Most Electro +ve element (non-radioactive) → Caesium (Cs)
2. Most electro -ve element → Fluorine (F)
3. Max. Electron Affinity → Cl
4. Dense metals → Os, Ir
5. Smallest non-metal → Hydrogen
6. Li is stored in paraffin wax
7. Na & K stored in Kerosene oil.
8. Phosphorous is stored in Water (non-metal)
9. Ga & Cs → melt when kept on palm
10. Hg & Br → Liquid elements at room temp. (25°C)

Thank You