PERIODIC TABLE, PERIODIC PROPERTIES AND VARIATION OF PROPERTIES

- Periodic table may be defined as a table which classifies all the known elements in accordance with their properties in such a way that elements with similar properties are grouped together in the same vertical columns and dissimilar elements are separated from one another.

HISTORICAL BACKGROUND

DOBEREINER TRIADS:

The elements were grouped in groups of three with similar properties such that the atomic weight of the middle element was the arithmetic mean of the other two.

NEWLANDS 'LAW OF OCTAVES':

When the elements are ~~arranged~~ in increasing order of their atomic weights, every 8th element beginning from any element resembles the first element in its physical and chemical properties.

MENDELEEV'S PERIODIC LAW:

The properties of the elements are the periodic functions of their atomic masses.

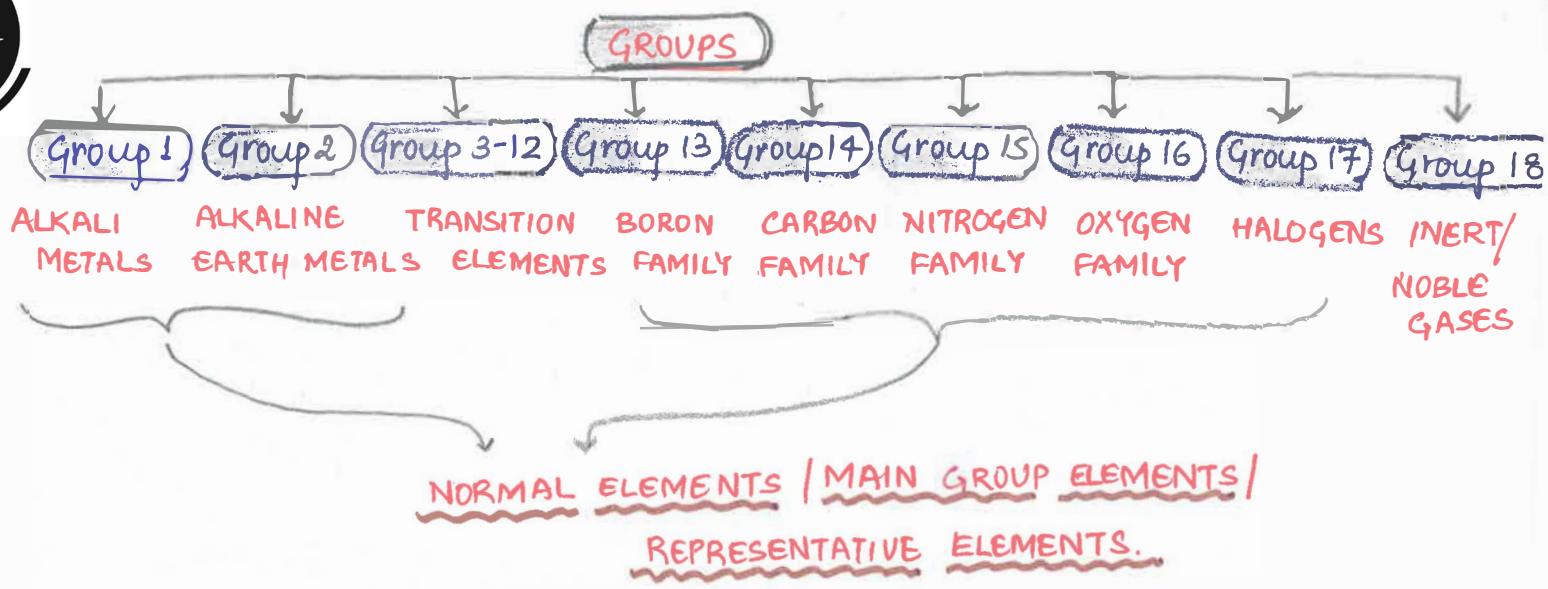
- This method could not explain the properties of certain elements, the rare earth metals and the isotopes.

MOSELEY'S : MODERN PERIODIC LAW :

The physical and chemical properties of the elements are the periodic functions of their atomic numbers.

MODERN PERIODIC TABLE:

Modern periodic table has 18 vertical columns. The vertical columns are known as 'groups' arranged from left to right in the order of increasing atomic numbers.



PERIODS : There are seven horizontal rows in the modern periodic table. They are known as 'periods'.

- The number of shells present in an atom determines its period.

PERIOD NO	TYPE	NO. OF ELEMENTS	ATOMIC NUMBER	
1	SHORTEST	2	1 and 2	→ [illegible]
2	SHORT	8	3 to 10	→ [illegible]
3	SHORT	8	11 to 18	
4.	LONG	18	19 to 36	
5.	LONG	18	37 to 54	
6.	LONGEST	32	55 to 86	→ LANTHANIDES (Rare Earth Elements)
7.	LONGEST		87 to	→ ACTINIDES (Radioactive elements)

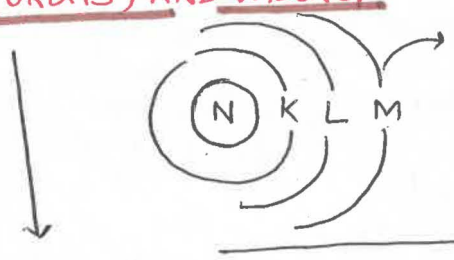
Lanthanides and Actinides → Inner Transition Elements

PERIODICITY:

The properties that reappear at regular intervals or in which there is a gradual variation at regular intervals are called 'periodic properties' and the phenomenon is called 'periodicity of elements'

- The cause of periodicity is the recurrence of similar electronic configuration

- **SHELLS (ORBITS) AND VALENCY:**



→ Definite circular paths in which electrons revolve around the Nucleus = ORBITS

Down the group
No of shells /orbits ↑
and is equal to the number of the period to which that element belongs

→ Along the period / Across the period, the number of shells remains the same.

VALENCY: Valency denotes the combining capacity of ~~the~~ an element.
It is equal to the number of electrons an atom can donate or accept.

Across the Period: valency increases upto Group 14 where it becomes 4 and then it decreases in Group 17, it becomes 1.

↓ Down the Group: valency remains the same

PERIODIC PROPERTIES

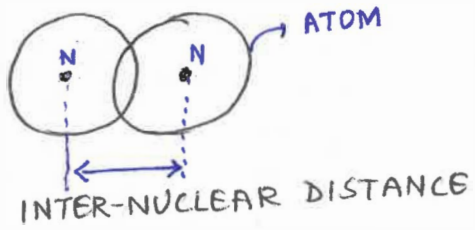
The properties which are directly or indirectly related to their electronic configuration and which shows a regular gradation when we move from left to right in a period or from top to bottom in the group. are called as 'Periodic properties'.

Periodic Properties

- Atomic size / Atomic radius
- Metallic and Non-metallic character
- Ionisation Potential
- Electron affinity
- Electronegativity

I) ATOMIC RADIUS:

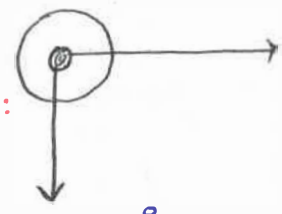
It is the distance between the centre of the nucleus of an atom and its outermost shell.



$$\text{At. radius} = \frac{1}{2}(\text{Internuclear distance})$$

Unit: $1\ A^\circ = 10^{-10}\ m$

$1\ pm = 10^{-12}\ m$



Down the Group:

- No. of shells ↑

thereby increasing the atomic radius due to ↑ in the distance of the outermost shell.

Across the Period:

Atomic radius decreases as we move from left to right in a period due to the increase in the effective Nuclear charge.

IONIC RADIUS: The effective distance from the centre of the nucleus of the ion upto which its exerts its influence on its electronic cloud.

Anion > Parent atom > cation

- **ISOELECTRONIC SPECIES:** The ions having the same number of electrons are called Isoelectronic species.

$$\text{size} \propto \frac{1}{\text{Nuclear charge}}$$

II) METALLIC CHARACTER:

Those elements, which have a tendency to lose their valence electrons and form a positive ion are called metals.

- Metallic character depends on: (i) Atomic size (ii) Nuclear charge

$$\text{Atomic size} \propto \text{Metallic character}$$

$$\text{Nuclear charge} \propto \frac{1}{\text{Metallic character}}$$

ACROSS THE PERIOD:

- ATOMIC RADIUS DECREASES
- NUCLEAR PULL INCREASES
- METALLIC NATURE DECREASES.

DOWN THE GROUP

- ATOMIC RADIUS INCREASES
- TENDENCY TO LOSE ELECTRONS INCREASES
- METALLIC CHARACTER INCREASES

METALS ARE GOOD REDUCING AGENTS AS THEY HAVE A GREATER TENDENCY TO LOSE e^-

Li Be | B | C N O F

Li, Be — METALS; B — METALLOID; C, N, O, F — NON-METALS

(III) **NON-METALLIC CHARACTER** Those elements which have a tendency to gain electrons, in order to attain octet in their outermost orbit, are considered as Non-metals.

- NON METALLIC CHARACTER DEPENDS ON: (i) Atomic size (ii) Nuclear charge

- Atomic size $\propto \frac{1}{\text{Non-metallic character}}$

Nuclear charge $\propto$ Non-metallic character

NON-METALS ARE GOOD OXIDISING AGENTS AS THEY HAVE A GREATER TENDENCY TO ACCEPT ELECTRONS

C - NON METAL

Si, Ge — METALLOID

Sn, Pb — METAL

ACROSS THE PERIOD

- ATOMIC SIZE ↓
- NUCLEAR PULL ↑
- NON-METALLIC CHARACTER ↑

DOWN THE GROUP

- ATOMIC SIZE ↑
- NUCLEAR CHARGE ↑
- NON-METALLIC CHARACTER ↓

Na < Mg < Al < Si < P < S < Cl

Na, Mg, Al — METALS; Si — METALLOID; P, S, Cl — NON-METALS

- **NATURE OF OXIDES:**

ACROSS THE PERIOD

Acidic Nature of oxides increases on moving from left to right in a period

DOWN THE GROUP

Basic Nature of oxides increases on moving down the group

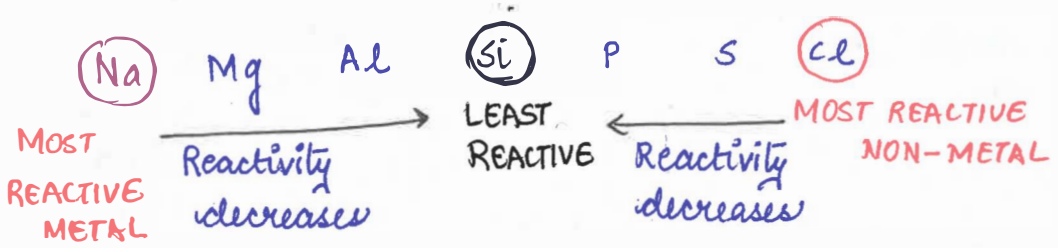
Na_2O MgO Al_2O_3 SiO_2 P_2O_5 SO_3 Cl_2O_7

↑ IN ACIDIC NATURE OF OXIDES

Na_2O, MgO — BASIC; Al_2O_3 — AMPHOTERIC; SiO_2, P_2O_5, SO_3, Cl_2O_7 — ACIDIC

CHEMICAL REACTIVITY :

Greater the tendency to lose / gain electron $\propto$ Chemical reactivity



- As we move down the group, tendency to lose electrons increases therefore, reactivity increases on moving down the group. Fr is the most reactive metal
- The chemical reactivity of non-metals decreases on moving down the group. Fluorine is most reactive non-metal

- **GRADATION IN PHYSICAL PROPERTIES :**

⇒ **MELTING AND BOILING POINTS :**

METALS - mpt and b.pt decrease on going down the group

NON-METALS - mpt and bpt increase on going down the group

- Across a period, left to right mpt and bpt usually increase upto group 14 and then decrease.

⇒ **DENSITY :** Down a group : Density ↑

Across a period; density gradually increases to maximum and then decrease slightly.

IONISATION POTENTIAL OR IONISATION ENERGY OR IONISATION ENTHALPY

The energy required to remove an electron from a neutral gaseous isolated atom and convert it into a positively charged gaseous ion is called ionisation potential (I.P), ionisation energy (I.E)

$$M_{(g)} + I.E \longrightarrow M^+_{(g)} + e^-$$

UNIT : eV/atom
KJ/mol

I.E depends on: (i) Atomic size (ii) Nuclear charge

Atomic size $\propto \frac{1}{I.E}$ Nuclear charge $\propto$ I.E

DOWN A GROUP

I.E ↓ as atomic size increases

- Metals usually have low I.E

ACROSS A PERIOD

I.E ↑ as atomic size decreases

Non-metals have high I.E

ELECTRON AFFINITY (E.A) OR ELECTRON GAIN ENTHALPY:

The amount of energy released while converting a neutral gaseous isolated atom into a negatively charged gaseous ion by the addition of electron is called Electron Affinity (E.A)

$$X_{(g)} + e^- \longrightarrow X^-_{(g)} + E.A$$

UNIT: eV/atom
KJ/mol

- Electron affinity depends on: (i) Atomic size (ii) Nuclear charge.

Atomic size $\propto \frac{1}{E.A}$

Nuclear charge $\propto$ E.A

DOWN THE GROUP

Electron affinity decreases, as the atomic size increases more than the nuclear charge

ACROSS THE PERIOD

Atomic size decreases
Nuclear charge increases
Electron affinity increases.

- EXCEPTION: IN GROUP 17, FLUORINE HAS LOWER ELECTRON AFFINITY THAN CHLORINE.

Cl > F

IN GROUP 16, OXYGEN HAS LOWER E.A THAN SULPHUR

S > O

- INERT GASES HAVE +VE VALUES OF E.A/ZERO ELECTRON AFFINITY

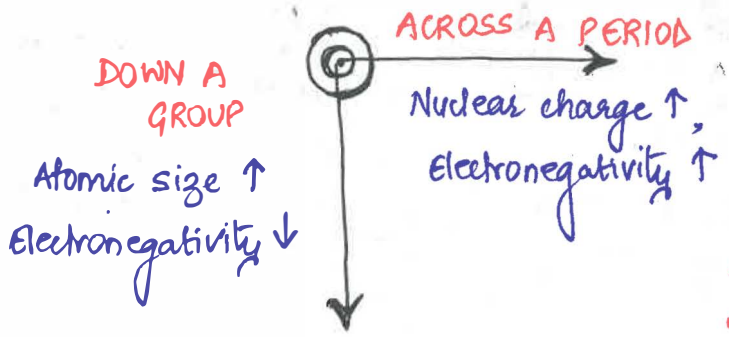
ELECTRONEGATIVITY

The tendency of an atom in a molecule to attract the shared pair of electrons towards itself is called its electronegativity.

- Dimensionless property.
- Electronegativity values depends on: (i) Atomic size (ii) Nuclear charge.

Atomic size $\propto \frac{1}{\text{Electronegativity}}$

Electronegativity $\propto$ Nuclear charge



- Metals show lower electronegativity as compared to Non-metals.
- Metals are electropositive
- Non-metals are electronegative

DIAGONAL RELATIONSHIP:

Properties which have increasing trend in a group, generally have decreasing trend in a period.

- Elements of the second period shows resemblance in properties with the elements of the third period, present at right diagonal of the element. This is called as 'DIAGONAL RELATIONSHIPS'

GROUP →	1	2	13	14	
PERIOD 2 →	Li	Be	B	C	BRIDGE ELEMENT
PERIOD 3 →	Na	Mg	Al	Si	

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