# CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

## *EARLIER CLASSIFICATION*

- **Dobereiner – Law of Triads**
  - Group of three elements and the middlth element has the average **atomic weight** of remaining two elements
- **Chancourtois – Cylindrical Or Helix –** Based on **atomic weight**
- **Newland – Law of Octaves**
  -Arranged in the increasing order of **atomic weight** and noticed that **"eighth element is similar with first element in properties"**
- **Lothar Meyer – Graphical classification** on the basis of **Atomic volume**

## *MENDELEEV'S CLASSIFICATION*

- Mendeleev classified the elements in the increasing order of their **atomic weights.**
- He founded that the properties of elements repeat after a regular interval.
- Based on this observation, he proposed a periodic law is known as **"Mendeleev's periodic law or Classical periodic law"**

***"The properties of elements are the periodic functions of their atomic weights."***

Merits:

- Arranged elements in horizontal rows (periods) and vertical columns (groups)
- He left vacant places for undiscovered elements and predicted some of their properties.
  ***Eka Aluminium- Gallium***
  ***Eka silicon - Germanium***
  ***Eka boron - Scandium***
- Elements with similar properties are placed in the same group.

Demerits:

- Elements with dissimilar properties are found in same group.
- He could not give an exact position for hydrogen.
- He could not give exact position for Lanthanoids and Actinoids and also for isotopes.
- Mendeleev's periodic table did not strictly obey the increasing order atomic weight

## *MODERN CLASSIFICATION*

- Done by **Henry Moseley** through **X-ray spectral study**
- Arranged in the increasing order of **Atomic number**
- Introduced a law known as **Modern periodic law**

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

- 18 vertical columns – Groups
- 7 Horizontal rows - Periods
- 4 Blocks (s,p,d,f)

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## Nomenclature of elements with atomic number greater than 100

| Digit | Name | Symbol |
|---|---|---|
| 0 | nil | n |
| 1 | un | u |
| 2 | bi | b |
| 3 | tri | t |
| 4 | quad | q |
| 5 | pent | p |
| 6 | hex | h |
| 7 | sept | s |
| 8 | oct | o |
| 9 | enn | e |

Eg ; Name the element with atomic number also provide symbols

110, 112, 104

110 – Ununnilium(Uun)
112 – Ununbium(Uub)
104 – Unnilquadium(Unq)

## Periods

| Periods | Orbitals into which electrons are filled over previous period | Maximum electrons can accommodate in these orbitals | Number of elements | Name of the period |
|---|---|---|---|---|
| 1 | 1s | 2 | 2 | Very short |
| 2 | 2s, 2p | 8 | 8 | Short |
| 3 | 3s, 3p | 8 | 8 | Short |
| 4 | 4s, 4p, 3d | 18 | 18 | Long |
| 5 | 5s, 5p, 4d | 18 | 18 | Long |
| 6 | 6s, 6p, 5d, 4f | 32 | 32 | Monster |
| 7 | 7s, 7p, 6d, 5f | 32 | 32 | Incomplete |

## Group wise Electronic Configuration

| Group | General Electronic Configuration(GEC) | Common name of the group |
|---|---|---|
| 1 | $ns^1$ | Alkali metals |
| 2 | $ns^2$ | Alkaline earth metals |
| 13 | $ns^2np^1$ | Boron Family |
| 14 | $ns^2np^2$ | Carbon Family |
| 15 | $ns^2np^3$ | Pnictogens |
| 16 | $ns^2np^4$ | Chalcogens |
| 17 | $ns^2np^5$ | Halogens |
| 18 | $ns^2np^6$ | Noble gases/Inert Gases |

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**s-, p-, d- and f- blocks**

- **The s- and p- block** elements are called **main group elements** or **representative elements.**

*s- block elements:*

- Group-1 (Alkali metals) and Group-2 elements (Alkaline earth metals)
- Electropositive and highly reactive
- Fixed oxidation state ($1^{st}$ group +1, and $2^{nd}$ group +2)
- All are metals
- GEC is $\mathbf{ns^{1-2}}$

*p- Block elements:*

- They belongs to group- 13 to 18.
- General electronic configuration is $\mathbf{ns^2\ np^{1-6}}$
- Contains metals, non metals and metalloids
- Contains solids, liquid and gases

*d- block elements:*

- Group 3 to 12
- Also known as **Transition elements** (Gradual conversion from metallic character to nonmetallic character)
- Various oxidation state and forms coloured compounds
- Used as catalysts and forms alloys
- General electronic configuration $\mathbf{(n\text{-}1)d^{1-10}\ ns^{0-2}}$ .

*f block elements:*

- Two series

| |
|---|
| **Lanthanoids:**14 elements from $6^{th}$ period: Ce(58) – Lu(71) :Coming after Lanthanum |
| **Actinoids:** 14 elements from $7^{th}$ period: Th(90) – Lr(103) : Coming after Actinium |

- Also known as **Inner transition elements**
- Rare earth elements and radioactive elements
- Elements after Uranium is known as **Transuranium elements**
- GEC is $\mathbf{(n\text{-}2)f^{1-14}(n\text{-}1)d^{0-1}ns^2}$

***TRENDS IN PHYSICAL PROPERTIES***

**a) Atomic radius**

- **Distance from center of nucleus to outer most orbital of an atom**
- Measured in terms of Covalent radius, Ionic radius , metallic radius
- Unit $A^0$ or pm
- **Variation along a period :** Decreases from left to right *(Reason : There is no increase in number of shell but there is increase in nuclear attraction)*
- **Variation in a group :** Increases from top to bottom *(Reason : There is increase in number of shell and there is decrease in nuclear attraction)*

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| | |
|---|---|
| • *Size of cation is smaller than parental atom*<br>*As cation forms nuclear attraction increases*<br>• *As the positive charge increases size again decreases* | • *Size of anion is greater than parental atom*<br>*As anion forms nuclear attraction decreases*<br>• *As the negative charge increases size again increases* |

***Isoelectronic Species : Species having same number of electrones***

**b) Ionisation enthalpy ( $\Delta_i H$)**

- **Energy required to remove loosely bounded electron from the outer most orbital of an isolated gaseous atom**
- Positive in sign and unit is **kJ/Mol**
- Successive ionisation enthalpy is greater than previous state due to increase in nuclear attraction

*Factors affecting*

*Nuclear force of attraction*
*Shielding effect*
*Atomic size*

- **Variation along a period :** Increases from left to right *(Reason : There is increase in nuclear attraction)*
- **Variation in a group :** ~~Increases~~ Decreases from top to bottom *(Reason : There is decrease in nuclear attraction)*

- Ionisation enthalpy of **Be** is greater than **B** due to stable **full filled** configuration
- Ionisation enthalpy of **N** is greater than **O** due to stable **half filled** configuration

c) **Electron gain enthalpy ($\Delta_{eg}$ H) – Electron Affinity**

- **Energy released when an electron is added to the outermost orbital of an isolated gaseous atom**
- Negative in sign and unit is **kJ/Mol**
- Group 18 elements has positive Electron gain enthalpy due to completed octet
- *Factors affecting*

*Nuclear force of attraction*
*Shielding effect*
*Atomic size*

- **Variation along a period :** Increases from left to right *(Reason : There is increase in nuclear attraction)*
- **Variation in a group :** ~~Increase~~Decreases from top to bottom *(Reason : There is decrease in nuclear attraction)*

- Electron gain enthalpy of **O is less than S and F less than Cl** due to **electron-electron repulsion due to their extreme small size**

- *Cl has the highest electron affinity*

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d) **Electronegativity**

- **Ability of an atom to attract shared pair of electron towards it**
- Unitless
  *Factors affecting*
  *Nuclear force of attraction*
  *Shielding effect*
  *Atomic size*
- **Variation along a period :** Increases from left to right *(Reason : There is increase in nuclear attraction)*
  **Variation in a group :** ~~Increases~~ Decreases from top to bottom *(Reason : There is decrease in nuclear attraction)*
- *F has the highest electronegativity*

***TRENDS IN CHEMICAL PROPERTIES***

**a) Oxidation state or Valency**

- Along a period first increases then decreases

| Group | 1 | 2 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| Valency | 1 | 2 | 3 | 4 | 3 | 2 | 1 | 0 |

- In a group valency remains constant

**b) Anomalous properties**

- Second period elements(First element of each group) shows dissimilarities with elements of same group
  Reason : Small size
  High polarizing power
  ***Various anomalous properties***
- Maximum covalency is only 4 due to absence of d orbital
- Greater ability to form multiple bonds
- Shows diagonal relationship

**c) Reactivity**

- Extreme left elements have a tendency to lose electrons(Metallic character) and extreme right elements has a tendency to accept electrons (Non metallic character), so most reactive elements found at extreme left and right
- F and Cs are vigorously reactive

Acidic Oxides: $Cl_2O_7$ , $SO_3$
Basic oxides : $Na_2O$ , MgO
Amphoteric : $Al_2O_3$ , $As_2O_3$
Neutral oxides: CO, NO, $N_2O$

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