The Periodic Table

- The classification of elements was necessary to make their study more convenient.
- The earliest classification was based on grouping the known elements as metals and non-metals.
- Dobereiner was the first person to illustrate the relationship between the atomic masses of elements and their properties. He also formulated the Law of Triads.

Li	Ca	Cl
Na	Sr	Br
K	Ba	I

- Newlands arranged the known elements in the increasing order of their atomic masses. He also formulated the Law of Octaves. However, the Newlands' Law of Octaves is applicable only to the elements having low atomic masses.

Notes of music	**sa**	**re**	**ga**	**ma**	**pa**	**dha**	Ni
Arrangement of elements	H	Li	Be	B	C	N	O
	F	Na	Mg	Al	Si	P	S
	Cl	K	Ca	Cr	Ti	Mn	Fe
	Co and Ni	Cu	Zn	Y	In	As	Se
	Br	Rb	Sr	Ce and La	Zr	–	–

- Mendeleev gave a periodic law which states that the properties of elements are a periodic function of their atomic masses.
- Achievements of Mendeleev's periodic table:
  - Mendeleev left some gaps in his periodic table so that the undiscovered elements could get a place in it without disturbing the positions of the other elements.
  - Noble metals were not discovered at that time. When they were discovered later, they got a place in Mendeleev's table without disturbing the positions of the other elements.
  - Mendeleev predicted the existence of gallium and named it as *ek*a-aluminium.

- **Limitations of Mendeleev's periodic table**
  - It failed to explain the position of hydrogen.
  - It was not able to explain the position of isotopes.
  - In the table some elements having higher mass were kept before the elements having lesser atomic mass.

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Modern periodic law states that the properties of elements are a periodic function of their atomic numbers, not their atomic masses.

The modern periodic table consists of 7 periods and 18 groups. Elements having the same valence shell are present in the same period. Elements having the same number of valence electrons are present in the same group.

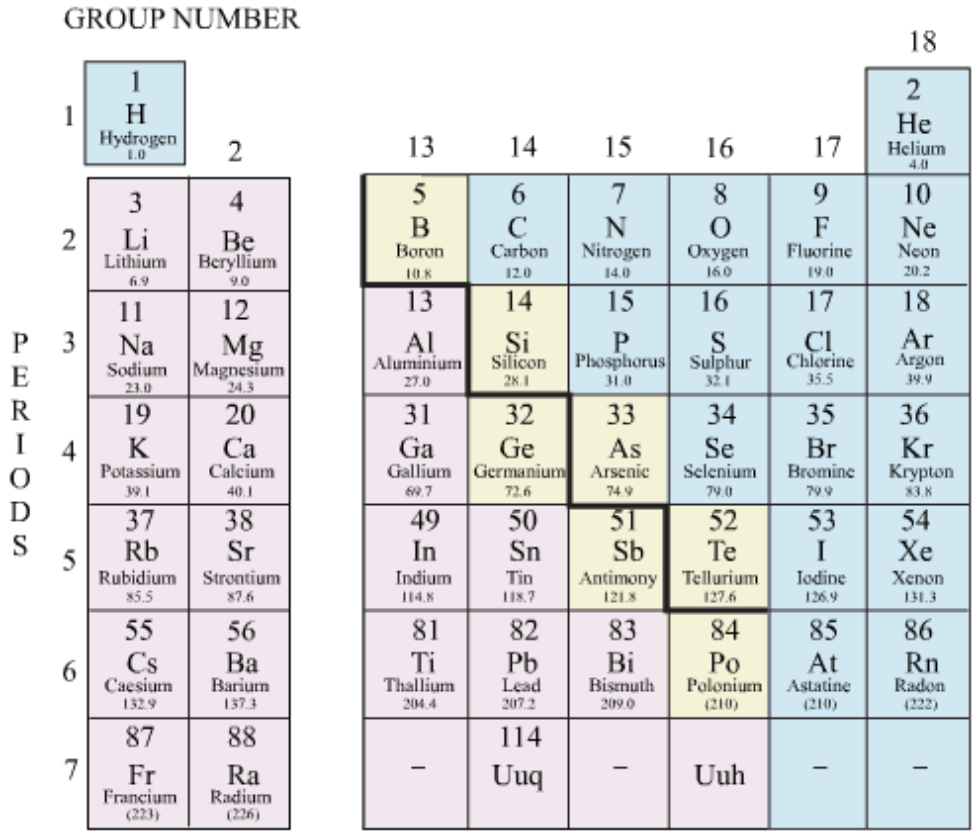
Metals are present on the left-hand side of the periodic table, whereas non-metals are present on the right hand side of the periodic table.

Group 1, 2 and 13-18: Representative elements

Group 3-12: Transition elements

Period 6: Elements with atomic numbers 58-71: Lanthanoids

Period 7: Elements with atomic numbers 90-103: Actinoids



Characteristic of Periods:

- All the elements of same period have same number of shells
- Electronic configuration and chemical properties of the elements change along the period.
- Atomic size of elements decreases along the period.
- Metallic character decreases while non metallic character increases along the period.

Characteristic of Groups:

- The number of shells increases while going down the group.
- The elements of same group have identical chemical properties.
- The physical properties of the elements of same group such as melting point, boiling point, density etc. vary gradually.
- Atomic radii of an element of same group increases down the group.

Advantages of the Modern Periodic Table:

- It is based on atomic number which is a more fundamental property.
- It is able to correlate the position of elements with its electronic configuration more clearly.
- It has more logical completion of each period.
- It does not have any sub group.
- All the isotopes of elements are placed on the same group as they all have same atomic number.
- All the transition elements are present in the middle as the properties of transition metals
- It completely separates metals from nonmetals.
- It justifies the position of some elements which were earlier misfit.
- It provides the justification for the placement of lanthanides and actinides at bottom of the periodic table.

Defects in Modern Periodic Table:

- It does not give fix position to hydrogen.
- Position of lanthanides and actinides
- It does not provide justification for the exact electronic configuration of some of transition and inner transition elements.
- ***s*-block elements:** Group 1 (alkali metals) and 2 elements (alkaline earth metals) having ns^1 and ns^2 outermost electronic configuration respectively
- ***p*-block elements:** Elements belonging to Group 13 to 18; the outermost electronic configuration varies from ns^2np^1 to ns^2np^6

  Elements of Group 16, 17, and 18 are called chalcogens, halogens, and noble gases respectively.
- ***d*-block elements:** Elements belonging to Group 3 to 12

  The general electronic configuration is $(n–1)d^{1–10}ns^{0–2}$.They are also called transition metals.
- ***f*-block elements** (Inner-transition metals): Lanthanoids and actinoids, with outermost electronic configuration $(n-2)f^{1–14}(n–1)d^{0–1}ns^2$

Metals, non-metals, and metalloids:

1. Metals are present on the left side of the periodic table and non-metals are located at the top right hand side of the periodic table.
2. The elements that exhibit properties of both metals and non-metals are called **metalloids** or **semi-metals**.

- The valencies of the elements remain same down the group. However while moving across the period, the valency first increases and then decreases.
- The atomic size of elements increases on moving down the group and decreases on moving from left to right in a period.

- Elements show periodicity because of their valence shell configuration. All elements showing periodicity in properties have the same number of electrons in the last or valence shell.
- Metallic character of elements increases on moving down the group and decreases on moving from left to right in a period.
- Ionisation energy as well as electron gain of enthalpy of elements increases on moving left to right in a period. However while moving across the group, they decreases.

- Group 1 elements: lithium, sodium, potassium, rubidium, caesium, and francium

- Called alkali metals because their hydroxides are alkaline in nature

Electronic Configuration

- General outer electronic configuration is ns^1.

Physical Properties

- Silvery white, soft, and light metals

- Density increases down the group. (exception: Na is denser than K)

- Low melting and boiling points − Reason: weak metallic bond due to the presence of only one electron in the outermost shell

- Physical properties

1. Generally, silvery white, lustrous, and relatively soft, but harder than the alkali metals
   Be, Mg → greyish

1. Melting points and boiling points are higher than those of corresponding alkali metals → due to smaller sizes
2. Flame test → Be and Mg do not give any colour to flame (because their electrons are strongly bound).

- Atomic and ionic radii

1. Smaller than those of corresponding alkali metals in the same period (due to increased nuclear charge)
2. Increase on moving down the group

- Ionisation enthalpy

1. Low in a particular period
2. Decreases on moving down the group
3. First ionisation enthalpy → Higher than those of corresponding alkali metals (due to smaller size)
4. Second ionisation enthalpy → Smaller than those of corresponding alkali metals

- Hydration enthalpy
  $Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$
  (Decreases with increase in ionic size)

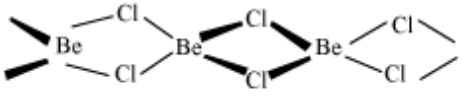
- Chemical properties
  Less reactive than alkali metals

1. Reactivity towards air and water:
2. React with air to form oxide and nitride
3. React with water to form hydroxides

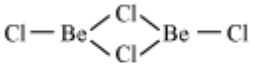
1. Reactivity towards halogens:

$M + X_2 \rightarrow MX_2$ (X = F, Cl, Br, I)

1. Beryllium halides are covalent in nature.



$BeCl_2$ in solid state



$BeCl_2$ in vapour phase

1. Reactivity towards hydrogen:

Form hydrides, MH_2 (except Be)

1. Reactivity towards acids → liberate H_2

$M + 2HCl \rightarrow MCl_2 + H_2$

1. Reducing nature:

Strong reducing agent (but less stronger than corresponding alkali metals)

1. Solutions in liquid ammonia:

Dissolve in liquid ammonia to give deep blue black solutions

1. Salts of Oxoacids

- Thermal stability of Carbonates: $BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3 > BeCO_3$
- Thermal stability of Sulphates: BaSO4> SrSO4> CaSO4> MgSO4> BeSO4

- Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and Radon (Rn)
- All are gases.
- Chemically uncreative − Hence, they are termed as noble gases.

Atomic Properties

- Outer shell remains completely filled.
- High ionisation enthalpy

- Atomic radii increase down the group.

Physical Properties

- Monoatomic
- Colourless, odourless, and tasteless
- Sparingly soluble in water
- Low melting and boiling points.

Chemical Properties

- Less reactive
- Completely filled valence shell electronic configuration
- Only xenon-fluorine compounds have been synthesised.
- XeF_2, XeF_4, and XeF_6