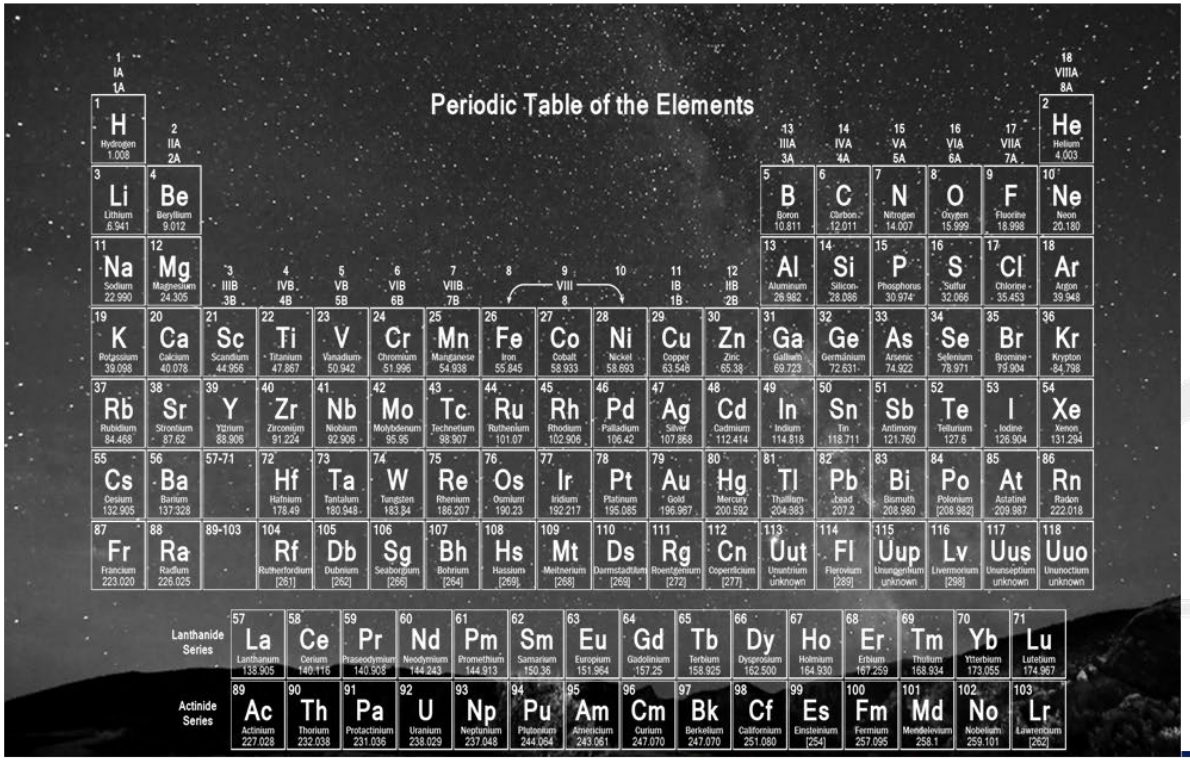
MIND MAP

Periodic Table



Dobereiner Triad Rule

(i) He made groups of three elements having similar chemical properties called TRIAD.

(ii) In Dobereiner triad, atomic weight of middle element is nearly equal to the average atomic weight of first and third element.

Newland's Octave Rule

Elements in the increasing order of their atomic masses

Properties of every 8th element was similar to the 1st element

(like in the case of musical vowels notation).

Drawbacks or Limitations :

(a) This rule is valid only upto Ca, because after Ca there is difference of 18 elements instead of 8 element.

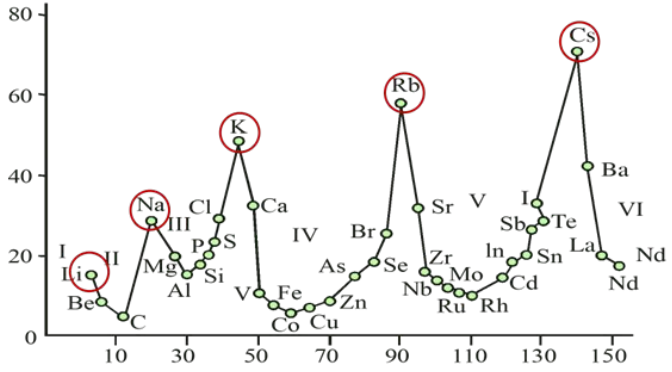
(b) After the discovery of Inert gases and including them into the periodic table it becomes the 8th element from Alkali metal so this law had to be dropped out.

Development of Periodic Table

Lavoisier Classification :

(i) Lavoisier classified the elements simply in metals and non metals.

Lother meyer's curve



Periodic Table

MIND MAP

Periodic Table

Periodic function

When the elements are arranged in the increasing order of their atomic weight, elements having similar properties gets repeated after a regular interval.

Mendeleev's Periodic Table

The physical and chemical properties of elements are the periodic function of their atomic weight.

Characteristics of Mendeleev's periodic table :

(a) It was based on atomic weight.
(b) 63 elements were known, noble gases were not discovered.

Moseley's Discovery

$\sqrt{\nu} \propto Z$

wave length of x-ray decreases (or frequency increases) in the regular way on moving from lighter to heavier element.
Property of x-ray depends on charge in nucleus (positive charge, proton).
Moseley found that the physical and chemical properties of the elements are periodic function of their atomic number.
This is also known as 'Modern Periodic Law'.

Nomenclature of elements

0	Nil
1	Un
2	Bi
3	Tri
4	Quad
5	Pent
6	Hex
7	Sept
8	Oct
9	Enn

101	unnilunium	Unu
102	unnilbium	Unb
103	unniltrium	Unt

- The general electronic configuration of p-block elements is ns^2, np^{1-6} (where n = 2 to 6)
- The elements, in which the last electron enters into (n – 1)d-orbital are called d-block elements.
- The general electronic configuration of d block elements is $(n-1)s^2, p^6, d^{1-10} ns^{1-2}$ [except Pd-$4d^{10}, 5s^0$]where n = 4 to 7.
- The d-block elements are placed in the groups named 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.
- The f-block elements are from atomic number 58 to 71 and from 90 to 103. The general electronic configuration of f block elements is $(n-2)\ s^2\ p^6\ d^{10}\ f^{(1-14)}$ $(n-1)\ s^2\ p^6\ d^{0-1}\ ns^2$ where n = 6 & 7.
- Their outermost electronic configuration is similar to d-block elements i.e. $(n-1)\ d^{1-10}\ ns^{1-2}$.
- Zn, Cd and Hg (IIB or 12th group) are d-block elements but not transition elements because these elements have d^{10} configuration in neutral as well as in stable +2 oxidation state.

Inner Transition Elements

(a) In these elements last three shells i.e. outermost, penultimate and prepenultimate shells are incomplete.

(b) These are related to IIIB i.e. group 3.

Period number (n) = number of outermost shell/highest shell number.

MIND MAP

Periodic Table

Block identification

- If np electron present in the last shell then p - block ($ns^2\ np^{1-6}$)
  group number = 12 + np electrons

In the periodic table

Number of elements in
1st period = 2
2nd period = 8
3rd period = 8
4th period = 18
5th period = 18
6th period = 32
7th period = 32

Number of Gaseous elements –
11 (H, N, O, F, Cl + Noble gases)
Number of Liquid elements – 6
(Cs, Fr, Ga, Hg, Br, Uub)
Bromine is the only non-metal which exists in liquid form.
Number of Solid elements – 95
(if discovered elements are 112)

(a) Metals

Majority of the elements in periodic table are metals and appear on the left side of the periodic table.
All d-block elements are metals.

(b) Non-Metals

These are placed at the top right hand side of periodic table. As we move horizontally along a period, the property of elements changes from metallic (on left) to non-metallic (on the right).

Periodicity

The regular gradation in properties from top to bottom in a group and from left to right in a period is called periodicity in properties.

Periodicity

The regular gradation in properties from top to bottom in a group and from left to right in a period is called periodicity in properties.

3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne

1 H
3 Li
11 Na
19 K
37 Rb
55 Cs
87 Fr

In a period, the ultimate shell remains same, but the number of e– gradually increases.

In a group, the number of e– in the ultimate subshell remains same, but the values of n increases.

(a) The cause of periodicity in properties is due to the same outermost shell electronic configuration coming at regular intervals.

(b) In the periodic table, elements with similar properties occur at intervals of 2, 8, 8, 18, 18 and 32. These numbers are called as magic numbers.

Atomic Radius

The average distance of valence shell e^- from nucleus is called atomic radius.

(i) The decrease in force of attraction on valence e^- due to inner shell e^- is called screening effect or shielding effect.

$Z_{eff} = Z - \sigma$

MIND MAP

Periodic Table

Periodic variation :

(a) From left to right in a period Z_{eff} increases ,generally.

Element Li < Be < B < C

Element N < O < F < Ne

From top to bottom in a group Z_{eff} remain constant for almost all.

Element Na ≈ K ≈ Rb ≈ Cs ≈ Fr

Zeff for ions

$$Z_{eff} \propto \frac{\text{positive charge}}{\text{negative charge}}$$

(ii) Z_{eff} of isoelectronic species

Ex. $H^- < Li^+ < Be^{+2} < B^{+3}$
($2e^-$ species)
Ex : $N^{-3} < O^{-2} < F^- < Na^+ < Mg^{+2}$
(10 e^- species)

Endothermic	Exothermic
1. If energy is absorbed during a process, it is called an endothermic process.	1. If energy is released during a process, it is called an exothermic process.
2. Energy absorbed is taken as positive by sign convention.	2. Energy released/evolved is taken as negative by sign convention.

Ionisation Potential / Ionisation Energy / Ionisation Enthalpy (IP / IE)

Minimum energy required to remove most loosely bonded outer most shell e^- from an isolated gaseous atom is known as ionisation energy.

Ionisation Energy Li = 520 KJ/mol

Successive Ionisation Energy

$$M_{(g)} + E_1 \xrightarrow{E_1} M^+_{(g)} + e^- \quad E_1 = I^{st} \text{ Ionisation energy}$$
$$M^{+1}_{(g)} + E_2 \xrightarrow{E_2} M^{+2}_{(g)} + e^- \quad E_2 = 2^{nd} \text{ Ionisation energy}$$
$$M^{+2}_{(g)} + E_3 \xrightarrow{E_3} M^{+3}_{(g)} + e^- \quad E_3 = 3^{rd} \text{ Ionisation energy}$$

$$E_1 < E_2 < E_3 \ldots\ldots\ldots$$

(Always for an element)

Factors Affecting IE

(i) Atomic size : with increasing size ionisation energy decreases.

$$\text{Ionisation Energy} \propto \frac{1}{\text{atomic size}}$$

(ii) Effective nuclear charge (Zeff)

$$\text{Ionisation Energy} \propto Z_{eff}$$

Penetration power of sub shells

$$s > p > d > f$$

Ionisation Energy Ga > Al (due to poor shielding of 3d)

Ionisation Energy of 5d > 4d (due to lanthanide contraction) Ex. Hf > Zr

The value of ionization energy of Be($1s^2 2s^2$) is more than B($1s^2 2s^2 2p^1$) because the penetration power of 2s-electrons of Be is more than the 2p electron of B

(b) In a period, the ionization energy of 15th group elements is more than the elements of 16th because the half filled p^3 configuration of 15th elements is comparatively of higher stability.

(c) IE Al < IE Ga due to poor shielding of 3d

MIND MAP

Periodic Table

Electron Gain Enthalpy (ΔHeg)

(1) The amount of energy change when an electron is added to the valence shell of an isolated gaseous atom is known as EGE.

$$X(g) + e^- \longrightarrow X^-(g) \qquad \Delta H_{eg}$$

Is EGE positive or negative?

(2) Generally first electron addition in an isolated gaseous atom is an exothermic process
(except stable electronic configuration)

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

(a) Atomic Size

$$\text{Atomic Size} \propto \frac{1}{EA}$$

(b) Effective Nuclear Charge

As effective nuclear charge increases, amount of energy released is more. Hence electron gain enthalpy value becomes more negative.

(c) Stability of Half-filled and Completely filled Orbitals

Half-filled orbitals of a sub shell is comparatively more stable, so it is difficult to add electron in such orbitals and lesser energy is released on addition of electron hence the electron gain enthalpy will become less negative.

EGE of N, Be, Ne are positive

(a) In Group

In a group, the electron affinity decreases on moving from top to bottom, that is, less and less amount of energy is released.

Electron affinity of 3rd period element is greater than electron affinity of 2nd period elements of the respective group.

F	Cl
$[He]\ 2s^2 2p^5$	$[Ne]\ 3s^2 3p^5$

Electronegativity (χ)

The tendency of a covalently bonded atom to attract shared pair of electrons towards itself is called electronegativity.

(a) $A-B \longrightarrow A^- + B^+$ (EN A > EN B)

(b) $A-B \longrightarrow A^+ + B^-$ (EN A < EN B)

(a) Atomic size

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

(b) Effective nuclear charge (Z_{eff})

$$\text{Electronegativity} \propto Z_{eff} \propto \frac{\text{positive charge}}{\text{negative charge}}$$

$O^{-2} < O^{-1} < O < O^{+1} < O^{+2}$

Variation in Electronegativity

(a) Electronegativity decreases down the group.

(b) In period on moving from left to right electronegativity increases.

						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
K 0.8						Br 2.8
Rb 0.8						I 2.5

Schomaker and Stevenson law

As per Schomaker and Stevenson– The reduction in bond length depends on the difference in electronegativities of atoms in following manner –

$$d_{A-B} = r_A + r_B - 0.09\,(\chi_A - \chi_B)$$

Nature of oxides

1. Along a period acidic nature increases.
2. Down the group basic nature increases.

When in periodic table the distance between the element and oxygen increases, basic character increases.

BeO, Al_2O_3, ZnO, SnO, PbO, SnO_2, PbO_2, Sb_2O_3 etc. are amphoteric oxides.

CO, H_2O, NO, N_2O etc. are neutral oxides.