PERIODIC CLASSIFICATION OF ELEMETNS

INTRODUCTION:

Before the beginnings of the **eighteenth century** when there are only 30 elements were known, it was earlier to study and remember their properties. In later years when number of elements discovered were increased then it become difficult to study them. So scientist fell the need of simple method to facilitate the study of the properties of various elements and their compounds. After numerous attempts they got success & elements were arranged in such manner that similar elements were grouped together and different elements were separated. This arrangement of elements is known as classification of elements which led to the formation of periodic table.

Periodic table may be defined as the arrangement of all the known elements according to their properties in such way that the elements of similar properties are grouped together in a tabular form.

Earlier attempts of classification of elements (development of periodic table):

Earlier attempts to classify the elements resulted in grouping as metals and non-metals. Later on they were classified on the basis of their atomic masses.

DÖBEREINER TRIADS RULE:

In 1817, **Johann Wolfgang Döbereiner.** A German chemist arranged the elements are group of three elements and in a manner that the atomic mass of middle element was roughly the average of the atomic masses of the other two elements of the triad.

Example: Element: Lithium, Sodium and Potassium.

Atomic mass 7 23 39

Average of the atomic masses of Lithium and Potassium is $\frac{7+39}{2}=23$ only three triads could be arranged in this manner at that time. They were:

Triads	Elements	Atomic masses	Average of the atomic masses of first and third element
1	Li Na K	7 23 39	$\frac{7+39}{2}=23$
2.	Ca Sr Ba	40 87.5 137	$\frac{40+137}{2}=88.5$
3.	Cl Br I	35.5 80 127	$\frac{35.5+127}{2}=81.2$

SHORT COMING OF DÖBEREINER'S TRIADS RULE:

This classification was not found satisfactory as it could be applied to the limited number of elements. Now a days some more triads have been made they are

(i)	Potassium K	Rubidium Rb	Cesium Cs
(ii)	Phosphorus P	Arsenic As	Antimony Sb
(iii)	Sulphur S	Selenium Se	Tellurium Te
(iv)	Hydrogen H	Fluorine F	Chlorine Cl
(v)	Scandium Sc	Yttrium Y	Lanthanum La

For a **Döbereiner's triad** all the three elements should belong to the same group and the difference in atomic number should be 8 or 18.

New lands law of octave: In 1866. J.A.R. Newlands correlated the chemical properties of the elements with the increasing order of atomic masses. i.e. to arrange the element having lowest atomic mass (H) firstly and ended to at secondly the element having highest atomic mass. **(Thorium** which was 56th known element at that time).

Definition: When the elements are arranged in order of their increasing atomic masses, every eighth element has the properties similar to those of the first elements like the eighth note of an octave in music. Thus according to this law, the physical & chemical properties are repeated after an interval of eight elements and this is similar to eight notes of an octave on a musical scale shown below:

Sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
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	-	-

The properties of Lithium are similar to that of 8th element i.e. Na, Be is similar to Mg and so on.

Limitations:

1. Law of octaves was applicable only up to calcium. It worked well with lighter elements only.

2. At that time only 56 elements were existed in nature, but later several elements were discovered which can not be kept in periodic table as per this law. Their properties were not in accordance with the law of octaves.

Law of octaves:

3. (i) In order to fit element in to his table New lands adjusted two elements in the same column. For example cobalt and nickel were placed in the same position and in the same column as fluorine and bromine.
(ii) Iron which resembles cobalt and nickel in properties were placed far away from these elements.
4. After the discovery of inert gases & included in the periodic table it becomes the eighth elements from alkali so this law has to be dropped out.

Ques. Did Döbereiner's triads also exist in the columns of Newland's Octaves? Compare and find out.
Ques. What were the limitation of Döbereiner's Classification?
Ques. What were the limitations of Newlands' Law of Octaves?

Mendeleev's Periodic table:

In the year 1861, **Dmitri Ivanovich Mendeleev** arranged all the known elements (63 elements) in the form of a table in which elements were arranged in the increasing order of their atomic mass and also on the similarities of chemical properties.

Group	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
Oxide Hydride	R_2O RH	RO RH_2	R_2O_3 RH_2	RO_2 RH_3	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4
↓Period	A B	A B	A B	A B	A B	A B	A B	Transition Series
1.	H 1.008							
2.	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3.	Na 22.99	Mg 24.31	Al 29.98	Si 28.09	P 30974	S 32.06	Cl 35.453	
4. First series second series	K 39.102 Cu 63.54	Ca 40.08 Cu 65.37	Sc 44.96 Ga 69.72	Ti 47.90 Ge 72.59	V 50.94 As 74.92	Cr 50.20 Se 78.96	Mn 54.94 Br 79.909	Fe Co Ni 55.85 58.93 58.71
5. First series second series	Rb 85.47 Ag 107.87	Sr 87.62 Cd 112.40	Y 88.91 In 114.69	Zr 91.22 Sn 118.69	Nb 92.91 Sb 121.75	Mo 95.94 Te 127.60	Tc 99 I 126.90	Rh 102.91 Ru Pd 101.07 106.4
6. First series second series	Cs 132.9. As 196.97	Ba 137.34 Hg 200.59	La 138.91 Hg 200.59	Hf 178.49 Pb 207.19	Ta 183.85 Bi 208.98	W 183.85		Ir Os 192.2 190.2 Pt 195.09

❒ The arrangement of element was based on the physical and chemical properties of the elements and also the formulae of the compounds they formed with oxygen and hydrogen. He selected hydrogen and oxygen as they are very reactive and formed compound with most elements.
The table which classifies the elements in such a way that elements having similar properties are placed in same vertical column or group in known as periodic table. The term periodic means repetition of elements having similar properties after a certain regular interval. The periodic table consists of vertical columns which are called as groups and horizontal rows called as periods. **Mendeleev's** periodic table had six periods and eight groups as shown in the table, he arranged all the elements horizontally fin the order of their increasing

atomic masses and vertically according to their similarities in properties. Each group was further sub divided into two sub groups A & B.

Achievements of the Mendeleev's periodic table:

1. **Systematic study of the elements:** All the elements in general were arranged systematically in increasing order of their atomic masses. This arrangement helped to study the properties of various elements. If the nature of the element present in a group is known, it become easier to predict or guess the expected properties of other elements.
2. **Prediction of new elements:** Mendeleev predicted the properties of some unknown elements and left gaps for these elements to be filled as and when discovered For eg. Scandium, Gallium and Germanium were not known at that time but Mendeleev already named these elements as **eka-boron, eka-aluminium** and **eka-silicon.** When these elements were later on discovered, they were found to have more or less similar properties as predicted by Mendeleev.

3. **Position of Noble gasses:** When noble gases were discovered they were placed in a new group without disturbing the existing order.

4. **Correction of atomic masses:** Atomic masses of several elements were corrected on the basis of periodic table. eg. Atomic mass of Beryllium was corrected from 135 to 9. Mendeleev predicted that atomic mass of gold is incorrect. Later on it was found to be so. Similarly atomic masses of Indium, Uranium and Platinum were also corrected.

Drawbacks of Mendeleev's periodic table:

Position of Hydrogen is uncertain becomes it resemble with IA group alkali metals elements and VII A (halogens) group elements.

(i) Isotopes: Isotopes of an element have similar chemical properties but different atomic masses.

(ii) Position of isotopes: Since basis of periodic table was increasing atomic mass. So isotope should be placed separately but no separate place was given to isotopes.

(iii) Anomalous pairs of certain elements: Certain elements were not arranged according to their increasing atomic mass e.g.
(a) Argon (Atomic mass 39.9) was placed before potassium (atomic mass 39.0)
(b) Cobalt (58.95) before Nickel (58.70)
(c) Tellurium (127.6) before Nickel (126.9)
(d) Thorium (232) before **Protactinium** (231)

(iv) Similar elements were placed in different groups. e.g.
(a) Silver and thallium
(b) Barium and lead
(c) Copper and mercury
(d) Platinum and gold.

(v) Dissimilar elements were placed in same group e.g. silver and gold were placed in a same group while there is little similarity in physical and chemical properties.

(vi) Cause of periodicity: Mendeleev did not explain the cause of periodicity in the physical and chemical properties of the elements.

(vii) Metals have not been separated from non-metals.

(viii) Position for elements of group (VIII): There is no proper position for the elements of group (VIII) consisting of elements in three triads. These elements are placed out side the main structure of the periodic table.

The modern periodic table:

In 1913 **Henry Moseley** showed that properties of the elements are determined by atomic numbers instead of the atomic mass. It formed the basis of modern periodic law. The law is –

"The physical and chemical properties of the elements are periodic function of their atomic numbers". Since atomic mass is a nuclear property where as atomic number implies for the no of electrons in neutral atom or no. of protons in nucleus. Nucleus is deep seated in the atoms and does not take part in chemical reactions. Therefore the physical and chemical properties depends upon the no. of electrons and their electronic configuration which in turn depends upon atomic number (Z) . So when elements are arranged in the increasing order of atomic numbers. After a regular interval elements have similar no of valence electrons therefore chemical properties are repeated i.e. periodicity in the chemical properties of the elements of the elements occurs.

Ques. Use Mendeleev's periodic table to predict the formulae for the oxides of the following elements: K, C, Al, Si, Ba

Ques. Besides gallium, which other elements have since been discovered that were left by Mendeleev in his periodic table? (any two)

Ques. What were the criteria used by Mendeleev in creating his periodic table?

Ques. Why do you think the noble gases are placed in a separate group?

Modern periodic table or long form of the periodic table:

- It is also called as **Bohr, Bury** & **Rang.** Werner periodic table

(1) It is based on the **Bohr-Bury** electronic configuration concept and atomic number.

(2) This model is proposed by Rang and Werner.

This table is based on modern periodic law, the elements are arranged in the increasing order of atomic numbers in such a way that elements having the same number of valence electrons are placed in the same vertical column. It consists of 18 vertical columns and seven horizontal rows. Vertical columns of periodic table are known as groups while horizontal rows are known as periods.

The co-relation between the groups in long form of periodic table and in modern form of periodic table are given below:-

IA	IIA	IIB	IVB	VB	VIB	VIIB	VIII	IB	IIB
1	2	3	4	5	6	7	8,9,10	11	12
IIIA	IVA	VA	VIA	VIIA	O				
13	14	15	16	17	18				

Elements belonging to same group having same number of electrons in the outer most shell so their properties are similar.

Description of periods:

Period	n	Sub shell	No. of elements	Element	Name of Period
1.	1	1s	2	$_1H,_2He$	Shortest
2.	2	2s, 2p	8	$_3Li$ - $_{10}Ne$	Short
3.	3	3s,3p	8	$_{11}Na$ - $_{18}Ar$	Short
4.	4	4s,3d,4p	18	$_{19}K$ - $_{36}Kr$	Long
5.	5	5s,4d,5p	18	$_{37}Rb$ - $_{58}Xe$	Long
6.	6	6s,4f,5d,6p	32	$_{55}Cs$ - $_{86}Rn$	Longest
7.	7	7s,5f,6d,	26	$_{87}Fr$ - $_{112}Uub$	Incomplete

Description of Groups:

1st /IA/Alkali metals

H = $1s^1$

Li = $1s^2$, $2s^1$

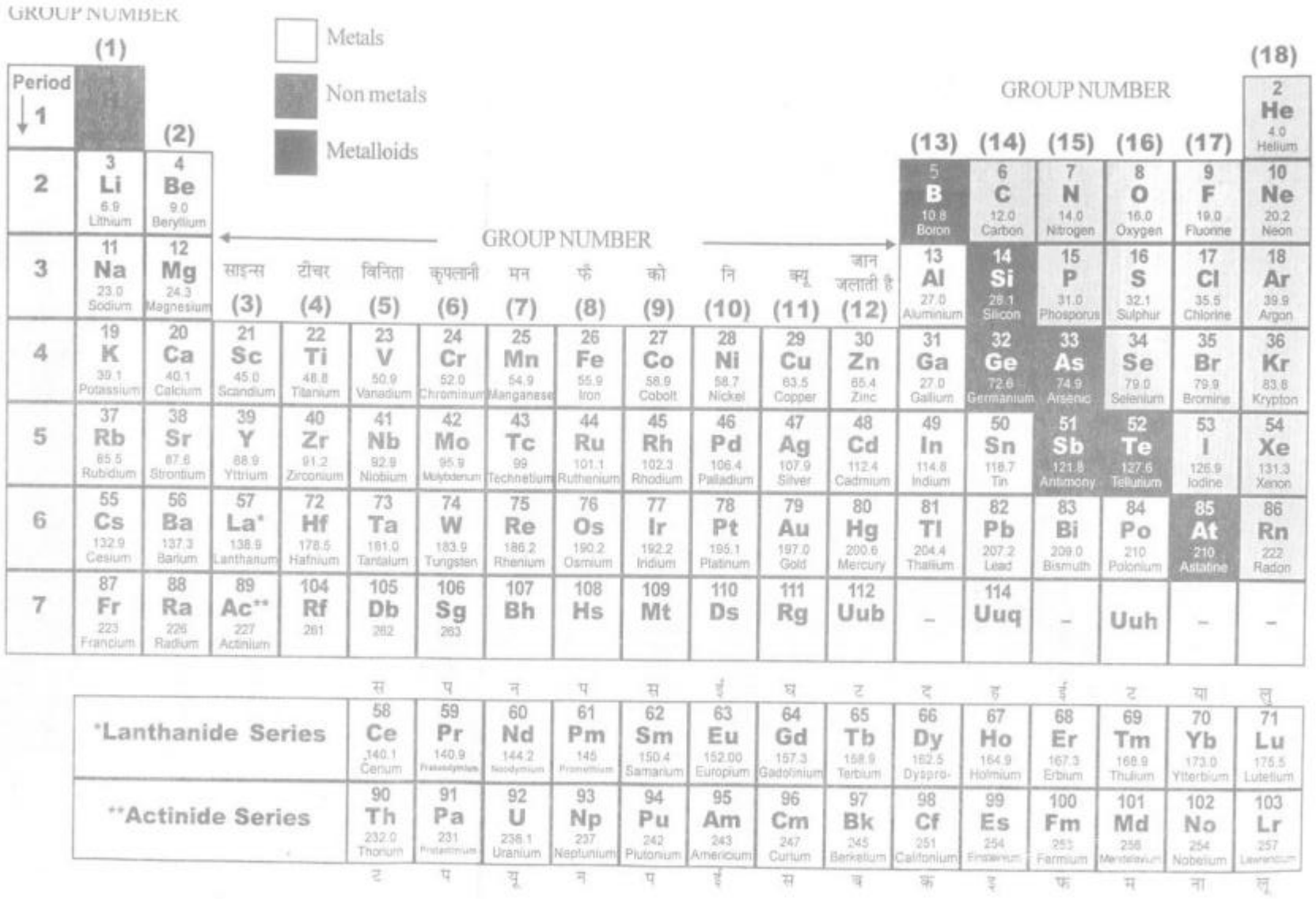
Na = $1s^2$, $2s^2$ $2p^6$, $3s^1$

K = $1s^2$, $2s^2$ $2p^6$, $3s^2$ $3p^6$, $4s^1$

General electronic configuration = ns1 (n= Number of shell)

Number of valence shell e^- = 1

MODERN PERIODIC TABLE



2nd /IIA/Alkali earth metals:

Be = $1s^2, 2s^2$

Mg = $1s^2, 2s^2, 2p^6, 3s^2$

Ca = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$

General electronic configuration = $\mathbf{ns^2}$

Number of valence shell e^- = 2

13th /IIIA/Boron Family ;

B = $1s^2, 2s^2, 2p^1$

Al = $1s^2, 2s^2. 2p^6, 3s^2, 3p^1$

Ga = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^2, 4p^1$

General electronic configuration = $\mathbf{ns^2\ np^1}$

14th /IVA/Carbon Family:

C = $1s^2, 2s^2, 2s^2$

Si = $1s^2, 2s^2, 2p^6, 3s^2, 3p^2$

Ge = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^2$

General electronic configuration = $\mathbf{ns^2\ np^2}$

Number of valence e^-s= 4

15th /VA/Nitrogen family/ Pnictogens: (Used in fertilizer as urea)

N = $1s^2, 2s^2, 2p^3$

P = $1s^2. 2s^2. 2p^6, 3s^2, 3p^3$

As = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^3$

General electronic configuration = $\mathbf{ns^2\ np^3}$

Number of valence shell e^- = 5

16th /VIA/ Oxygen family/ Chalocogen: (Ore forming)

O = $1s^2, 2s^2, 2p^4$

S = $1s^2, 2s^2, 2p^6, 3s^2, 3p^4$

Se = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^2, 4p^4$

General electronic configuration: $\mathbf{ns^2\ np^4}$

Number of valence e^-s=6

17th /VIIA/ Fluorine family/ Halogens: (Salt forming)

F = $1s^2, 2s^2, 2p^5$

Cl = $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$

Br = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^5$

General electronic configuration = $ns^2\ np^5$

Number of valence e^-s=7

18th /Zero group/ Inert gases / Noble gases:

Ne = $1s^2, 2s^2, 2p^6$

Ar = 1s+, $2s^2, 2p^6, 3s^2, 3p^6$

Kr = $1s^2, 2s^2, 3p^6, 3s^2, 3p^6, 3d^{10}, 4s^2, 4p^6$

General electronic configuration = $\mathbf{ns^2\ np^6}$ (except. He)

Number of valence shell e^-= 8

Elements of group 16 are known as chalocogen Elements of group 17 are known as halogens.

Classification on the basis of subshell in which last electron (e^-) enters

Important Question:

1. 1 period contains ..... And II period contains ..... elements.
2. Group 17 elements are called .....
3. Group 18 elements are ..... valent.
4. Which one has the bigger size
   Na (11) or Cl (17): Cl (17) or F (9)?
5. Name two elements whose valencies are equal to their group numbers.
6. How many elements are there in the 4^{th} period.
7. Give two examples of elements of Groups 1,2, 16 and 17.
8. Group 2 elements are known as .....

Periodicity in properties:

The electronic configurations of atoms display a periodic variation with increase in atomic number. Since the properties of elements depends upon the electronic configurations. So the elements exhibit periodic variation of physical & chemical properties. Some properties of elements are:-

(A) **Valency:-** It is defined as the combining capacity of the element. Valency is determined by the number of electrons present in outer most shell. These electrons are known as valence electrons.

Variation of valency across a period:- The number of valency electron increases from 1 to 8 on moving across a period. The valency of an element with respect to hydrogen and halogen increases from 1 to 4 and then decreases from 4 to zero. With respect to oxygen valency increases from 1 to 7.

Variation of valency along a group:- On moving down a group. The no. of valence electrons remains same so the valence of all the elements of a group is same.

Group (1) elements have valency – 1
Group (2) elements have valence – 2

Atomic size:- Atomic size means atomic radius of an atom which is defined as the distance between the centre of the nucleus of an atom and valence shell containing electrons in an isolated atom since it is very difficult to measure the atomic radius because –

(i) The isolation of single atom is very difficult.
(ii) There is no well defined boundary for the atom.

So the more accurate definition of atomic radius is –

(Half the internuclear distance between the two atoms in a homatomic molecule is known as atomic radius)

This internuclear distance is also known as bond length. It depends upon the type of bond by which two atoms combine. Based on chemical bonds, atomic radius is divided in to four categories.

(a) Covalent radius (Single bonded covalent radius) For homoatoms
It is half of the internuclear distance between two singly bonded homoatoms.

(b) Covalent radius for hetero atoms.

(i) In case of hetero atomic molecule (A-B), if the electronegativity difference is less. Then covalent radius of oxygen, nitrogen and carbon is taken from the compound H_2O_2, N_2H_4 and C_2H_6 respectively. This radit is subtracted from the bond length of A-B molecules.
eg. C-I (electronegativity is almost some 205)
Internuclear distance C-I is 2.13 Å, covalent radius of carbon in compound C_2H_6 is 0.77 Å covalent radius of I^- will be.

$d_{C\text{-}I} = r_C + r_I$ (covalent radius of iodine)

i.e. $2.13 = 0.77 + r_I$

$r_I = 2.13 - 0.77 = 1.36$ Å

(ii) When electronegativity difference is more. Then bond length is determined by the school maker and Stevenson law-

$d_{A\text{-}B} = r_A + R_B - 0.09(X_A - X_B)$

where $d_{A\text{-}B}$ = Bond length of $d_{A\text{-}B}$ molecule

X_A = Electronegativity of A

X_B = Electronegativity of B

Example - Bond length of F_2 = 1.44 Å

i.e. $d_{F\text{-}F} = 1.44$ Å $\quad r_F = \frac{1.44}{2} = 0.72$Å

$d_{H\text{-}H} = 0.74$ Å $\quad r_H = \frac{0.74}{2} = 37$Å

Electronegativity of Fluorine is 4.0 and Electronegativity of Hydrogen is 2.1

$d_{H-F} = r_F + r_H + 0.09(X_F - X_{H)}$

$= 0.72 + 0.37 - 0.09(4\text{-}2.1)$

$= 1.09 - (0.09 \times 1.9)$

$= 1.09 - 0.171 = 0.919$ Å

(B) Ionic Radius -

(i) Cationic radius (ii) Aniotic radius

(i) Cationic Radius –

$$Size\ of\ cation \alpha \frac{1}{magnitude\ of\ the\ charge\ or\ z_{eff}}$$

eq. $Fe > Fe^{+2} > Fe^{+3}$

(ii) Anionic radius -

Anionic radius is always greater than atomic radius because in an anion electrons are more than the protons so effective nuclear charge reduces and inter electronic repulsion increases so size anion also increases.

(C) Metallic Radius -

Half of the inter nuclear distance between two adjacent metallic atoms.

$$Metallic\ radius\ \alpha \frac{1}{Metallic\ bond\ strength}$$

(D) Vander Waal's radius -

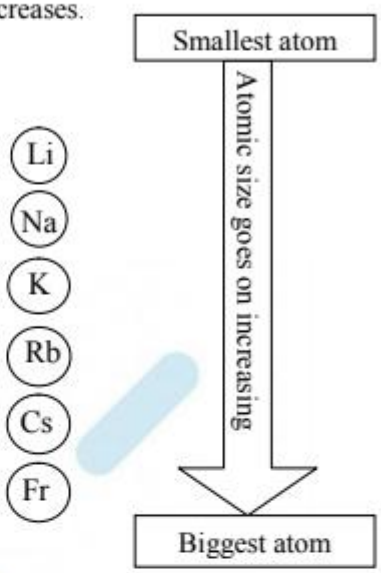
Those atoms which are not bonded with each other experiences a weak attractive to come nearer. Half of the distance between the nuclei of adjacently placed atoms in solid state of a noble gas is Vander Waals' radius.

Vander wall radius = 2 × Covalent Radius

Variation of Atomic size in a group:

On moving down a group of periodic table, the size of the atom increases.

Group-I Elements	Atomic Radii (pm)
Lithium (Li)	152
Sodium (Na)	186
Potassium (R)	231
Rubidium (Rb)	244
Cesium (Cs)	262
Francium (Fr)	-

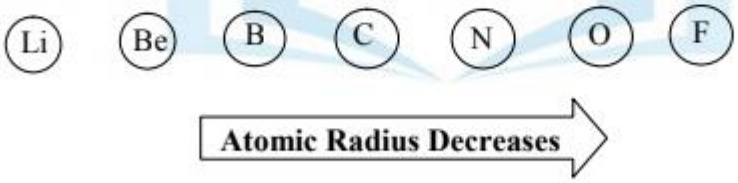


When we move from top to bottom in a group a new shell of electron is added in each period. This addition increases the size.

Variation of atomic size in period:

In general atomic radil decreases across a period from left to right eg. In IInd period. L atom is largest and Fluorine is the smallest atom because nuclear charge increases with increase in atomic number. Electrons are also increasing but these are added to the same shell.

Element	Li	Be	B	C	N	O	F
Atomic Number	3	4	5	6	7	8	9
Nuclear charge	+3	+4	+5	+6	+7	+8	+9
Electronic configuration	2, 1	2, 1	2, 3	2, 4	2, 5	2, 6	2, 7
Radius (pm)	152	111	88	77	74	66	64



Atomic Size:- Decreases along the period. Increases down the group.

Metallic and Non-metallic character:

- Metallic character is the tendency of atoms of the elements to lose electrons and form positive ions. It can be expressed as

$$M \rightarrow M^{+} + e^{-}$$

Therefore metals are also called as electropositive elements.

The metallic character increases from top to bottom in a group the metallic character of the element goes on increasing eg. Li is least metallic element while caesium is most metallic element.

Elements	Metallic character
Lithium (Li)	Least Metallic
Sodium (Na)	
Potassium (K)	
Rubidium (Rb)	
Cesium (Cs)	Most Metallic

If we use the term electropositive in place of metallic character, we can say that electropositive character goes on increasing as we move from top to bottom in the periodic table. If we consider the electronegative character, it goes on decreasing as we move down in a group of the periodic table.

Ionization Enthalpy:

The minimum amount of energy required to remove the most loosely bounded electron from an isolated gaseous neutral atom to form gaseous electropositive ion called Ionization enthalpy. Its unit is kilo joules per mole (kJ/mol)

$$M_{(g)} + Energy \rightarrow M^{+}{}_{(g)} + e^{-}$$

It is a measure of tendency to lose electrons by atoms. The tendency to lose electron from top to bottom in a group and it decreases on moving left to right in a period.

Electron gain enthalpy:

It is defined as the amount of energy released when as isolated atom in the ground state accepts an electron to form gaseous negative ion i.e. and anion. It is a measure of tendency of an atom to accept an extra electron to form an anion. Its unit is kilo joule mole (kJ/mole). Electron gain enthalpy of elements goes on increasing as we move from left to right in a period. In group it decreases from to bottom.

PREVIOUS YEARS' BOARD QUESTIONS:

1 Which physical and chemical properties of the elements were used by Mendeleev in creating his periodic table? List two observations which posed a challenge of Mendeleev's periodic law. **(C.B.S.E 2009)**

Ans. The creation of Mendeleev's periodic table was based upon certain physical and chemical properties.
Physical properties: The atomic mass of the elements was taken into account and the elements were arranged in order of increasing atomic masses. The influences of their physical properties such as melting points, boiling points, density etc.
Chemical properties: The distribution of the elements into different groups was linked with formation of hydrides by combining with hydrogen and formation of oxides by combining with oxygen. This is linked with the valency of the elements.
The two main observations which posed challenge to Mendeleev's periodic table are as follows.
(i) Position of isotopes: Since the isotopes of an element differ in their atomic masses, they must be assigned separate slots or positions in the periodic table.
(ii) Anomalous positions of some elements: In the Mendeleev's periodic table, certain elements with higher atomic masses precede or placed before the elements with lower atomic masses. For example, the element Ar (Atomic mass = 39.9) is placed before the element K (Atomic mass = 39.1)

2. Using the part of the periodic table given below, answer the questions that follow.

Group Period	I	II	III	IV	V	VI	VII	Zero
1	H							He
2	Li	Be	B	C	N	O	F	Ne
3	Na	Mg	Al	Si	P	S	Cl	Ar
4	K	Ca						

(i) Na has physical properties similar to which elements and why?
(ii) Write the electronic configuration of N and P
(iii) State one property common to fluorine and chlorine. **(C.B.S.E. All India 2008)**

Ans. (i) Na has physical properties similar to Li and K. All the three elements have one electron each in the valence of their atoms. These are known as alkali metals.
(ii) Electronic configuration of N(z = 7) = 2,5
Electronic configuration of P (z = 15) = 2,8,5
(iii) Both the elements have seven electrons in the valence shells as their atoms
Fluorine (z = 19) = 2, 7
Chlorine (z = 17) = 2,8,7

3. Table given below shows a part of the periodic table

H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar

Using this table explain why
(a) Li and Na are considered as active metals.
(b) Atomic size of Mg is less than that of Na.
(c) Fluorine is more reactive than chlorine. **(C.B.S.E. Foreign 2008)**

Ans. (a) Both Li and Na are active elements since their atoms have only one, electron in their valence shells. They readily lose this electron to have the configuration of the nearest noble gas element.
(b) Mg is placed after Na in the same period (third.) As the atomic size decreases along a period, the size of Mg is less than that of Na.
(c) Both F and Cl belong to group 17 (halogen family). Since fluorine is more electronegative than chlorine, it is therefore more reactive also.

4. (a) Why do all the elements of the same group have similar properties?

(b) How will the tendency to gain electrons change as we go from left to right across a period? Why?

(C.B.S.E. All India, 2009)

Ans. (a) The properties of the elements are linked with the valence shell electronic configuration of their atoms. The elements with the same configuration are expected to have similar properties. In a group, the elements are separated by definite gaps of atomic numbers and have same number of electrons in the valence shells of their atoms. For example, the alkali metals in group I have one electron each. They have similar properties. For further details, consult text part.

(b) In moving from left towards the right across a period, the tendency of the elements to gain electrons increases

Explanation: In general, the atoms of all the elements have a desire or urge to have stable electronic configuration of the nearest noble gas elements or to have eight electrons in their outermost or valence shell, Now, across a period the valence electrons are added one by one from left to the right. This is supported by the electronic configuration of the elements present in period 3 or third period.

Element	**Na**	**Mg**	**Al**	**St**	**P**	**S**	**Cl**	**Ar**
No. of valence electrons	1	2	3	4	5	6	7	8
No. of electrons needed in Valence shells	7	6	5	4	5	2	1	0

This clearly shows that the element chlorine needs one electron while oxygen requires two to have to stable electronic configuration. Thus, tendency to gain electrons increases from left to right across a period.

- Element are classified on the basis of similarities in their physical and chemical properties.
- **Döbereiner** grouped elements into **triads.**
- **Newland** grouped elements on the basis of law of **octaves.**
- **Mendeleev** grouped elements in the increasing order of their atomic masses and similarity in chemical properties.
- **Mendeleev** was able to predict the existence of some elements on the basis of gaps in the periodic table.
- Moseley discovered that fundamental property of an element is its atomic number rather than atomic mass. He revised **Mendeleev Periodic Table** on the basis of **atomic numbers** of elements and removed some of its anomalies.
- Elements in the long form of Modern Periodic Table are arranged in **18 vertical columns** called groups and **7 horizontal** rows called periods.
- The elements arranged in the **long form of periodic table** show (i) periodicity of properties (ii) atomic size (iii) valency (iv) metallic and non-metallic character.

EXERCISE

OBJECTIVE TYPE QUESTIONS:-

1. According to IUPAC recommendations, the number of groups in the long form of the periodic table is:-
(A) 7 (B) 8 (C) 16 (D) 18

2. The law of modern periodic table was proposed by:-
(A) D. I. Mendeleev (B) Döbereiner (C) H.G.I Moseley (D) Newlands

3. The least metallic element of group 1 is:-
(A) Lithium (B) Sodium (C) Potassium (D) Caesium

4. Which of the following properties generally increases on moving from top to bottom?
(A) Ionisation energy (B) Non-metallic character
(C) Atomic size (D) Valency

5. Which of the following statement is not correct about the trends when going from left to right across the periodic table?
(A) The elements become less metallic in nature (B) The number of valence electrons increases
(C) The atoms lose their electrons more easily (D) The oxides becomes more acidic

6. The law of octaves was proposed by:-
(A) New lands (B) Lothar Meyer (C) Döbereiner (D) Mendeleev

7. The number of periods in the long form of the periodic table is:-
(A) 6 (B) 7 (C) 10 (D) 18

8. Which of the following has the maximum non-metallic character?
(A) F (B) Cl (C) Br (D) I

9. Which of the following sets of elements do not belong to the same group?
(A) F, Cl, Br (B) Na, K, Rb (C) P, S, Cl (D) C, Si, Ge

10. Which of the following has lowest number of electrons in the valency shell?
(A) O (B) C (C) N (D) B

11. Which of the following pairs of elements does not belong to same group?

(A) Cl, Br (B) N, p (C) Mg, Ca (D) Al, Si

12. Which of the following has largest atomic size?

(A) Be (B) C (C) O (D) F

13. Which of the following belongs to group 18?

(A) Sr (B) I (C) Ar (D) Rb

14. What is the basis of long form of the periodic table?

(A) Atomic mass (B) Atomic number

(C) Atomic size (D) Metallic and Non-metallic character

15. Which one is more metallic element?

(A) Na (B) Mg (C) Al (D) Si

16. Element X forms a chloride with the formula XCl_2. Which is a solid with a high meting point, X would most likely be in the same group of the periodic table as:-

(A) Na (B) Mg (C) Al (D) Si

FILL IN THE BLANKS:-

1. The horizontal rows in the periodic table are known as .....

2. The vertical columns of in the periodic table are known as .....

3. A very short period contains ..... elements.

4. The element having electronic configuration (2, 8,3) belongs to .....group.

5. In a group atomic radii ..... from top to bottom and in a period atomic radii ..... from left to right.

6. Size of Na^+ is ..... than sodium atom.

7. Size of Cl^- is ..... than Cl atom.

8. An element 'B' belongs to the second period and group 13, formula of its oxide is .....

9. Elements in the same group have similar .....

10. Elements in the same group have similar ..... in their outer most shell.

11. The alkaline earth metal with the smallest atomic number is .....

12. A,B & C are the elements of the Döbereiner's triads. If the atomic mass of A is 7 and that of B is 23, then the atomic mass of 'C' will be …….

13. When Mendeleev made the periodic table the number of elements discovered till then were .....

14. Among alkali metal …….. has the smallest atomic radius.

15. Among halogens…….. has the smallest atomic radius.

16. The amount of energy released when a neutral gaseous atom gains one electron is called……

17. The energy required to remove an electron from an isolated gaseous atom is called…….

18. Non-metallic character …….. from left to right in a period.

19. Metallic character …….. down a group.

20. Ionisation energy …… down a group and …….. along a period.

21. Atomic size …….. form left to right in a period.

GIVE THE ANSWER FOLLOWING QUESTIONS:-

1. Why did Mendeleev leave some gaps in the periodic table of element? Give you answer with examples.

2. Explain why the properties of the 8th element are repeated in case of elements arranged in 2nd and 3rd period of the long from of the periodic table.

3. Where in period 3 of the modern periodic table do we fine:
   (a) non-metals (b) elements forming negative ions
   (c) elements with high melting points (d) elements forming positive ions
   (e) metals
   (f) elements with low boiling points?
   Mention their atomic number only.

4. If you look at the long of periodic table, you will find that the elements Li, B, C, N, O, F and Ne are present in the second period. Write down their electronic configurations.

5. Examine elements of the third period and classify them as metals and non-metals.

6. Nitrogen (atomic number 7) and phosphorus (atomic number 15) belong to Group 15 of periodic table. Write the electronic configuration of these elements. Which of these will be more electronegative? Why?

7. How could the modern Periodic Table remove various anomalies of Mendeleev's Periodic Table?

8. Name two element you would expect to show chemical reactions similar to magnesium. What is the basis for your choice?

9. Name

(a) Three elements that have a single electron in their outermost shells.

(b) Two elements that have two electrons in their outermost shells.

(c) Three elements with filled outermost shells.

10. (a) Lithium, sodium, potassium are all metal that react with water to liberate hydrogen gas is thre any similarity in the atoms of these atoms.

11. In the Modern Periodic Table, which are the metals among the first ten elements?

12. By considering their position in the periodic table, which one of the following elements would you expect to have maximum metallic characteristic.

Ga Ge As Se Be

13. Which of the following statements is not a correct statement about the trends when going from left to right across the periods of periodic table?

(a) The elements become less metallic in nature.

(b) The number of valence electrons increases

(c) The atoms lose their electrons more easily

(d) The oxides become more acidic

14. Element X forms a chloride with the formula XCl_2, which is a solid with a high melting point X would most likely be in the same group of the periodic table

15. (a) What property do all elements in the same column of the periodic table as boron have in common?

(b) What property do all elements in the same column of the periodic table as fluorine have in common?

16. An atom has electronic configuration 2.8.7

(a) What is the atomic number of this element?

(b) To which of the following elements would it be chemically similar? (Atomic number are given in parentheses)

N(7) F(9) P(15) Ar(18)

17. The position of three elements A, B and C in the periodic table are shown below:

Group 16	**Group 17**
-	-
-	A
-	-
B	C

(a) Nitrogen whether A is a metal or non-metal

(b) State whether C is more reactive or less reactive than A.

(c) Will C is larger or smaller in size than B?

(d) Which type of ion, cation or anion, will be formed by element A

18. How does the electronic configuration of an atom relate to its positions in the Modern Periodic Table?

19. In the Modern Periodic Table, calcium (atomic number 20) is surrounded by elements with atomic numbers 12, 19 21 and 38. Which of these have physical and chemical properties resembling calcium?

20. Compare and contrast the arrangement of element in Mendeleev periodic table and the Modern Periodic Table.

PERIODIC CLASSIFICATION OF ELEMENTS | **ANSWER KEY** | **EXERCISE**

- ***Objective type quesitons***

1. D **2. A** **3. A** **4. D** **5. C** **6. A** **7. B** **8. A** **9. C** **10. D**

11. B **12. A** **13. C** **14. B** **15. A** **16. B**

- ***Fill in the blanks***

1. Periods **2.Groups** **3. 2** **4. 13** **5. Increases, decreases**

6. Smaller **7. Larger** **8. B_2O_3** **9. Properties** **10. electrons**

11. 4 **12. 15** **13. 63 elements** **14. Li**

15. F **16. Electron affinity** **17. Ionisation energy** **18. Increases**

19. Increases **20. Decreases, Increases** **21. Decreases**