CHEMISTRY

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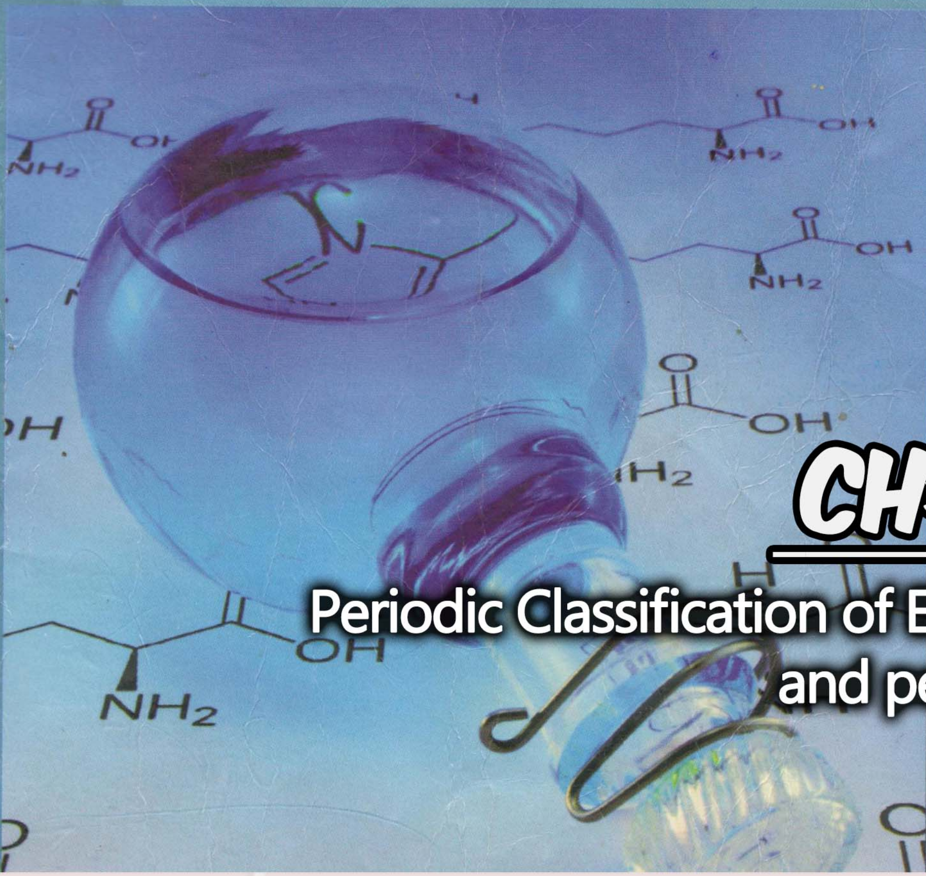


CH#1

Periodic Classification of Elements and periodicty

These Notes Have been Prepared and Developed By

ADNAN SHAFIQUE

Chapter 1

PERIODIC CLASSIFICATION OF ELEMENTS AND PERIODICITY

Introduction:- We know that 110 elements have been discovered so far. A table in which similar elements are placed in same group is called periodic table. Periodic table is the most significant achievement in the field of chemistry. It serves the students to know the properties of elements in a systematic way. It is the basic framework to study the periodic variations in physical and chemical behaviour of elements or their compounds.

Historical Background (تاریخی پس منظر)

Many chemists have been working for the periodic classification of elements. In this field the names of **Al-Razi** (الرازی), **Dobereiner**, **Newland**, and **Mendeleev (Mendelejeff)** are very important.

(i) Al-Razi :- Al-Razi was a great muslim chemist. He classified the elements on the basis of their physical and chemical properties. His work proved as a basic tool (آلہ - اوزار) for his followers.

(ii) **Dobereiner** was a German Chemist. In 1829 he arranged the similar elements into the groups of three three. These groups are called **Triads**.
e.g $Li - Na - K$, $Cl - Br - I$
In a triad the atomic mass of the central element is the arithmetical mean اوسط of the other two. It is called **Law of Triads**.
e.g Atomic mass of $Na = \frac{7 + 39}{2} = 23$ amu.
The law of triads is not applicable for all known elements.

(iii) **Newland** was an English chemist.
In 1864, Newland arranged the elements in the increasing order of their atomic masses. He gave a law called "**Law of Octaves**"
This law states, "If elements are arranged in the increasing order of their atomic masses, then properties of every eighth element are similar to the first one". e.g Li is similar to Na, Be is similar to Mg and Boron is similar to Aluminium. The law of octaves is not valid for all elements.

(iv) **Mendeleev** was a Russian Chemist. He classified the elements in a systematic way. He presented (gave) the first regular periodic table of elements. In Mendeleev's

Periodic table there were eight groups and twelve periods. The vertical Column of elements are Called groups. The horizontal rows (افقی قطاریں) of elements in Periodic table are Called Periods. Mendeleev's Periodic table is based upon a law Called **Periodic Law**. This law states, "If elements are arranged in ascending (increasing) order of their atomic masses, their Chemical properties repeat in a periodic manner (دوری طور پر). Mendeleev's table Provides a base for modern classification of elements. Although it has some Confusions (defects)

Defects of Mendeleev's Table:-

(i) Mendeleev's table does not explain structure of atoms

(ii) It does not clear the Position of isotopes.

(iii) In this table Position of K, Ar and Ni, Co is against the Periodic law.

(iv) In Mendeleev's table many Positions were vacant. These Positions were for unknown elements. e.g Germanium (Ge), Gallium (Ga).

(v) Zn, Cd, Hg and alkaline earth metals have very different Properties. They are placed in same group. It is against the Periodic law

(vi) In this table the Position of Lanthanides and Actinides is against the Periodic law

Improvement in Mendeleev's Periodic Table (Modern Periodic Law)

In 1913, Mosley discovered atomic number. After the discovery of atomic number the Periodic table was improved. This improvement is based upon Modern Periodic Law. This law states, "If the elements are arranged in ascending order of their atomic numbers, their Chemical Properties repeat in a Periodic manner."

By modern periodic law, Confusions (defects) in Mendeleev's table are removed.

(i) Because all the isotopes of an element have Same atomic number. So they have only one Position in Periodic table.

(ii) The position of misfit Pairs (K, Ar and Ni, Co) has been Corrected

(iii) An extra group (group VIII) for noble gases has been introduced.

(iv) The Position of Zn, Cd, Hg and alkaline earth metals has been corrected by introducing two types of Subgroups A and B. The alkaline earth metals are placed in group II A and Zn, Cd, Hg are placed in group II B

The Modern Periodic Table

The modern Periodic table is based upon modern Periodic law. This law states, "If elements are arranged in ascending order of their atomic number, their Chemical Properties repeat in a periodic manner". In modern Periodic table all elements are arranged in ascending order of their atomic number. Some essential features of moder Periodic table are given below.

1:- **Groups**:- The vertical columns of elements in Periodic table are called groups. There are eight groups. They are represented by Roman numbers I to VIII. Each group is divided into two Sub-groups A and B. The Sub-group A contains typical or normal elements. The Sub-group B contains transition elements. The elements of a group have similar properties.

2:- **Periods**:- The horizontal rows of elements in Periodic table are called Periods. There are seven Periods. They are represented by Arabic numbers 1 to 7.

1st Period:- First Period contains two elements. They are Hydrogen and Helium. It is the Shortest Period.

2nd and 3rd Periods:- Second and third Periods contain eight elements each. They are called Short

Periods. The elements of these Periods are normal (representative) elements and belong to A-subgroups. In these Periods the Properties of every eighth element are similar to the first element. For example Lithium of 2nd Period is Similar to Sodium of third Period Similarly Boron and Aluminium both show oxidation State of +3. Similarly fluorine of 2nd Period is Similar to Chlorine of third Period

4th and 5th Periods:- The 4th and 5th Periods Contain eighteen elements each. They are called long Periods. There are eight representative elements, and ten transition elements in these Periods. In these Periods Properties repeat after 18 elements. For example $_{19}K$ is Similar to $_{37}Rb$

6th Period:- The 6th Period contains 32 elements It is first very long Period. It contains 8 normal elements, 10 transition and 14 inner transition elements A new set of fourteen elements which start after $_{57}La$ are called Lanthanides. All the Lanthanides have Similar Properties. They are Placed at the bottom of Periodic table. The Lanthanides are also called inner transition elements.

7th Period:- The 7th Period is the last Period in Periodic table. It is incomplete so far. It is second very long Period. It contains two normal elements ($_{87}Fr$ and $_{88}Ra$), 10 transition

Francium

and 14 inner transition elements. A set of fourteen elements which follow $_{89}Ac$ are called Actinides. They are placed at the bottom of Periodic table under the Lanthanides.

Rare earth elements:- All Lanthanides and actindes are called inner transition elements. Due to their Scarcity (rareness قلت) they are called rare earth elements.

(3) Some more families in Periodic Table

Some normal elements of sub-groups-A are given their family names. For example, the elements of group I-A are called alkali metals because they form strong alkalies with water

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

The elements of group II A are called alkaline earth metals. The elements of group VIIA are called Halogens (Salt forming elements)

The elements of group VIII A are called Noble gases (Least reactive or Zero group elements

(4) Blocks in the Periodic Table

[illegible] the table [illegible] four [illegible] (s block, p-block, d-block [illegible] block. The elements of groups IA and IIA are called s-block elements because their valence electrons are present in s-orbital. The elements of group III A to VIII A are called p-block elements because their valence electrons are present in p-orbital. The <u>transition elements</u> are called <u>d-block</u> elements because their valence electrons are present in d-orbital. The <u>Lanthanides and Actinides</u> (Inner transition elements) are called **<u>f-block elements</u>** because their valence electrons are present in f-orbital.

5:- Metals, Non-metals and Metalloids

The elements which have tendency to lose electrons and form positive ions are called **metals**. They are good conductor of heat and electricity. They form basic oxides, which give bases when dissolved in water. The elements which have tendency to gain electrons and form negative ions are called **non-metals**. They are poor conductor of heat and electricity. They form acidic oxides which give acids when dissolved in water.

$$SO_3 + H_2O \longrightarrow H_2SO_4 \text{ (acid)}$$

$$Na_2O + H_2O \longrightarrow 2NaOH \text{ (base)}$$

The elements which have properties of metals as well as non metals are called Metalloids or Semi-metals. They form amphoteric oxides. The oxides which have both acidic and basic

Properties are called amphoteric oxides. In the Periodic table lower members of groups IIIA to VA are metalloids (Si, As, Te). The elements on the top right corner of Periodic table are non-metals. All the gases in Periodic table are non-metals. All the elements on left hand side, in the centre and at the bottom of Periodic table are metals.

MODERN PERIODIC TABLE OF THE ELEMENTS

← New Proposal of IUPAC →
← Old proposal of IUPAC →

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
IA	IIA	IIIB	IVB	VB	VIB	VIIB		VIIIB		IB	IIB	IIIA	IVA	VA	VIA	VIIB	0 or VIIIA
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 *La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 +Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt									

s-block ←→ d-block ←→ p-block ←→

*LANTHANIDE SERIES:	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
+ ACTINIDE SERIES:	90 Th	91 Pa	92 U	93 NP	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

← f-block →

Periodic Trends in Physical Properties

The cyclic changes in properties of elements after regular interval in atomic number are called Periodic trends. It is also called Periodicity of Properties. e.g Atomic Size, Ionization energy.

(1) Atomic Size → metallic character

(a) Atomic Radius:-

The average distance between the nucleus of an atom and its outermost shell is called atomic radius.

e.g atomic radius of Na = 157 pm

Cl = 99 pm . H = 37 pm

metallic character

Atomic radii in a group:- The atomic radius increases from top to bottom of a group. It is due to increase in atomic number and addition of extra shells of electrons. In this way force of attraction between nucleus and outermost electron decreases Thus atomic radii increase from top to bottom of a Group

Atomic radii in a Period:- The atomic radius decreases from left to right of a Period. The reason is that no extra shell of electrons is added but Positive charge in the nucleus goes on increasing. Thus force of attraction between nucleus and outermost electron increases. Hence atomic radii decrease from left to right of a Period. This effect is significant for the elements of longer Periods which involve d or f orbitals. For example there is a gradual reduction (کمی) in atomic size of **Lanthanides**. It is called **Lanthanide Contraction**

(b) Ionic Radius

The average distance between nucleus of an ion and its outermost shell is called ionic radius.

e.g ionic radius of Na^+ is 95 Pm

$Cl^- = 181$ Pm , $F^- = 136$ Pm

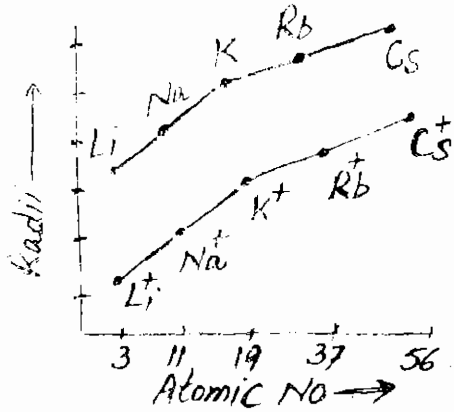
Cationic radius :- Positive ion (Cation) is formed by removal of one or more electrons. It may result in the loss of outermost shell. Moreover force of attraction between nucleus and remaining electrons increases Hence Positive ion is smaller than the neutral atom. e.g $Na = 157$ Pm , $Na^+ = 95$ Pm

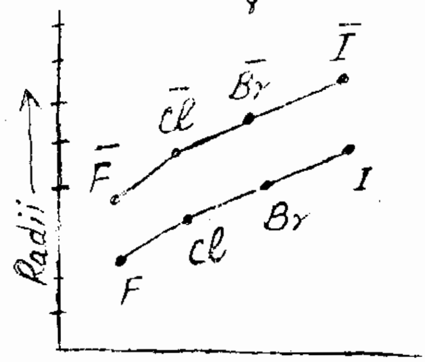
Anionic radius:- Negative ion (anion) is formed by addition of one or more electrons. Thus attraction between nucleus and electrons decreases. Therefore electronic cloud expands. Hence negative ion is always bigger than its parent atom.

e.g $F = 72$ Pm , $F^- = 136$ Pm

$Cl = 99$ Pm , $Cl^- = 181$ Pm

Ionic Radii in a group:- The size of Positive ions increases from top to bottom of a group. Similarly the size of negative ions increases from top to bottom of a group. The atomic and ionic radii for alkali metals and halogens are shown in graphs.





Ionic Radii in a Period:-
The size of isoelectronic Positive ions decrease from left to right of a Period. It is due to increasing nuclear charge. In the same way the size of isoelectronic negative ions increases from left to right of a Period. It is due to the increasing electronic charge.

Isoelectronic Ions:- The ions which have same number of electrons are called isoelectronic ions e.g $Na^{+1}, Mg^{+2}, Al^{+3}$ are isoelectronic ions having ten electrons.

(2) **Ionization Energy:-** The minimum amount of energy required to remove the most loosely bound electron from gaseous atom is called ionization energy. For example,

gaseous state

$$Na_{(g)} \longrightarrow Na^{+}_{(g)} + \bar{e}, \; \Delta H = 513 \, Kj \, mol^{-1}$$

$$Mg_{(g)} \longrightarrow Mg^{+} + \bar{e}, \; \Delta H = 738 \, Kj \, mol^{-1}$$

The amount of energy required to remove an electron after the removal of first electron is called Second ionization energy. e.g

$$Mg^{+} \longrightarrow Mg^{++} + \bar{e}, \; \Delta H = 1451 \, Kj \, mol^{-1}$$

Factors affecting Ionization energy:-

Ionization energy depends upon following factors.

(i) Nuclear Charge
(ii) Size of atom
(iii) Shielding effect of inner electrons.

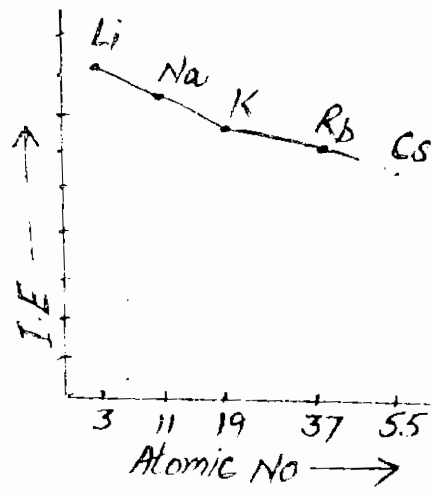
I.E in a group:- The ionization energy decreases from top to bottom of a group. The reason is that from top to bottom of a group nuclear charge (atomic number) goes on increasing.

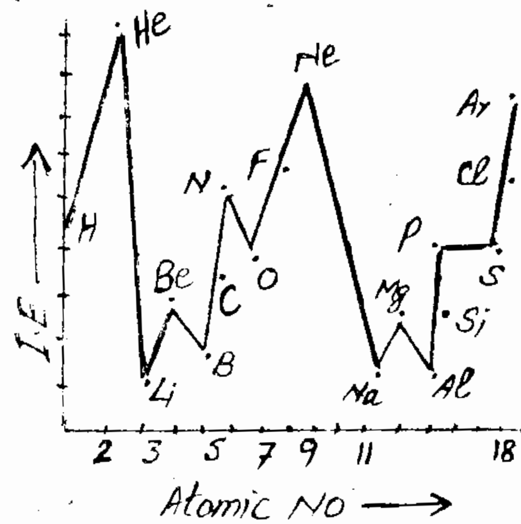
Moreover extra shells are added successively and shielding effect of inner electrons increases. Thus distance between nucleus and outermost electron increases. So force of attraction between nucleus and outermost electron decreases. Hence I.E decreases from top to bottom of a group.

Ionization energy in a Period:-

The ionization energy increases from left to right of a period. The reason is that atomic number increases one by one but outer shell remains the same. So attraction between nucleus and outermost electron increases. Hence I.E increases from left to right of a period.

The variation of I.E in a group and period is shown by following graphs.





From R.H.S graph it is clear that inert gases (He, Ne, Ar etc) have the highest I.E values. The reason is that inert gases have their complete outermost shell. It is very difficult to remove an electron from a completely filled shell.

(3) Electron Affinity

The amount of energy released or absorbed when an electron is added to a gaseous atom to form a negative ion is called electron affinity.

e.g $F + \bar{e} \longrightarrow \bar{F}$, $\Delta H = -337\ KJ\ mol^{-1}$

$O + \bar{e} \longrightarrow \bar{O}$, $\Delta H = -141\ KJ\ mol^{-1}$

When second electron is added to a uni-negative ion then energy is absorbed (جذب ہوتی). It is due to the repulsion between incoming electron and negative charge already present. e.g

$\bar{O} + \bar{e} \longrightarrow \bar{O}^{2}$, $\Delta H = +780\ KJ\ mol^{-1}$

Factors:- The electron affinity depends upon following factors.

(i) Atomic Size
(ii) Nuclear Charge
(iii) Shielding effect of inner electrons
(iv) Vacancies in the outermost shell

Generally, atoms with small size have large value of electron affinity.

E.A in Periodic Table:- The E.A values decrease from top to bottom of a group.

The E.A values increase from left to right of a period.

(4) Metallic Character

The elements which have tendency to lose electrons and form positive ions are called metals.
e.g Li, Na, K, Rb, Cs etc.
The elements which have tendency to gain electrons and form negative ions are called non-metals. e.g N, O, S, P etc.

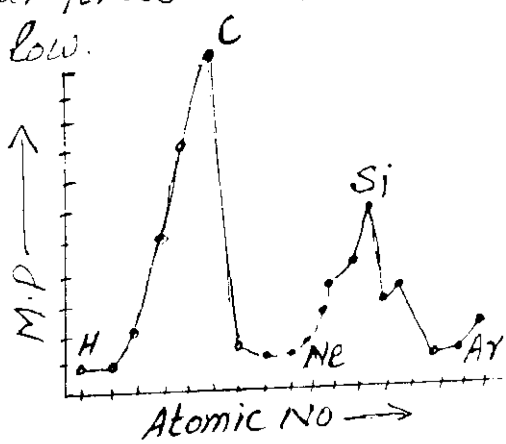
In a group:- The metallic character increases from top to bottom of a group. The non-metallic character decreases from top to bottom of a group. For example, in group VIA (O, S, Se, Te, Po) oxygen and sulphur are non metals and polonium is pure metal. The reason is that atomic size increases from top to bottom of a group and it is easier to remove an electron from an atom of bigger size.

In a Period:- The metallic character decreases and non-metallic character increases from left to right of a period. For example in second period (Li, Be, B, C, N, O, F) Lithium, Beryllium are metals and Carbon, Nitrogen, oxygen and Fluorine are non-metals. The reason is that in a period atomic size decreases from left to right. It is difficult to remove an electron from a smaller size atom.

(5) Melting and Boiling Points

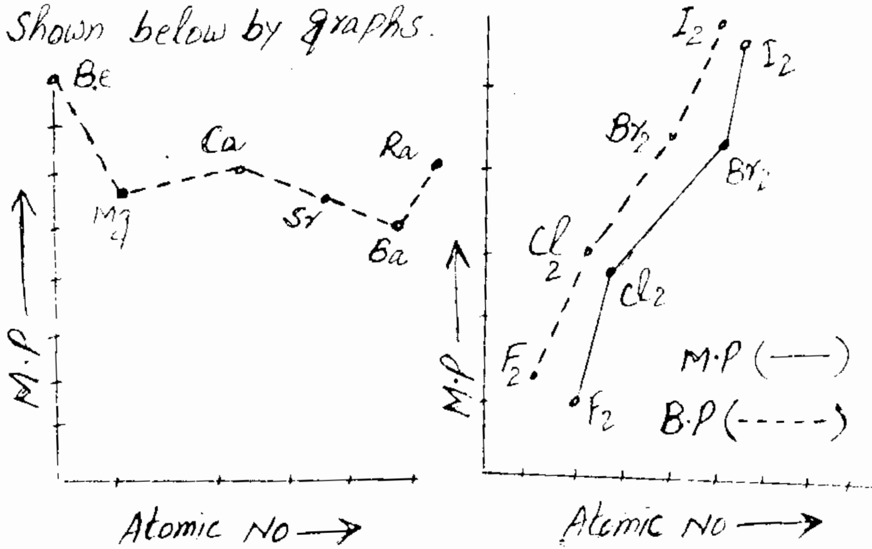
a) Variation in a Period:- The melting and boiling points of elements increase upto the middle of a period and then decrease upto the noble gases. For example in second period M.P and B.P increase upto Carbon and then decrease upto Neon. It depends upon number of valence electrons (binding electrons). Lithium has one valence electron and forms one bond with other atom. Beryllium has two valence electrons and it can form two bonds. Similarly Carbon has four valence electrons and it can form four bonds. So it is bound to four other atoms. Thus Carbon (diamond) has high melting point in second period due to giant covalent structure. The other elements of second period (N, O, F, Ne) are small, covalent molecules. They exist as simple molecules but not three dimensional giant molecules. They have very weak intermolecular forces. Therefore their M.P and B.P are very low.

The variation of melting point for second and third period elements is shown in graph.



(b) Variation in a group:-

The melting and boiling points of elements decrease from top to bottom of a group. The reason is that from top to bottom of a group atomic size increases and interatomic binding forces become weaker. So less heat is required to melt the elements. Hence M.P and B.P of IA and IIA group elements decrease down the group. In case of VIIA group, the elements exist in the form of molecules. Their molecular size increases down the group. So they show higher polarizabilities. Hence their molecules have stronger forces of attraction. Therefore M.P and B.P of group VII elements increase down the group. The variation of M.P and B.P for group IIA and VIIA elements is shown below by graphs.



(6) Oxidation State (Oxidation Number)

The apparent charge positive or negative on an atom in a Compound is called oxidation state. e.g In NaCl, the oxidation state of Na is +1 and that of Cl is −1. The oxidation state of an element in free state is zero. The oxidation states of elements are related to their group number. The oxidation number of group IA, group IIA and group IIIA elements are +1, +2 and +3 respectively. It is equal to the number of valence shell electrons. The oxidation number of group IVA is +2 or +4. The oxidation number of group VA elements is +3 or +5. It is equal to the number of electrons present in outermost shell or the number of vacancies in the outermost shell. The oxidation No of group VI A elements is +6 (number of electrons in outermost orbit) or −2 (number of vacancies in the outermost shell) e.g In H_2SO_4 the oxidation No of Sulphur is +6 and in H_2S it is −2. The oxidation number of group VIIA elements is −1. It is equal to the number of vacancies in outermost shell. The oxidation number of the elements of the group VIIIA (Zero group) is Zero because

(The transition elements show more than one oxidation states due to their partly filled d-orbitals their normal oxidation state is equal to their group number.) e.g Cu (I), Zn (II), V (V), Cr (VI) and Mn (VII)

(7) Electrical Conductance

The Flow of electric current through a substance is called electrical conductance. It is due to

(i) Presence of loose electrons in an element.
(ii) Movement of loose electrons in solid lattice.

The electrical conductance decreases from top to bottom of a group. e.g group IA, IIA. In Periodic table, the Coinage metals (group IB) have very high value of electrical conductance. The non-metals have very low electrical conductance or they are non conductors. e.g the elements of group VIA and VIIA. In transition metals the electrical conductance vary (change) without any general trend. In group IVA, Carbon has dual nature. (Diamond is non-conductor because its four valence electrons are tightly bound which can not move freely. Graphite is a very good conductor because its one valence electron is loosely bound which can move freely. Tin and Lead of group IVA are also good conductors).

(8) Hydration Energy

The amount of energy released or absorbed when one mole of gaseous ions are hydrated is called hydration energy. Its unit is $KJ\,mol^{-1}$.

e.g $H^+_{(g)} + \text{Water} \longrightarrow H^+_{(aq)}$, $\Delta H_{hyd} = -1075\,KJ\,mol^{-1}$

ΔH_{hyd} of Li^+ is $-499\,KJ\,mol^{-1}$, ΔH_{hyd} of Na^+ is $-390\,KJ\,mol^{-1}$. The hydration energy depends upon charge density of ions (Charge/Size). Greater the charge density of an ion, higher will be the hydration energy and vice versa.
For example, ΔH_{hyd} of group IA ions decreases from top to bottom of group. The reason is that charge density decreases from top to bottom of group. The ΔH_{hyd} increases from left to right of a period. The reason is that charge density (charge to size ratio) increases from left to right of a period.

Periodic Relationship in Compounds

(a) Halides:- Binary Compounds of halogens

Types of Halides

There are three types of halides
(i) Ionic halides
(ii) Covalent halides
(iii) Polymeric halides

(i) Ionic halides:- The halides in which halogen is bonded with other element by ionic bond are called ionic halides.

e.g $NaCl$, LiF, AlF_3 etc

Properties:- (i) They are solid compounds
(ii) They have high melting and boiling points
(iii) They have three dimensional ionic lattice.
(iv) Their melting and boiling points decrease in the order
Fluoride > Chloride > Bromide > Iodide
(V) Due to small size, the fluorides have the highest lattice energy

(ii) Covalent Halides:- The halides in which halogen is bonded with other element by covalent bond are called covalent halides.

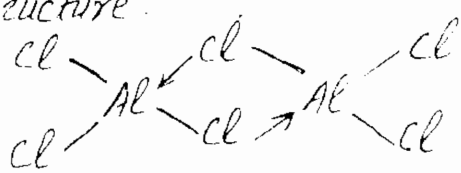
e.g $SiCl_4$, S_2Cl_2, PCl_3 etc.

Properties:- (i) They have low M.P and B.P
(ii) They have weak Vander Waal's forces
(iii) They are gases, liquids or low M.P solids

(v) In covalent halides, the fluorides have high melting and boiling points.

iii) Polymeric Halides:- The halides in which halogen atom acts as a bridge between two atoms of other element are called Polymeric halides.
e.g Al_2Cl_6, Ga_2Cl_6 etc.

Properties:- (i) They form layer or chain lattice.
(ii) They are partly ionic and partly covalent.
(iii) They are used as catalysts in organic reactions.
(iv) Aluminium Chloride is dimeric having bridge like structure



Bonding Character of Halides in a Period

From left to right of a Period, the ionic character of halides decreases and their covalent character increases. The reason is that E.N difference is decreasing from left to right of a Period.
For example, in 3rd Period NaCl is pure ionic, $MgCl_2$, $AlCl_3$ are partly ionic and other Chlorides ($SiCl_4$, PCl_3, S_2Cl_2) are Polar Covalent.
The M.P and B.P of halides also decrease from left to right of the Period.

Bonding Character of halides in a group

When we go from top to bottom of a group, the ionic character of halides decreases and their covalent character increases. e.g AlF_3 is pure ionic, $AlCl_3$ and $AlBr_3$ are partly ionic but AlI_3 is mainly (85%) covalent. Moreover ionic character of halides is in the following order

Fluoride > Chloride > Bromide > Iodide

Metal halides in different Oxidation States

Some metals can form more than one halides. e.g $PbCl_2$, $PbCl_4$, $SnCl_2$ and $SnCl_4$

The metal halides with low oxidation state are mainly ionic and those with high oxidation state are mainly covalent. e.g $PbCl_2$, $SnCl_2$ are ionic and $PbCl_4$, $SnCl_4$ are covalent. It is due to high polarizing power of Pb^{+4}, Sn^{+4} ions than Pb^{+2} and Sn^{+2} ions.

(b) Hydrides

The binary compounds of hydrogen with other elements are called hydrides. e.g NaH, H_2O etc.

There are three types of hydrides:

(i) Ionic hydrides (ii) Covalent hydrides
(iii) Intermediate hydrides.

(i) **Ionic Hydrides:-** The hydrides in which hydrogen is bonded with other element by ionic bond are called ionic hydrides e.g NaH, CaH_2, BaH_2 etc

Properties:- (i) They are crystalline solids

(ii) They have high melting and boiling points.

(iii) They conduct electricity in molten state

(iv) They react with water and produce H_2

$$NaH + H_2O \longrightarrow NaOH + H_2$$

(V) Their ionic character decreases from left to right in periodic table.

(ii) **Covalent Hydrides:-** The hydrides in which hydrogen is bonded with other element by covalent bond are called covalent hydrides. e.g H_2O; NH_3

Properties:- (i) They are usually gases or liquids.

(ii) They have low melting and boiling points.

(iii) They are non-conductor of electricity.

(iv) They are soluble in organic solvents. e.g alcohol

(V) They are formed by elements of group IIIA to group VIIA.

(VI) Their bond energy depends on the size and electronegativity (E.N) of elements

(VII) Their stability increases from left to right of a period and decreases from top to bottom of a group.

(VIII) Their boiling points decrease down a group

(ix) HF is the most stable hydride

(X) The hydrides of Lead, Bismuth and thallium are the least stable

(XI) The hydrides with high Polarity (H_2O, HF) show intermolecular hydrogen bonding

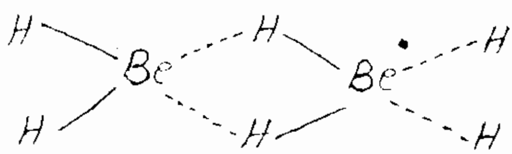
(iii) Intermediate Hydrides

The hydrides of Be, Mg, Zn and Cd are called intermediate hydrides. OR the hydrides whose properties are in between the ionic and covalent hydrides are called intermediate hydrides. e.g BeH_2, MgH_2, ZnH_2 etc.

Properties:- (i) They are white solids

(ii) They are insoluble in organic solvents

(iii) They have polymeric structures. e.g



(C) Oxides (آکسائیڈز)

The binary compounds of oxygen with other elements are called oxides. e.g Na_2O, SO_2.

There are four classes of oxides

(i) Normal oxides (ii) Peroxides

(ii) Superoxides (iv) Suboxides

Here we explain only normal oxides.

Normal Oxides

The oxides in which oxidation state of oxygen is −2 are called normal oxides. e.g Na_2O, CaO

There are three types of normal oxides.
(i) Acidic Oxide (ii) Basic Oxide (iii) Amphoteric Oxides

(i) **Acidic Oxides:-** The oxides of non-metallic elements are called acidic oxides. e.g CO_2, SO_3. They dissolve in water and produce acidic solution

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

$$CO_2 + H_2O \longrightarrow H_2CO_3 \text{ (Carbonic acid)}$$

(ii) **Basic Oxides:-** The oxides of alkali and alkaline earth metals are called basic oxides.

e.g Na_2O, CaO

They dissolve in water and produce basic solution. $Na_2O + H_2O \longrightarrow 2NaOH$

The basic oxide contain oxide ion (O^{-2}) which can not exist alone (freely) in aqueous solution. Therefore it takes up proton from water and forms OH^- ion.

$$O^{-2} + H_2O \longrightarrow 2OH^-$$

Basic and acidic oxides react together and form salt. e.g

$$\underset{\text{(Basic)}}{Na_2O} + \underset{\text{(acidic)}}{SO_3} \longrightarrow Na_2SO_4$$

(iii) **Amphoteric Oxide:-** The oxides which show both acidic and basic properties are called amphoteric oxides. e.g ZnO, Al_2O_3, Bi_2O_3

The oxides of less electropositive elements are usually amphoteric. They can react with strong acids and strong bases. e.g

$$ZnO + H_2SO_4 \longrightarrow ZnSO_4 + H_2O$$

$$ZnO + 2NaOH + H_2O \longrightarrow Na_2Zn(OH)_4$$

(Sodium Zincate)

Acidic and Basic Character in Periodic Table

In a Period:- When we go from left to right in a period, the basic character decreases and acidic character increases. It changes from strong basic through weak basic, amphoteric, weak acidic to strong acidic character. e.g oxides of 3rd period Na_2O, MgO, Al_2O_3, P_4O_{10}, SO_3, Cl_2O_7

In a group:- From top to bottom of a group, the basic character of oxides increases. e.g

$$BeO < MgO < CaO < SrO < BaO$$

Acidity and Oxidation State:- The oxidation state of metal affects acid/base character. The acidity increases with increasing oxidation state. e.g the acidity of $MnO < Mn_2O_3 < MnO_2 < Mn_2O_7$

Examples
- Polymeric Halides ⇒ ...
- intermediate Hydrides ⇒ BeH_2, MgH_2, ZnH_2
- Amphoteric Oxide ⇒ ZnO, Al_2O_3, Bi_2O_3

The Position of Hydrogen

The Position of hydrogen in Periodic table is not fix. It can be placed in IA, IVA and VIIA groups of Periodic table. We can justify it by Comparing hydrogen with elements of these groups.

Hydrogen in Group IA

a) Points in favour:-

(i) Like alkali metals hydrogen has one valence electron

(ii) Like alkali metals hydrogen forms monopositive ion (H^+, M^+)

(iii) Like alkali metals hydrogen has valence electron in S-orbital.

(iv) Like alkali metals hydrogen combines with halogens to form halides.

(v) Like alkali metals hydrogen forms ionic Compounds which dissociate in water.

(vi) Like alkali metals hydrogen deposits on Cathode during electrolysis (برق پاشیدگی)

b) Points not in favour:-

(i) Hydrogen is gas but alkali metals are Solids.

(ii) Hydrogen is non-metal but alkali metals are typical metals

(iii) Hydrogen does not lose electron as easily as the alkali metals do.

(iv) Hydrogen forms diatomic molecules (H_2) and alkali metals do not.

Hydrogen in Group IVA

(a) Points in favour:-

(i) Like group IV elements, hydrogen has half filled its valence shell.

(ii) Like group IV elements, hydrogen forms covalent bonds with other elements

(iii) Like Carbon, hydrogen also acts as reducing agent.

$$CuO + H_2 \longrightarrow Cu + H_2O$$

$$SnO_2 + C \longrightarrow Sn + CO_2$$

(iv) Both hydrogen and Carbon have close relation in organic Compounds.

(v) Thermodynamic Properties (I.E, E.A) of Hydrogen and group IV elements are similar.

(b) Points not in favour:-

(i) Hydrogen is a gas but group IV elements are solids.

(ii) Carbon forms long chain compounds (catenation) but hydrogen does not form such compounds

(iii) Carbon can form four bonds at a time but hydrogen can form only one bond at a time.

Hydrogen in Group VII

(a) Points in favour:-

(i) Hydrogen is a gas like halogens (F, Cl)

(ii) Hydrogen like halogens form diatomic molecules. (H_2, F_2, Cl_2 etc)

(iii) Hydrogen like halogens needs one electron to complete its valence shell.

(iv) Hydrogen like halogens form uni-negative ion by accepting one electron (H^-, F^-, Cl^-, Br^-)

(V) Both Hydrogen and halogens form ionic compounds with alkali metals. e.g NaH, $NaCl$

(b) Points not in favour:-

(i) Hydrogen has one electron but halogens have seven electrons in their valence shells.

(ii) Hydrogen forms H^+ by losing its only electron but halogens do not form positive ions

(iii) Hydrogen forms stable oxides but halogens lack this property.

(iv) Halide ion is stable in aqueous solution but Hydride ion immediately reacts with water as

$$H^- + H_2O \longrightarrow OH^- + H_2$$

From above discussion it is clear that properties of hydrogen donot match exactly with any of the groups. However being a unique element, hydrogen is placed at the top of group IA

EXERCISE

Q1. Fill in the Blanks.

(i) Mendeleev, in his periodic table, arranged the elements according to their atomic ______.

(ii) Vertical columns in modern periodic table are called ______ and horizontal rows are called ______.

(iii) Members of group VIIA are called ______ and "alkali metals" is the family name of IA group members.

(iv) Metals form ______ oxides and non-metals form ______ oxides.

(v) Hydrogen can be placed above the groups ______ of the periodic table.

(vi) Shielding effect is actually the ______ due to electrons in between the nucleus and the outermost shell.

(vii) Noble gases have the ______ values of ionization energy due to complete outermost shell.

(viii) When a second electron is added to a uni-negative ion, the incoming electron is ______ by the already present negative charge.

(ix) Due to having partly filled orbitals ______ metals usually show variable valency.

(x) Melting and boiling points of halogens Increase down the group.

ANSWER

(i)	Atomic Weight	(ii)	Groups, Periods
(iii)	Halogens, IA	(iv)	Basic, Acidic
(v)	IA, IVA & VIIA	(vi)	Repulsion
(vii)	Highest	(viii)	Repelled
(ix)	Transition	(x)	Increase

Q2. Indicate True or False

(i) In Mendeleeve's table elements Be, Mg, Zn and Cd are placed in the same group.

(ii) The second and third periods contain eighteen elements each.

(iii) Alkaline earth metals are present in Group IIA.

(iv) Metals are present in the top right corner of the Periodic table.

(v) Metalloids are present in the lower half of Groups IVA, VA and VIA.

(vi) Hydrogen forms uni-negative ion like halogens.

(vii) Oxidation state of an element is related to the number of period it belongs.

(viii) Diamond is a good conductor of electricity.

(ix) Melting points of halogens decrease down the group.

(x) Zinc oxide is an example of amphoteric oxide.

ANSWER

(i)	True	(ii)	False	(iii)	True
(iv)	False	(v)	False	(vi)	True
(vii)	False	(viii)	False	(ix)	False
		(x)	True		

Q3. Multiple Choice questions. Encircle the correct answer.

(i) Keeping in view the size of atoms, which order is the correct one.

(a) Mg > Sr (b) Ba > Mg

(c) Lu > Ce (d) Cl > I

(b) Melting points of halogens increase down the group.

(c) Melting points of halogens remain the same throughout the group.

(d) Melting points of halogens first increase and then decrease down the group.

(x) Mark the correct statement.

(a) Covalent character of metal halides increases from left to right in a period.

(b) Boiling points of Group IVA hydrides decrease down the group.

(c) Ionic character of hydrides increases from left to right in a period.

(d) The basicity of group IIA oxides decreases on descending the group.

ANSWER

(i)	b	(ii)	a	(iii)	c
(iv)	d	(v)	a	(vi)	b
(vii)	d	(viii)	b	(ix)	b
		(x)	a		

Q4. What are the improvements made in the Mendeleeve periodic Table?

Ans. See on Page No. 4, 5

(I) atom [illegible] (E)
(II) (E) [illegible] required to fill the [illegible]
(III) Magnitude of E [illegible] I.E.

Q5. How the classification of elements in different blocks helps in understanding their chemistry?

Ans. All the elements in Periodic table are divided into four blocks. They are s-block p-block, d-block and f-block. This division of elements is based upon the orbitals occupied by the valency electrons. The valency electrons have great importance for chemical properties of elements. e.g s-block elements (IA, IIA groups) are the most reactive in Periodic Table.

Q6. How do you justify the position of hydrogen at the top of various groups?

Ans. See on Page No. 10, 11, 12

Q7. Why the ionic radii of negative ions are larger than the size of their parent atoms?

Ans. See on Page No. 14

Q8. Why ionization energy decreases down the group and increases along a period?

Ans. See on Page No. 16, 17

Q9. Why the second value of electron affinity of an element is usually shown with a positive sign?

Ans. See on Page No. 18

Q10. Why metallic character increases down in a group of metals?

Ans. The metallic Character increases from top to bottom of a group. e.g In group VIA (O, S, Se, Te and Po), oxygen and Sulphur are non-metals and Polonium is pure metal. (The reason is that from top to bottom atomic size increases and tendency of elements to lose electron increases. Hence metallic character increases downward)

Q11. Explain the variation in melting points along the short periods?

Ans. The melting Points of elements increase upto the middle of a Period and then goes on decreasing upto the noble gases. e.g

In second Period m.p increases upto C and then decreases upto Ne. It depends upon number of Valence electrons. Carbon has four valence electrons. It can form four bonds and is bound to four atoms. Thus Carbon (diamond) has giant Covalent structure with very high melting point.

Q12. Why the oxidation state of noble gases is usually zero?

Ans. The noble gases (He, Ne, Ar, Kr, Xe, Rn) have completely filled valence shell. All the electrons are paired. Atoms of noble gase have no tendency to lose or gain electron. It is the reason that noble gases show zero oxidation state usually.

Q13. Why diamond is a non-conductor and graphite is fairly a good conductor?

Ans. Carbon has two allotropes (diamond and graphite). In diamond all four valence electrons are tightly bound in tetrahedral way. So they can not move freely. But in graphite one of the valence electrons is loosely bound which can move freely. It is the reason that diamond is a non-conductor and graphite is a good conductor of electricity.

sp^3-Hybridization
109.5
4-covalent C-C Bond

sp^2-Hybridization
Hexagonal
3-covalent C-C Bond

Q.14. Give brief reason for the following.

a. d and f-Block elements are called transition elements.

The d and f block elements are called transition elements due to following reasons (I) less electropositive than alkali & alkaline metals
(i) They are located between S block and P block elements in Periodic table (II)
(ii) Their Properties are ~~in transition~~ between metallic elements of S-block and non-metallic elements of P-block.

b. Lanthanide contraction controls the atomic sizes of elements of 6th and 7th periods.

omf
From left to right in a Period Proton number increases one by one but no extra shell of electrons is added. So electrons are strongly attracted by nucleus. Therefore atomic size decreases in a Period. This gradual reduction in atomic size is very significant in longer Periods (6th and 7th) It is called Lanthanides Contraction. It controls atomic size of elements in 6th and 7th Periods.

c) The melting and boiling points of the elements increase from left to the right upto the middle of s- and p-block elements and decrease onward.

From left to right in a period the number of valence electrons increases one by one. So middle elements Contain maximum number of Valence electrons. For example Carbon with four valence electrons forms four bonds with other Carbon atoms to give giant structure. It is the reason that M.P and B.P of elements increase upto the middle of Period and decrease onward

d) The oxidation states vary in a period but remain almost constant in a group.

From top to bottom in a group the number of valence electrons remains same. So Oxidation state remains Constant in a group. On other hand the number of valence electrons increases one by one in a Period. It is the reason that oxidation state varies in a Period.

e) The hydration energies of the ions are in the following order:

$Al^{3+} > Mg^{2+} > Na^+$

The hydration energy depends upon charge density of ions. The Na^+ ion has small charge and big size (95 pm). So its charge density (charge/size) is low. The Mg^{+2} ion has high charge density due to high charge and small size (65 pm). The Al^{+3} ion has highest charge density due to highest charge and smallest size (52 pm). Hence hydration energies of the ions are in following order

$$Al^{+3} > Mg^{+2} > Na^+$$

f) Ionic character of halides decreases from left to the right in a period.

The electronegativity difference of elements goes on decreasing from left to right in a period. It is the reason that ionic character of halides decreases from left to right in a period. e.g NaCl is ionic and S_2Cl_2 is covalent

g) Alkali metals give ionic hydrides.

Alkali metals have very low ionization energy. So they easily transfer their one valence electron to hydrogen atom. In this way alkali metal positive ion (M^+) and hydrogen negative ion (H^-) are formed. It is the reason that alkali metals give ionic hydrides. e.g Na^+H^-

h) Although both sodium and phosphorus are present in the same period of the periodic table yet their oxides are different in nature, Na_2O is basic while P_2O_5 is acidic in character.

From left to right in a period, basic character decreases and acidic character increases. It is the reason that Na_2O is basic and P_2O_5 is acidic in character.

$$Na_2O + H_2O \longrightarrow 2NaOH$$

$$P_2O_5 + 3H_2O \longrightarrow 2H_3PO_4 \text{ (Phosphoric acid)}$$

گلدستہ ڈاٹ پی کے کی جانب سے خوش آمدید

السلام علیکم ورحمتہ اللہ وبرکاتہ

مختصر تعارف

کافی عرصہ سے خواہش تھی کہ ایک ایسی ویب سائٹ بناؤں جس پر طالب العلموں کیلئے کچھ تعلیمی مواد جمع کر سکوں۔ اللہ تعالیٰ نے توفیق دی اور میں نے ایک سال کی محنت کے بعد ایک سائٹ "گلدستہ ڈاٹ پی کے" کے نام سے بنائی جو کہ قرآن و حدیث، اصلاحی، دلچسپ، تاریخی قصے واقعات، اُردو انگلش تحریریں، شاعری و اقوالِ زریں، F.Sc اور B.Sc کے مضامین کے آن لائن نوٹس، اسلامک، تفریحی، معلوماتی وال پیپرز، حمد و نعت، فرقہ واریت سے پاک اسلامی بیانات، پنجابی نظمیں و ترانے اور کمپیوٹر و انٹرنیٹ کی دنیا کے بارے میں ٹپس، آن لائن کمائی کرنے کے مستند طریقہ کار۔ کے ساتھ ساتھ اور بھی بہت سی چیزوں پر مشتمل ہے۔ اور انشاء اللہ میں مزید وقت کے ساتھ ساتھ اضافہ کرتا جاؤں گا۔ آپ کی قیمتی رائے کی ضرورت ہے۔ عدنان شفیق

اہم نوٹ

ذیل میں جو نوٹس مہیا کیے گئے ہیں وہ کئی گھنٹوں کی لگاتار محنت کے مرتب ہوئے ہیں۔ اور آپ کو بالکل مفت مہیا کر رہے کیے جا رہے ہیں۔ آپ سے ان کی قیمت صرف اتنی سی متوقع ہے کہ ایک بار درودِ ابراھیمی اپنی زبان سے ادا کر دیں۔

درود شریف

بسم اللہ الرحمٰن الرحیم

اَللّٰھُمَّ صَلِّ عَلٰی مُحَمَّدٍ وَّعَلٰی اٰلِ مُحَمَّدٍ کَمَا

اے اللہ! رحمت بھیج حضرت محمدؐ پر اور حضرت محمدؐ کی آل پر

صَلَّیْتَ عَلٰی اِبْرَاھِیْمَ وَعَلٰی اٰلِ اِبْرَاھِیْمَ

جس طرح تو نے رحمت بھیجی حضرت ابراھیمؑ پر اور حضرت ابراھیمؑ کی آل پر

اِنَّکَ حَمِیْدٌ مَّجِیْدٌ ۝

بے شک تو تعریف کیا گیا بزرگ ہے

اَللّٰھُمَّ بَارِکْ عَلٰی مُحَمَّدٍ وَّعَلٰی اٰلِ مُحَمَّدٍ کَمَا

اے اللہ! برکت دے حضرت محمدؐ کو اور حضرت محمدؐ کی آل کو جس

بَارَکْتَ عَلٰی اِبْرَاھِیْمَ وَعَلٰی اٰلِ اِبْرَاھِیْمَ

طرح برکت دی تو نے حضرت ابراھیمؑ کو اور حضرت ابراھیمؑ کی آل کو

اِنَّکَ حَمِیْدٌ مَّجِیْدٌ ۝

بے شک تو تعریف کیا گیا بزرگ ہے